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THE USE OF HEURISTIC METHODS IN THE APPLICATION OF DESIGN ANTINOMIES IN THE FOOD INDUSTRIES

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Abstract:

This article presents the use of ergonomic analysis methods to propose improvements to a cutting machine that is part of the kitchen equipment. The first part presents a review of the literature related to similar solutions (including patent analysis), then the REBA, QEC, Strain Index and Nasa TLX methods were used based on the example. The results were used to propose improvements to the workplace, consisting in its reorganization and technical retrofitting of the device. The result of the research was confirmation that the use of heuristic methods is conducive to the ergonomic design of workstations, an example of which is the presented solution that meets user requirements and has the features of novelty in comparison with solutions developed by other authors.

Keywords:

ergonomic design, safety improvement, accident prevention, human centred design

Introduction

Many people do not realize that kitchen is the second room in the house which is the most dangerous and is used every day by everyone and that is why the awareness of possible accidents [1]. These accidents are often caused by not enough ergonomic quality of workstations. This may be due to both the design of the tools used and the limited space resulting in a lack of space for the employee to move freely [2]. Work in the kitchen in those conditions can lead to musculoskeletal disorders in the parts of body such as: hand, wrist, elbow, shoulder and neck as well. Those afflictions can conduce to chronic diseases. The reasons of those problems are: often and long standing in uncomfortable position, rapid movements, incompatibility of machine dimensions with human parameters, overload of body due to abnormal body posture [3]. Many of these hazards also occur when working in the kitchen, where ergonomic assessments of the positions are rarely made (especially in small enterprises or at home). The improvements of the machines which can make people more comfortable during the work are for example: appropriate length of the machine for the

worker, ergonomic handles, applying ergonomic recommendations when carrying and moving goods. Moreover, the workstation should be at waist level, due to the fact that the human body is most comfortable when it is in normal position [4]. Some of those loads can be eliminated by whole automatization or part-automatization of processes. This reduces the ergonomic risk by reducing the load on the musculoskeletal system, the lack of direct contact of the employee with work tools and lower task load due to the possibility of setting the appropriate program on the machine. However, it should be remembered that the design of automatic task execution should also be well planned. Nowadays, with the development of the technology it is important to meet ergonomics requirements for the arrangement of workplaces so that they can fit the people who use them. The same should apply to kitchen workstations when implementing automation or semi-automation solutions. However, it is not always possible to apply them in the kitchen due to limited space or due to financial issue, because the implementation of such solutions can generate very high costs [5]. There are also different disadvantages of automatization, such as: dissatisfaction of the employees, increase of the importance of the maintenance, lack of any social bonds. That is why even in larger cooking enterprises sometimes replacing people with machines is avoided [6].

Given the above, this article attempts to introduce low-invasive and low-cost ergonomic solutions at the cutting station. The solutions were proposed after the ergonomic analysis of the workplace using various methods, they are also adapted to the surface capabilities of the analyzed workplace. The implementation of the changes allowed for better adjustment of the position to the user and allowed for a discussion on the use of heuristic methods for the design of kitchen workstations.

Description of the problem and how others were trying to solve that problem

In this article, the analyzed workstation is a stand with a device for cutting vegetables (Fig. 1). The following risk factors have been identified: lack of adjustment of the tools to the anthropometric dimensions of the employee, lack of height adjustment of the tool, load on the wrist and forearm, the possibility of jamming the blade, the possibility of getting cut food into the eye and the possibility of slipping on food residues.



Fig. 1. Cutting workstation
Source: own photo

Before proceeding to the ergonomic analysis of the workplace, the existing solutions to existing problems at similar workplaces were examined. The available patent solutions and solutions presented in the scientific literature were taken into account.

In large enterprises from the food industry, gradual automation or semi-automation of processes can be seen. Working conditions are also adapted according to ergonomic criteria, with adaptation adequate to the needs of users [7]. However, not all solutions are applicable due to various financial and resource constraints of these companies. In the case of the example presented in the article, a proposal was presented to solve the cutting problem based on ergonomic analyzes, taking into account the low costs of implementing the solution. However, this is not the only way to reduce accidents at similar workplaces. A way to eliminate the danger of getting cut food into the eye is to use devices with a press and a compression chamber. The knife then passes through the cut food, without splashing (Fig. 2) [8].

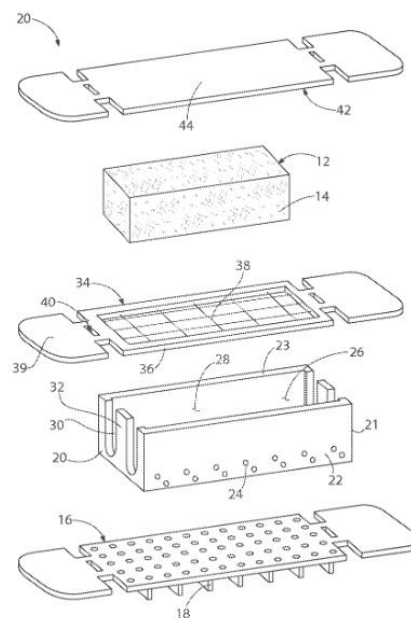


Fig. 2. Device and method for compressing and cutting soft food

Source: <https://patents.google.com/patent/US8146468B1/en>

An interesting solution in the field of cutting food products is also the use of a system of cutting boards and a sliding knife, with adjustable machine height. Lever cutting allows the use of low force to perform the cut, does not cause excessive load on the musculoskeletal system and ensures precise cutting with a low probability of injury or contact with cut food to the eye (Fig. 3) [9].

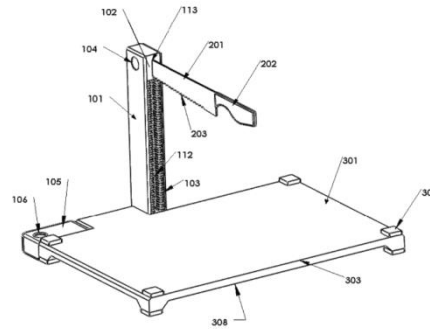


Fig. 3. Leverage based cutting board systems

Source: <https://patents.google.com/patent/US8430387B2/en>

Currently, there are also attempts to use robots that carry out all activities for humans in the area of cooking. Such solutions eliminate human contact with dangerous cutting elements, the risk of getting cut food in the eye is reduced, there is no load on the musculoskeletal system. However, it should be noted that these solutions are expensive, which is why their implementation is very limited [10].

Methods of research

Several ergonomic assessment methods were used to conduct the study. They refer to the physical and mental burden of users of the cutting tool presented above. The methods used in the research are:

- REBA (Rapid Entire Body Assessment)- fast, comprehensive method that allows to assess the risks associated with work. The assessment is performed by individual positions of body segments during work, and the risk arising from the type of grip, weight lifting, repetition of movements and static load [11]. The method was applied in relation to activities identified by employees as the most burdensome while performing tasks. The results were used for the initial assessment of the position and to identify the needs for corrective actions.
- Moore-Garg Strain Index- A method that allows to assess the load on your hand, wrist and elbow during work. The purpose of this research is to assess the risk of developing musculoskeletal disorders (MSD) in tasks requiring intensive work, including the left and right hand [12]. Due to the type of position being analyzed, the application of this method allowed estimating the load on hand segments when using the cutting tool.
- Quick Exposure Check (QEC)- method of ergonomic assessment of workplaces usually performed before and after making changes in the workplace. It allows you to assess the load on your back, shoulders and arms, hands, wrists and neck. The assessment is made from the point of view of the observer and the employee who has the ability to assess the tasks in terms of the task load [13]. This article uses the method to determine the difficulty of a task.
- NASA Task Load Index- In order to reliably evaluate the status and effectiveness of employees, the NASA self-assessment sheet has been used. It is a widely used, subjective, multidimensional assessment tool that rates perceived workload in order to assess a task, system, or team's effectiveness or other aspects of performance [14].

Results

As a result of the REBA method, the ergonomic risk associated with the analyzed workplace was determined. It was found that the risk is at an average level, which according to the method's assumptions indicates the need for further position analysis and the introduction of corrective measures in the near future. Based on the analysis, it was found that the employee's load is largely due to the still bent position during work, which is the result of the inability to adjust the height of the cutting tool position. Due to this consideration, this segment of the body was assessed with a high score.

REBA Employee Assessment Worksheet

Permission granted by Dr Lynn McAnatany to convert the paper based format to an Excel spreadsheet version.

A: Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

Step 1a Adjust....
If neck is twisted: +1
If neck is side bending: +1

Step 2: Locate Trunk Position

Step 2a: Adjust....
If trunk is twisted: +1
If trunk is side bending: +1

Step 3: Legs

Step 4: Look-up Posture Score in Table A

Using values from steps 1-3 above, locate score in Table A

Step 5: Add Force/Load Score

If Load < 5kgs: +0
If Load is 5 to 10kgs: +1
If load > 22lbs: +2
Adjust: If shock or rapid build up of force: add +1

Step 6: Score A, Find Row in Table C

Add values from steps 4 & 5 to obtain Score A.
Find row in Table C.

Scoring:

- 1 = Negligible risk
- 2 or 3 = low risk, change may be needed
- 4 to 7 = medium risk, further investigation, change soon
- 8 to 10 = high risk, investigate & implement change
- 11+ = very high risk, implement change

SCORES

Table A: Neck

	1			2			3						
Legs	1	2	3	4	1	2	3	4	1	2	3	4	
Trunk Posture Score	1	1	2	3	4	1	2	3	5	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table B: Lower Arm

	1			2			
Wrist	1	2	3	1	2	3	
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table C: Score A (score from table A + load/force score)

	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	1	2	3	3	4	5	6	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	4	5	6	7	8	8	9	9	9
6	6	6	6	6	7	8	8	9	9	10	10	10
7	7	7	7	7	8	9	9	9	10	10	11	11
8	8	8	8	8	9	10	10	10	10	11	11	11
9	9	9	9	9	10	10	10	10	11	11	12	12
10	10	10	10	10	11	11	11	11	12	12	12	12
11	11	11	11	11	11	11	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table D: Arms and Wrist Analysis

Step 7: Locate Upper Arm Position:

Step 7a: Adjust....
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or leaning: -1

Step 8: Locate Lower Arm Position:

Step 9: Locate Wrist Position:

Step 9a: Adjust....
If wrist is bent from midline or twisted: Add +1

Step 10: Look-up Posture Score in Table B

Using values from steps 7-9 above, locate score in Table B

Step 11: Add Coupling Score

Well fitted handles and mid range power grip, good: +0
Acceptable but not ideal hold or coupling acceptable with another body part, fair: +1
Hand hold not acceptable but possible, poor: +2
No handles, awkward, unsafe with any body part, unacceptable: +3

Step 12: Score B, Find column in Table C

Add values from steps 10 & 11 to obtain Score B- Find Column in Table C and match with Score A row from step 6 to obtain Table C score.

Step 13: Activity Score

+1 1 or more body parts are held longer than a minute (static)
+1 Repeated small range actions (more than 4x per minute)
+1 Action causes rapid large range change in postures or unstable base

Final REBA Score

Score A: 4 + Activity Score: 2 = Final REBA Score: 6

Fig. 4. Results of REBA assessment

Source: own preparation based on: ergo.human.cornell.edu › *CUergoTools* › *REBA 6*

On this basis, the initial assumptions for implementing the improvement proposals were determined, focusing on adjusting the height of the station and limiting the bent.

Another method which was used is Moore-Garg Strain Index. The results are shown in the Fig. 5. The calculation has been done on the example of an employee whose task is cutting vegetables approximately for 4/5 hours per day. The results refer to the evaluation before implementing the solutions and after applying the corrective actions presented in the next section of this article.

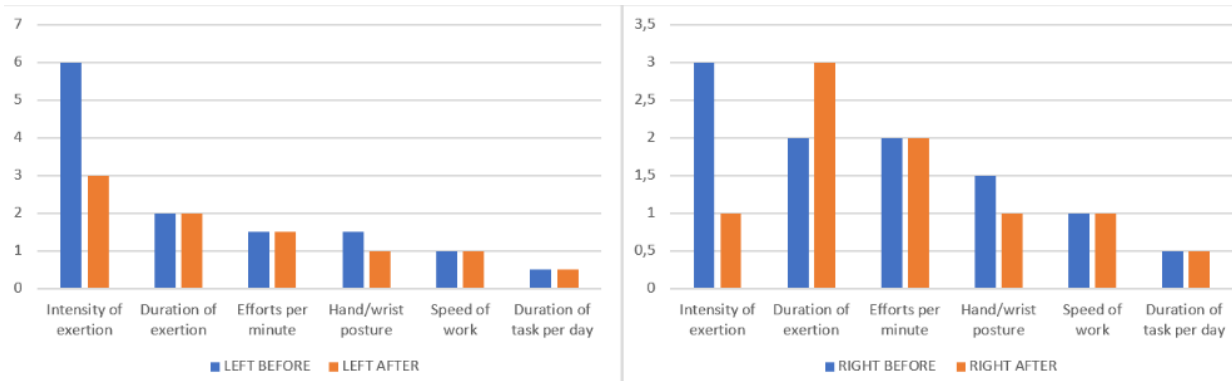


Fig. 5. Moore- Garg Strain Index analysis results

Source: own preparation

The following results were achieved in the given segments:

Tab. 1. Moore- Garg Strain Index analysis interpretation

Body segment	
LEFT HAND	RIGHT HAND
After the improvements, changes in the results were observed in the application of this method. Research shows that using the right hand after modernizations, the employee's effort is barely noticeable / relaxed due to the use of a movable knob. The body is in a more natural position. The duration of the work cycle has been shortened because the employee can be more comfortable and leads to greater productivity during work. Efforts per minute remain the same, for safety reasons - faster work can lead to injury and less precise work. The position of the hand and wrist seems to be almost neutral after the improvements - due to the introduced knob that changes the position of the body. The speed of work remains at the same level, this is due to the specification of the work, because the cutting must be precise. The same applies to the duration of the task. Nevertheless, the risk remains at a level that requires observation of the position.	After the introduction of corrective actions, it is possible to reduce the intensity of work, which is due to the possibility of changing the height using the knob. The knob gives the employee the ability to adjust the height of the machine to his height, so it does not require as much effort as before. The duration of the task is the same because the work is done mainly with right hand. Going further, the efforts per minute are the same, the same hand is still used. The position of the hand/wrist has become better - it is almost neutral - this is also due to the installed knob. The speed of work remains at the same level - it helps to prevent injuries during work. The duration of the task remains the same, because this factor does not depend on the machine, but on the type of work and the place where it takes place. After summarizing all the results, the risk is still at a level that requires observation of the position for the occurrence of work-related hand complaints.

Source: own preparation.

The next step was to carry out the analysis using the QEC method. The QEC survey was attended by a working 23-year-old woman (person X), an experienced cook, a 25-year-old man (person Y) and a 58-year-old woman (person Z) (Fig. 6).

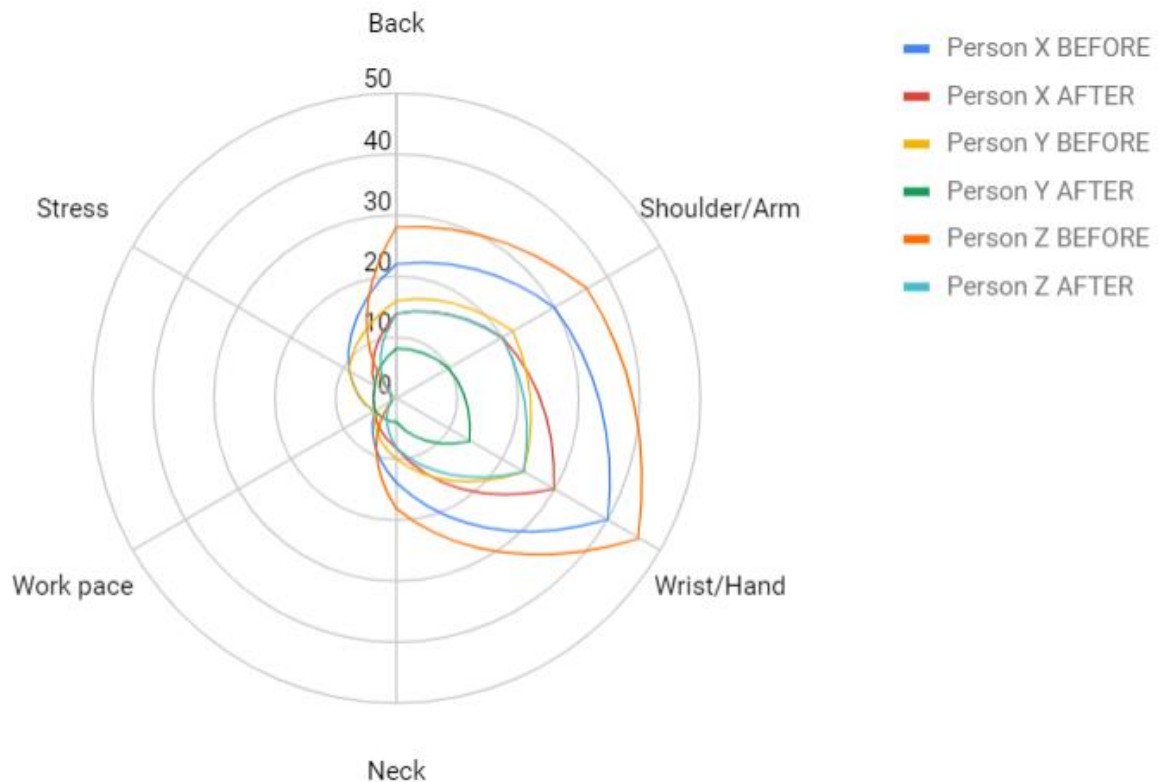


Fig. 6. Results of QEC survey
 Source: own preparation

The test results are similar to each other, all employees assessed their position at work as bad and tiring, particularly exposed to the burdened areas are: neck and wrist. Each of the respondents had the problem of scattering cut vegetables, stinging their eyes, which hinders and slows down the work, and what is more, as it turned out during the study, is frustrating. In the case of the second respondent, stress occurs when the movements are slowed down and it is not possible to complete the task in time. The results after the implementation of the improvements are satisfactory, thanks to the possibility of adjusting the height of the machine, in each of the examined the weight on the neck, back and hands decreased. A special mask on the machine increased eye protection and reduced splashing of cut vegetables in the workplace. Stress levels also decreased according to respondents.

In order to reliably assess employees' effectiveness and task load, NASA TLX assessment sheet was used on the same respondents as for QEC sheet. Interpreting the results, it can be stated that they were influenced by the age, sex and professional experience of the respondents (Fig. 7).

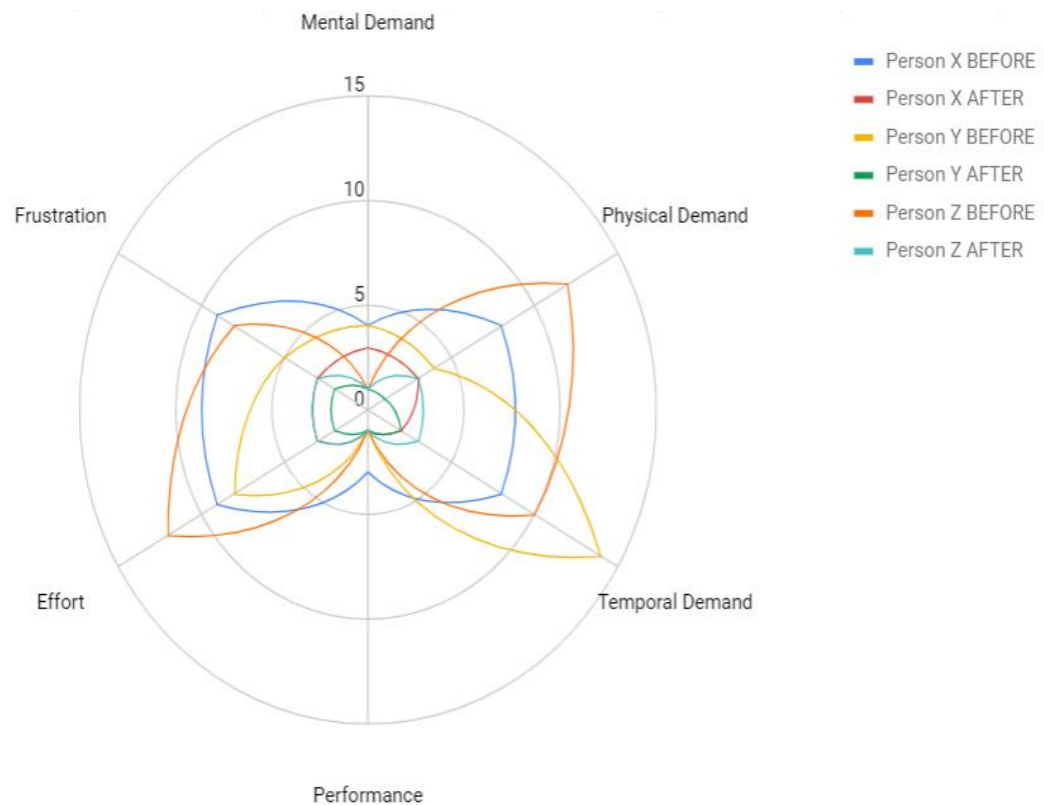


Fig. 7. Results of NASA TLX research
 Source: own preparation

The youngest man had to make the slightest effort to perform the task, unlike the older woman. Employees have determined that the task of cutting vegetables is physically, temporarily and effortfully demanding. Studies show that the implementation of improvements significantly improves the perception of the task by employees, they rated it as less burdensome in all aspects tested in the NASA TLX method.

Solution design

Considering the research results presented above, it was necessary to propose solutions improving the workplace, taking into account its adaptation to the capabilities of various users. One of the suggestions is to solve the problem of non-adaptation of the cutting device to the user's height through the use of adjustable screw jack (Fig. 8). It will allow to avoid an inclined position during cutting, which will reduce the pain of employees and prevent the occurrence of diseases of the musculoskeletal system in the future.

The design of the lift is easy to make, but there may be problems with the compatibility of other parts of the tool. Therefore, you can consider using ready-made solutions without having to redesign the height adjustment function.

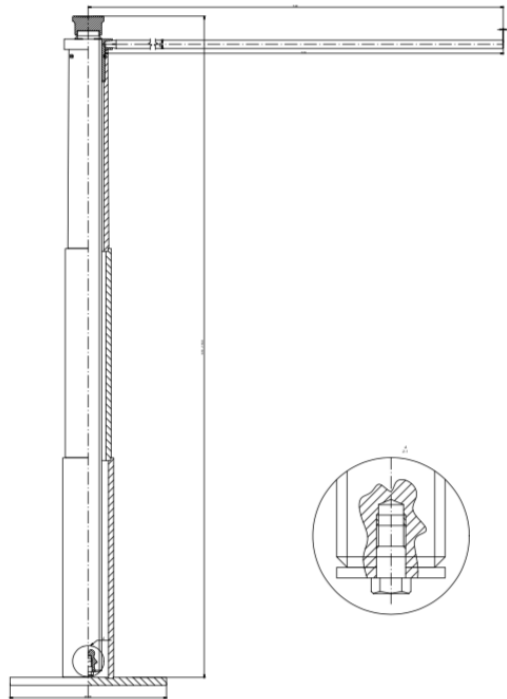


Fig. 8. Screw jack design

Source: own preparation

To solve the problem of getting into the eye of splashing cut vegetables, the device must be equipped with a mask, shielding the blade. In its current state, the mask is made of stainless steel, but it does not cover the entire blade, so that some of the food gets outside of it. The solution to this problem may be the use of a new mask with a larger surface (Fig. 9, Fig. 10) made of polyethylene, which is a low abrasion, chemically resistant material and is suitable for contact with food [15]. This will reduce the weight of the entire device, prevent vegetables from splashing, reduce the possibility of an accident due to contact with a sharp edge.



Fig. 9. Changing the cover - front view

Source: own preparation

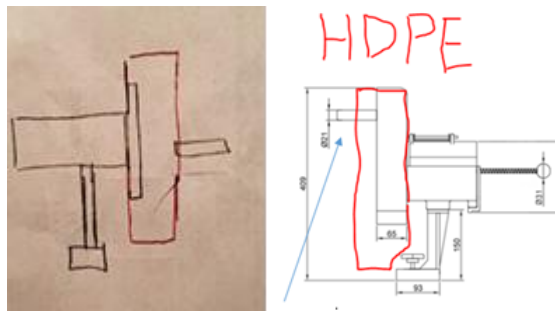


Fig. 10. Changing the cover - side view
Source: own preparation

The introduction of this solution will ensure higher level of safety, but also make work more efficient, faster and more comfortable for employees due to their protection against splashing food stains and makes it less likely to have to clean the workplace during the shift compared to the current state.

Conclusions

On the given example, it can be observed that the use of ergonomic assessment methods and the assessment of an employee's task load can be conducive to generating solutions to identified problems through technical and organizational projects. It is also visible that small changes, often not requiring large financial and time expenditures, can help to avoid serious problems for employees. However, when analyzing the above information, it should be noted whether in similar cases it is more advisable to design a new solution instead of retrofitting existing devices. The big problem can be the incompatibility of parts, which means that the device will not meet the expected utility functions. Therefore, such analyzes should be treated as an introduction to future changes in the workplace, which take into account the requirements of ergonomics, safety issues and employee demands.

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WICKER PRODUCTION AS A LOCAL PRODUCT OF THE NIŻAŃSKI POWIAT

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Abstract:

A characteristic feature of given cities are local and regional products. The local product for the niżański powiat is wicker, from which products have found worldwide demand. The purpose of this work was to present the tourist attractiveness of the niżański powiat and learn how a local product shapes the tourist attractiveness of the powiat. The main problem was to find out: how the promotion of the region is based on a local product. The goal was to answer the following question: what regional products - products, customs and other features of the region or town - would have a chance to become products or attractions of the region around which social and professional life could be organized?

Keywords:

local product, wicker, region, tourist attractiveness

Introduction

A local product is a product or service that the inhabitants of a given region identify with. It is produced in a non-mass, non-industrial way, using local raw materials or using local methods. A local product is a product that is common, everyday for the inhabitants of the region, while for people from outside it is something unique and specific [1].

Small producers are involved in the production of the local product, to whom it ensures sales, brings profit and provides a source of income. Production supports the local economy and reduces transport costs, and has a positive impact on the environment. Local products should be of better quality, they should be produced from local raw materials and thanks to a shorter chain of intermediaries and sales to the local population [2].

A regional product is a product that has been produced in a given region. When talking about such products, terms related to the location of a given area are used, e.g. a regional product from Podlasie, Kurpie Białe, from Wielkopolska or a highlander product from Podhale. The regional product has a precise definition in the regulations concerning high quality articles and foodstuffs. By regional products, otherwise known as products of known origin, are meant products whose high

quality and reputation are associated with the region in which they are produced, where the region should not be a region in the geographical sense, but rather means the area with which the production of the product is associated [3].

In 1992, a regulation on the protection of geographical indications and designations of origin was introduced, as well as a regulation concerning specificity certificates, which are the basis for implementing quality policy in the EU. These regulations are to help in rural development, diversification of agricultural activity and increasing the competitiveness of agri-food production [4].

The use of local products in tourism

Most attractions in Poland are attractions where people staying one day in a given place dominate [5]. It should be assumed that utilitarian crafts can be not only a tourist attraction, but also an attraction for residents of tourist reception areas and one-day visitors. It should be emphasized that the concept of "attractions for visitors" is narrower in meaning. It can be assumed that the attraction for visitors is much cheaper to market, because it is usually limited to the local market or also the regional one. However, it should change more in time, as the market of its recipients may be small, and only modifications and continuous development of attractions can ensure re-visits [6].

It can be assumed that the creation of tourist products based on crafts will be different from the use of artistic crafts. Therefore, in the case of craft-based tourist products, an important element of the offer may be the sale of the final product, but also observation or even, to a limited extent, an attempt to learn how to manufacture technology [4].

Partners operating on the development of the tourist product are widely understood tourist enterprises, as well as local government authorities, social organizations and other entities that have an impact on regional development [7].

Attractiveness of the niżański powiat

According to the administrative division of Poland, the Niżański powiat is located in the northern part of the Podkarpackie Voivodeship. The area is located in the Vistula River basin, and the largest river flowing through this area is San. The richness of the area are forests. In the southern part of the Niżański powiat there is the Sandomierska Primeval Forest existing until today, as well as from the north is the Solska Primeval Forest, Janowskie Forests form a botanical mosaic [8]. The powiat's advantage is very good climate conditions conducive to work as well as rest.

Tourist attractions

The most important elements that make the powiat area attractive in terms of cultural heritage include the fact that there are traces of the current Lasowiacka culture here, disappearing professions, traces of multiculturalism, wicker traditions and numerous monuments. Rafting traditions are alive in the powiat, cultivated in Ulanów, where rafting trips on the Vistula, Oder and Bug rivers are organized, known in Poland and abroad. Ulanów currently has the status of Rafting Capital.

Regional traditions related to saddlery or artistic smithing are still maintained. The functions of the utility and artistic wickerwork center are fulfilled by Rudnik nad Sanem, which has gained the name of the Polish capital of Wicker. The colorfulness of the area is influenced by the activities of folk groups, folk bands, folk artists, professional artists and amateurs [8].

Important elements constituting the wealth of the area are sacred and secular monuments. Particular mention should be made of historic churches in Ulanów (from the 17th century) and Krzeszów (from the 18th century), which are fragments of the "Wooden Architecture Trail".

Tourist infrastructure

Wicker products are the most important local product characteristic of the powiat area. In addition to traditional baskets, haberdashery and furniture are home furnishings. Wicker products from the Nizański powiat have found demand around the world. They are valued by European, American, Australian and Asian importers. On the EU market, interest is shown by: Dutch, Belgians, Germany, French, Italians and British.

Wicker as a local product of the communes of the Nizański powiat

Wickerwork at the beginning of its creation included classes on farms and consisted in supplying products for own needs. The exception included areas where the wealth of raw materials meant that the skill became a profession. However, the primitive production and the heterogeneity of raw materials meant that this craft occurred throughout the country. However, the developed form of wickerwork developed in the river basins, where due to the specificity it became an excellent resource base [9].

In Poland, at the turn of the 18th and 19th centuries, wicker centers in Nowy Tomyśl and Rudnik nad Sanem were established [10]. It seems that among the non-food plants, the most promising are fast-growing shrub willow species grown on plowed land. Willow shrubs are called wicker [5].

In Poland, interest in wicker is currently growing in field cultivation and the use of biomass for energy (fuel) as a raw material for the chemical (bioalcohol) and furniture industries (chipboard) or for plaiting (utility and decorative). They are also useful for reclamation of sites devastated by industrial and municipal activities [5].

The richness of wicker products, their variety and wide assortment mean that, for example, Rudnik nad Sanem is visited by more people, including entrepreneurs, tourists. A Wicker Center was established in the city with them in mind. Most of the products made in Rudnik nad Sanem are made of barked wicker, but weave it in non-colored wicker, the so-called Green, fresh or brewed and air-dried.

Wicker art products as part of the promotion of the region

In 2011, there were ten craft factories in the commune, fifteen the size of basketball wholesalers, and 50 smaller entities involved in trade. Rudnik's wickerworkers specialize mainly in the production of garden collections, furniture, and various types of baskets. The offer includes combined products resulting from the combination of materials: straw, wood, fabrics. Many of them

are original handicrafts, which include artistic products as well as spatial and outdoor arrangements. The products are made of the best quality raw material, and some are distinguished by an interesting design. The best quality, deep and diverse range is adapted to the needs of demanding customers.

Research methodology

The subject of research at work is the assessment of tourist attraction development based on a local product. The following research problem was adopted in the paper: how is the promotion of the region based on the local product. The method used in the work is a diagnostic survey. The technique that was used in this work is a survey. The study uses a research tool developed for research purposes which was the questionnaire. The research was conducted among the inhabitants of the communes of the nizański powiat using a questionnaire. The survey involved 100 respondents living in the nizański powiat. The majority of the respondents were women – 75%, and men constituted a group of 25%. The questionnaire contained 6 questions.

Analysis of test results

Most of the respondents: 55%, believe that the communes and the nizański powiat are attractive outside the wickerwork season. 30% of the respondents had a different opinion, while 15% had no opinion.

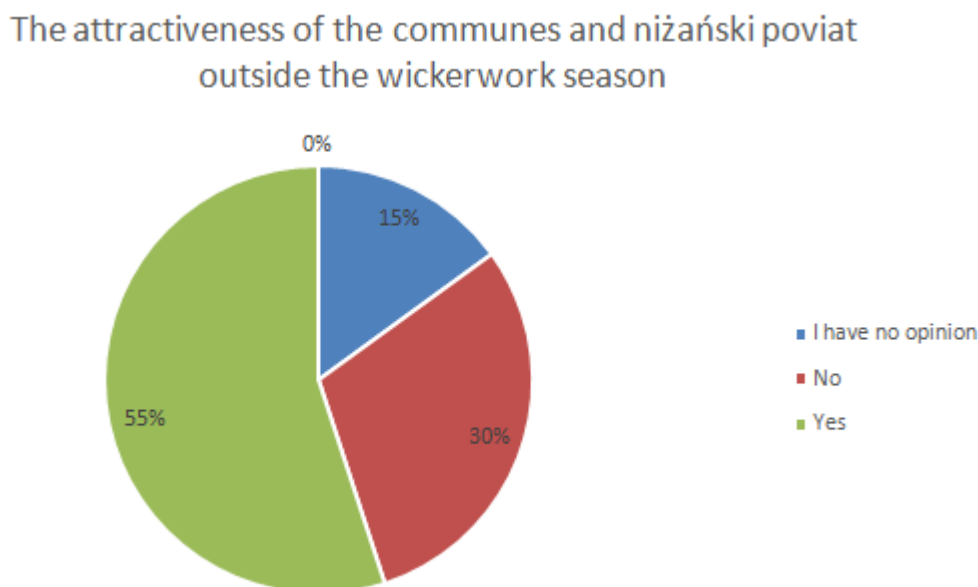


Fig. 1. The attractiveness of the communes and nizański powiat outside the wickerwork season
Source: research and own study

The second question was: what regional products, including products, customs and other features of the region or town, would have the chance to become products or attractions of the

region around which social and professional life could be organized? The respondents most often pointed to wickerwork 70%, local cuisine 15%, rafting traditions 15%.

Another issue concerned the forms of promoting communes as a region attractive for tourists. In the 74% of the answers, the respondents indicated yes, while 13% of the respondents indicated no. However, 13% of respondents did not have an opinion.

According to the respondents, the biggest incentive for tourists to arrive was: earlier stay – 28% of responses and recommendations of friends or family – 20%, information in tourist guides – 17% and advertising in the media or in the press – 15%.

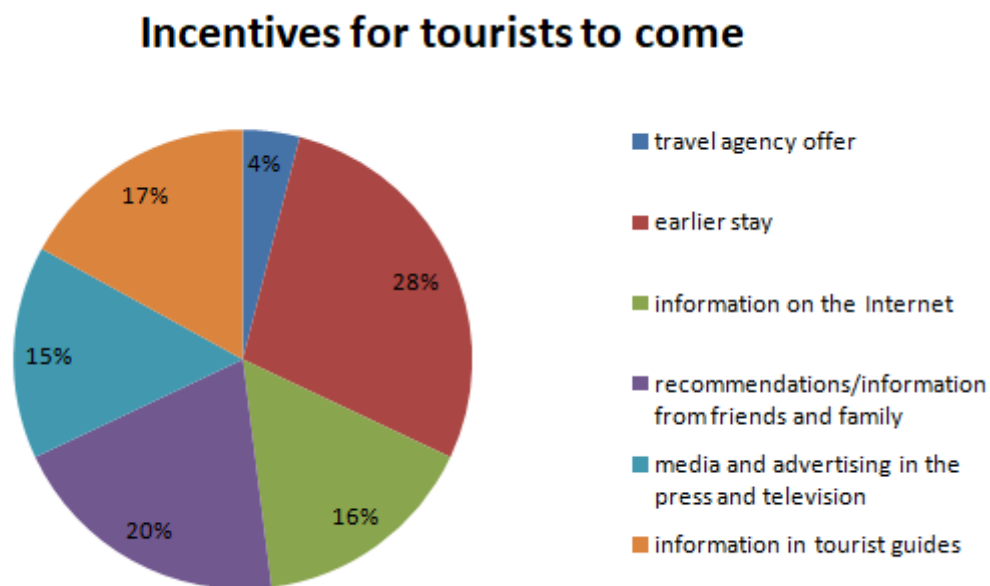


Fig. 2. Incentives for tourists to come
Source: research and own study

Then the respondents answered about the level of tourist promotion. Tourism promotion was rated very well in 34% of cases, and rather good in 32%. Rather badly rated it 7% and very badly 5%. 22% of respondents did not have an opinion.

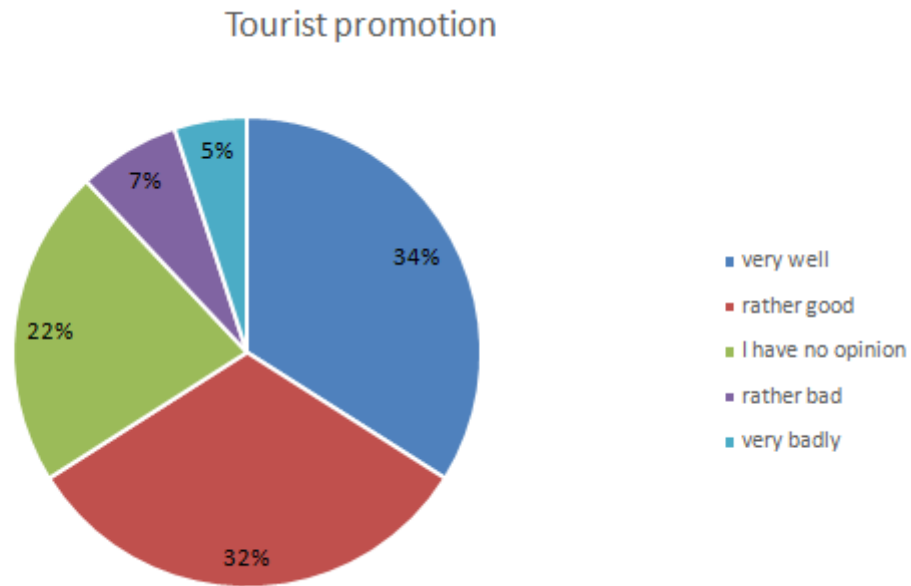


Fig. 3. Tourist promotion
 Source: research and own study

The next question concerned the level of the local product purchase offer. 43% of respondents rated it very well, and 42% rather well. There were a total of 5% negative answers, and 10% did not have a sentence.

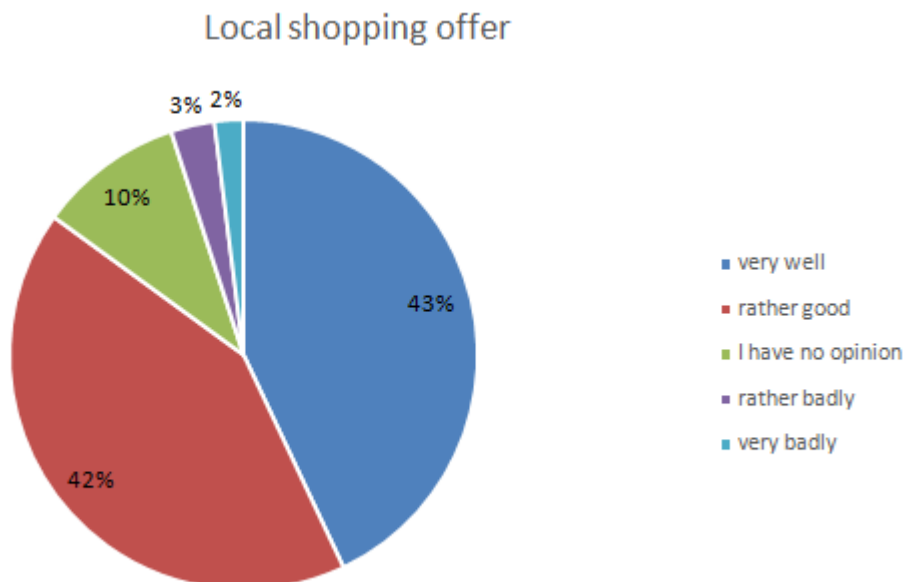


Fig. 4. Offer for the purchase of local products
 Source: research and own study

Summary

Unfortunately, the niżański powiat has never achieved full economic development, but it boasts a very rich cultural heritage. The most interesting factors that make the powiat area attractive in terms of cultural heritage include the fact that there are traces of colorful lasowiacka culture in these areas, disappearing professions, wicker tradition, traces of multiculturalism and numerous monuments.

Cultural institutions run environmentally tested forms of work. They aim to promote cultural and educational activities, maintain regional traditions, and organize cultural events. Cultural societies organize many events aimed at presenting their own achievements, as well as promoting talented artists and folk artists representing such artistic fields as handicrafts, painting, sculpture, blacksmithing and wickerwork.

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STATE AND OPPORTUNITIES FOR THE DEVELOPMENT OF SKI TOURISM IN BIESZCZADY

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Abstract:

Winter sports are popular way of spending free time in winter. More and more people are trying this form of activity. Very interesting, but distant for many people place are Bieszczady mountains. It is a region chosen more and more often by skiers. There are several reasons, but mainly because it is not a place visited by crowds. The main purpose of the work is to check why people choose Bieszczady as a new aim of travel in winter. Curiosity, new experiences and undiscovered edge of Poland may cause more and more interest of this place. Visitors can find out a higher standard of services such as accommodation base, catering facilities, quality of ski slopes and wider range of opportunities in ski tourism. It is not only downhill skis, but also cross-country skis and ski-touring. In other regions of Poland you can find exactly the same, but Bieszczady are original because only here is so calmly and wildy.

Keywords:

Bieszczady, tourism, skis, winter

Introduction

Winter tourist traffic in the Bieszczady Mountains has recently become a widely visible phenomenon. Numerous skiers go to the mountains, whose accumulation can be seen around the queues and lifts. It is rare to see small groups, usually several people, of tourist skiers who on the ski tourism equipment already available in Poland wander in the mountains. All this is increasingly attracting people from cities, including those who do not go skiing.

There is no doubt that downhill skiing is the most popular form of ski tourism in the Bieszczady Mountains. In recent years, ski tourism (so-called ski-touring) has been developing more and more. The availability of special equipment necessary for practicing this discipline, the ability to ski easier than on foot, and finally the desire to escape from prepared and crowded slopes and ski slopes caused that more and more people practice this type of winter tourism.

Bieszczady are the furthest Polish mountains to the south-east, in the Eastern Carpathians. They are located on the watershed between the Baltic and Black Sea basins. The Polish part of the

Bieszczady called the West extends from the Użocka Pass (853 m a.s.l.) in the east, to the Łupkowska Pass (640 m a.s.l.) in the west.



Fig 1. Podkarpackie Voivodeship with the Bieszczady area marked
 source: www.gminy turystyczne.pl

The Bieszczady borders cannot be treated rigidly and schematically, especially from a tourist point of view. Different researchers and geographers give different definitions and boundaries for this area, which vary depending on geographical, tourist or natural aspects. Bieszczady have two basic, differing borders - tourist and geographical. Tourists, guided mainly by public transport consider the Bieszczady area much larger.

In comparison with other Carpathian ranges, the Bieszczady Mountains are distinguished by a peculiar landscape, a different stacked arrangement of vegetation called the alpine meadow as well as the original fauna and flora. Among all Polish mountains, they have the best preserved natural environment, are the most wild and have many tourist values. Therefore, in 1973, the Bieszczady National Park was created in this area, which after transformations became the third largest national park in Poland (the largest mountain) [1].

The climate of the Bieszczady is varied, as is every mountain area. This is related to the terrain and altitude. It is an area in Poland with the highest average rainfall per year. The winter season is relatively long in the Bieszczady Mountains, the number of days with snow cover in the valleys is 115 on average. Snow cover appears at the end of November, consolidates in mid-December, and disappears, depending on the height above sea level only at the end of March or beginning of April. The average number of days with snow cover is 80-120 days in a year and up to 140-150 days in peak areas. Its average thickness ranges from about 10 cm in December to about 40 cm in February and March and increases with altitude, reaching even 150 cm. The average winter temperature is from -3 °C to -7 °C [2].

The Bieszczady Mountains are characterized by a grate construction of ridges that run parallel to each other from north-west to south-east. The height of the mountains increases to the east

reaching a maximum height of 1346 m above sea level (Tarnica). The valleys are located at an altitude of 600m above sea level. The Bieszczady Mountains are built of sedimentary rocks forming a thick rock complex, built of staggered layers of sandstone and shale, which we call flysch (rock formation was formed at the bottom of a deep sea reservoir, the Ocean of the Tethys). About 28 million years ago, the flysch was strongly folded due to tectonic movements [3].

The High Bieszczady Mountains are a great place to go mountain skiing, both for short and multi-day trips. Gentle mountain slopes and long ranges of alpine meadow create favorable conditions for this type of tourism. Sufficient snow for skis (over 10 cm) lasts about 60-95 days a year. In the peak parts of the mountains there is mainly snow (compacted gypsum), in the alpine meadow there is white frost, forming ice crusts. In the lower parts of the mountains and northern slopes there are good snow conditions, there is grainy snow, called firn, with overlapping layers of fresh rainfall. Adverse conditions prevail in forests where the snow is wet and heavy. There is no network of separate ski runs in the area of the Bieszczady Park, but marked hiking trails can be used for skiing. Favorable conditions for mountain skiing are usually from the beginning of December to the end of March (it depends on the amount of snow and abundance of rainfall in a given year).

Ustrzyki Dolne is a pioneer in terms of infrastructure for downhill skiing in the Podkarpackie Voivodeship. The routes at Gromadzyń and Laworta still enjoy the unflagging interest of skiers and are also among the longest in the region. Because the weather is sometimes capricious, there are more and more artificially snowed lifts in the Bieszczady Mountains. Many of them provide good downhill conditions - they are lit and groomed. They offer ski rentals, ski schools with professional ski instructors, GOPR lifeguards watch over safety, and you can use the catering and accommodation facilities. It should also be noted that today, many owners of farms or boarding houses provide tourists with transport to lifts.

Ski slopes are located in:

- Ustrzyki Dolne (Laworta, Gromadzyń);
- Weremień near Lesko;
- Bystre;
- Kalnica.

Bieszczady is also a perfect place for cross-country skiing. The so-called stokówki i.e. forest roads covering the entire Bieszczady Mountains. To freely use the cross-country tracks and appreciate this sport you do not have to be a competitor. We choose both the pace and style of driving according to our own capabilities. We can run, but also go skiing, it all depends on skills and condition. Unlike downhill skis, we don't need to take the lift, buy skipasses. We can run both on prepared and unprepared routes. The only difficulty may be that such routes can not be snowed and a lot depends on the weather. However, running routes in Ustjanowa have been dealing with this for several years and borrow cannons from nearby lifts in Ustrzyki Dolne. These produce snow, which is then distributed along the route. Cross-country trails are in:

- Wetlina and the surrounding area (led among others on railway tracks);
- Ustjanowa (with FIS type-approval);
- Muczne (with FIS type-approval).

Ski-touring is the use of skis for hiking in virtually any terrain without major restrictions. It is a universal combination of cross-country skis during walking and traditional "downhill" during downhill skiing. Wandering in the Bieszczady on ski-tour skis is becoming more and more popular. Thanks to these skis you can cover considerable distances and reach the highest peaks. For free movement on ski-touring skis, the minimum thickness of the snow cover should be 40 cm, and the snow should be collapsed and hardened [4].

Research methods and results

In connection with the dynamic development of ski tourism in the Bieszczady, a survey was conducted among tourists from Bieszczady to help assess the state of development of ski tourism in this region. The main goal of the survey was to acquire knowledge to assess the condition and development of ski tourism in the Bieszczady Mountains. The research problem was included in the following questions:

1. What is the condition and level of development of ski tourism in the Bieszczady Mountains?
2. What types of ski tourism in the Bieszczady Mountains are the most popular?
3. Does the condition and level of development of ski tourism affect tourist traffic in the Bieszczady Mountains?
4. How do tourists evaluate ski tourism in the Bieszczady Mountains?
5. How has the state and level of development of ski tourism changed in the Bieszczady Mountains in the last 20 years?

The constructed questionnaire was built on the basis of analysis of the literature on ski tourism in the Bieszczady Mountains. The main purpose of the survey was to acquire knowledge to assess the condition and development of ski tourism in the Bieszczady Mountains. Based on the survey questionnaire, which was conducted on 7-8.02.2019 in the Bieszczady Mountains, data that could be used to present the condition and development of Bieszczady ski tourism was collected. The obtained research results were used to verify research questions. A total of 36 respondents completed the survey.

The first issue in the research was to determine the form of tourism practiced by the study group. Definitely the most people, as many as 29, practice downhill skiing. 9 respondents practice cross-country skiing, and 6 ski-touring. The strongest group are people aged 46-65 - they are material stable, having more time due to adult children. This group comes from the city and has mostly higher education.

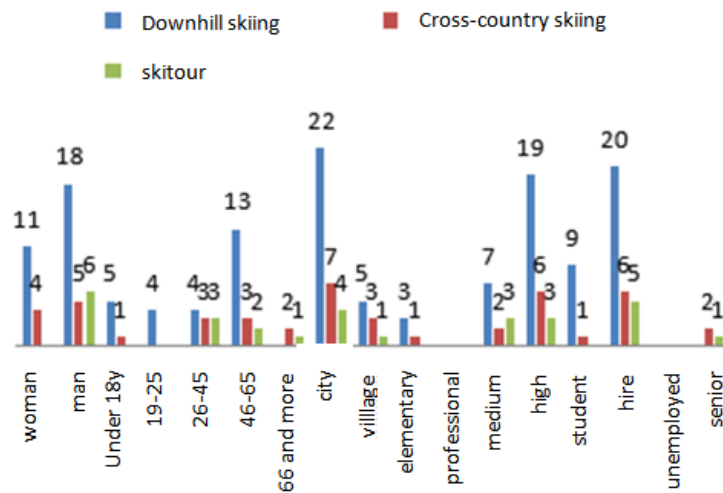


Fig. 2. Form of ski tourism cultivated by respondents
Source: own research

Respondents most often indicated the answer saying that the standard of ski resorts is satisfactory. The second most frequently chosen option was one that found a poor level of service. The answers 'good' and 'very good' represent only a small percentage of all, which may give you the thought that the standard does not really encourage you to come to Bieszczady for skiing.

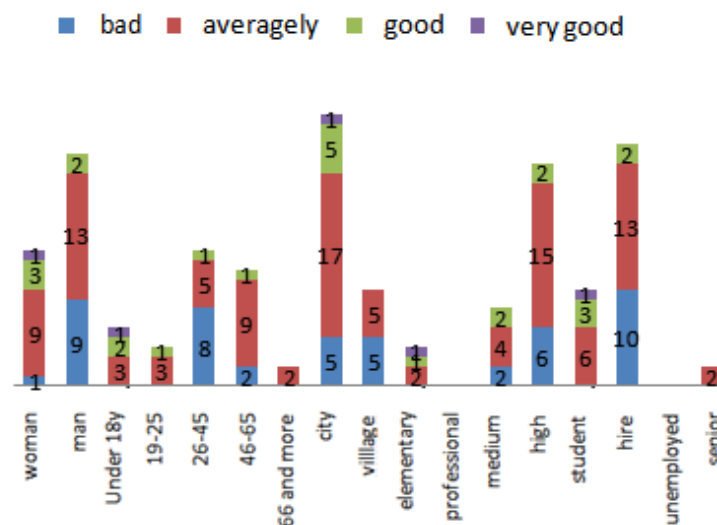


Fig. 3. Assessment of the standard and quality of service provision in terms of opportunities for skiing tourism in the Bieszczady Mountains
Source: own research

The biggest advantages of the Bieszczady ski resorts are: landscape and nature, climate (29 indications), short distance from the place of residence (11 indications), silence, small number of tourists (6 indications), cordiality of people (3 indications), gastronomic base (1 indication). Therefore, it is clear that it is natural assets, not infrastructure, that are a source of generating tourists in the Bieszczady Mountains.

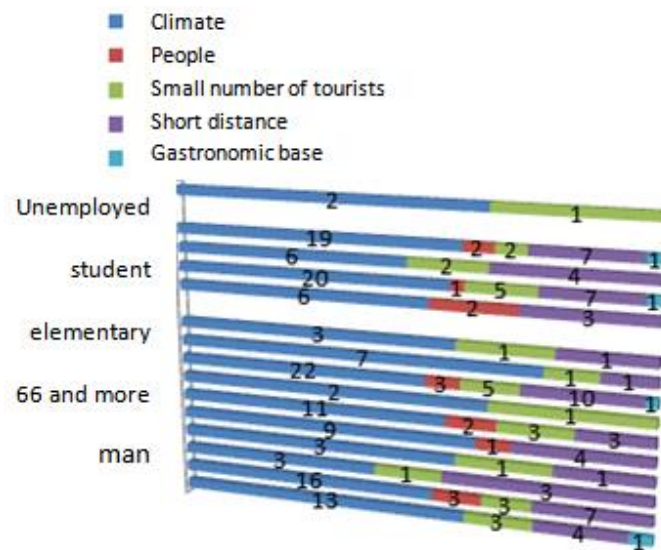


Fig. 4. The biggest advantages of the Bieszczady ski resorts
Source: own research

Tourists were also asked about the biggest disadvantages of the Bieszczady ski resorts. As it turned out, the biggest disadvantage are too short, poorly maintained routes with outdated infrastructure (28 people). Other indications are marginal and relate to a weak accommodation base - 3 people, high prices - 2 people, a small number of ski resorts - 1 person. This research result clearly indicates what should be improved to achieve greater efficiency in the field of generating ski tourism in the Bieszczady Mountains.

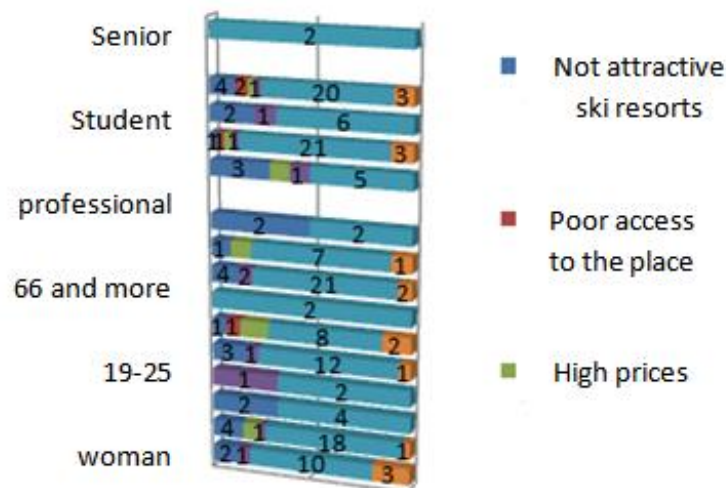


Fig. 5. The biggest disadvantages of the Bieszczady ski resorts
Source: own research

The vast majority of respondents go on a one-day stay. The next group are tourists coming for the weekend. Individuals from the studied group go skiing for more than 7 days. It is clear that for many professionally active people ski tourism is a form of relaxation during non-working days.

Tab. 1. How long does your skiing trip take?

		1 day	2 - 3 days	4 - 7 days	More than 7 days
sex	Female	8	5	3	1
	male	11	7	9	1
age	under 18	3	2	1	
	19 - 25	2	1	1	
	26 - 45	4	6	1	
	46 - 65	8	3	6	2
	66 -		1	2	
place of residence	city	11	9	8	2
	village	5	2	1	
education	basic	2	1	2	
	professional				
	average	6	5	3	
	higher	8	7	8	2
Type of work performed	student	5	3	3	
	hired	9	10	7	2
	unemployed				
	retired pensioner		1	2	

Source: own research

The last issue concerned the type of accommodation base used by tourists in the Bieszczady Mountains. The most important issues from this question relate to the largest number of indications for guest houses as a place to stay, and the fact that a large group of tourists do not use accommodation at all, which would confirm the thesis about one-day tourist arrivals for skiing (14 people). It can also be seen that tourists from the age group 46-65, with higher education, coming from the city are definitely more willing to use guest houses than private accommodation, which means that mature people look for comfort on this type of trips.

Summary

Do Polish mountains offer great opportunities for fans of various forms of skiing? It is best to determine this based on your own trips and experience. Of course, this can not be compared with the conditions in the countries where the Alps are, but it can be safely said that for the conditions in the Polish mountains, it is really good. Bieszczady also have potential, but it is not fully used. Perhaps the factor influencing this is the huge area of various forms of nature protection. Everything that tourists need is here, but this remote corner of Poland is often avoided due to the distance and lack of expressways and highways.

In addition, ski resorts are constantly raising their level of service. The end of 2019 newly purchased devices on the Gromadzyń slope (chairs, card reader) were tested and checked. Cross-country skiing routes and the surrounding infrastructure are constantly being refined in Muczne. The only access road was renovated there and the accommodation facility modernized. On

the Polish slopes you can clearly see what a national skier wants - above all comfort. Even flat, not very interesting slopes, but equipped with a new chair, will attract more skiers than interesting ski slopes served by old T-bars.

Bieszczady mountains, which are considered wild and sparsely populated mountains, have not been very popular among skiers until now. It resulted both from the lack of adequate accommodation base, a small number of facilities where it was possible to practice downhill skiing, as well as difficult accessibility in the winter season. In recent years, however, this form of tourism has become increasingly popular. More and more lifts are artificially snowed, lit and groomed. The issue of launching new ski runs and investment in accommodation facilities is of considerable importance. A big disadvantage is also the lack of advertising and poorly prepared tourist information. Comparing the Bieszczady Mountains to promoting the ski slopes more in the west of the country, it can be concluded that advertising does not actually exist. The conclusions of the survey are as follows:

- Downhill skiing is practiced in the vast majority. Few people go for cross-country skiing due to the low popularity of this discipline, despite the fact that there are two complexes of routes with FIS type-approval in Bieszczady, where competitions take place systematically. However, ski-touring is already on its own and these are units.
- The standard on the ski slopes is not satisfactory and only individual people recognized their level as at least good or better
- Landscape, nature and climate are the main reasons why tourists decide to choose Bieszczady resorts, but also tracks are too short, poorly maintained routes with outdated infrastructure.
- People usually go on a one-day trip to the ski slope, so they will look primarily at the access and catering base.

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HOW MANY GRASSLANDS DO WE REALLY HAVE? THE PROBLEM WITH GRASSLAND MAPPING IN POLAND

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Abstract:

Grassland ecosystems are distributed across all biogeographical regions of Europe and provide a wide range of ecosystem services related to biodiversity. As a result of management intensification and land-use transformation, the area of grasslands in Europe is constantly decreasing. Appropriate conservation of grasslands at regional and national scales needs knowledge about changes in their area. The main goal of this study was to compare area of grasslands provided by different, freely available databases: Corine Land Cover, Pan-European High-Resolution Layers and BDOT10k at a study area comprising 20 000 km² (Lower Silesia S-W Poland). The results showed that different data sources provide highly different grassland areas. The results also reveal that in Lower Silesia the area of improved, urban grasslands equalizing area of grasslands and pastures used for agriculture.

Keywords:

Corine Land Cover, Pan-European High Resolution Layers, BDOT10k, green infrastructure.

Introduction

In Europe grassland could be divided into the natural grasslands (steppes, alpine grasslands, azonal and extrazonal grasslands) and secondary grasslands including semi-natural and improved grasslands [1]. The latter category represents habitats developed on the formerly forested lands and maintained through regular, extensive management [2]. European secondary grasslands developed in the Mesolithic-Neolith transition, at the beginning of agriculture due to hay-demand in livestock production [3].

In Lower Silesia (South-West Poland), a rapid increase in the secondary grasslands area is dated in the VII century AD, but they occurred only at the lowlands [4]. Forests covering the highland areas of Lower Silesia were converted into secondary grasslands later, in the XII-XIII century [4]. In the 20th century, due to agriculture intensification, many semi-natural grasslands

have been abandoned or converted into arable lands or improved grasslands [5, 6]. Recently, the semi-natural grasslands are among the most species-rich and the most threatened terrestrial ecosystems worldwide. Preventing biodiversity loss of grasslands is among the main targets of the EU 2020 Biodiversity Strategy [7, 8], therefore, semi-natural grasslands are objective of many studies representing a wide range of scientific disciplines and conservation management strategies [9]. Also, the importance of improved grasslands in urban areas is increasing, as areas with potential to biodiversity maintaining [10].

The rational management of grasslands should be planned at landscape scale [11]. However, in Poland, such plans do not exist [12]. The planning needs accurate maps and knowledge regarding the grassland area. Data regarding grasslands distribution and area are presented on maps and provided by different databases, however, their quality is not optimal [12].

Here, we compare different, freely available databases: Corine Land Cover, Pan-European High-Resolution Layers, Statistics Poland and Topographic Object Database to assess their applicability to estimation grassland area at regional scale.

Materials and methods

Study area

The Lower Silesia voivodship (South-West Poland, area 19.9 thousand km², population 2.9 million) is characterized by diverse topography, geology, and climatic conditions. The altitudinal range varied from 30 m. a.s.l. up to 1603 m. a.s.l. at the highest peak of Silesia, Śnieżka Mountain. The voivodship is located mostly in the basin of the middle Oder River with its historic capital in Wrocław, while the southern border of Lower Silesia is mapped by the mountain ridge of the Sudety Mountains. The mean annual temperature ranges from around 4 °C in the mountains to 9.4 °C in the lowlands; the total annual precipitation ranges from 500 mm in the lowlands to over 1300 mm in the mountains [13]. The lowlands are generally dominated by arable lands, while the highlands and mountains are a mosaic of forest and grasslands. The agriculture on lowlands, on fertile soils, is intensive and highly developed, while in mountains the agriculture is rather extensive.

Grassland definitions and problems with typology

Because the grasslands provide a wide range of ecosystem services, they are under interest of numerous groups and scientific disciplines. It caused differences and uncertainty in grasslands typology which is also reflected in grasslands mapping practices. Bellow, we show a schematic illustration of grasslands typology framework (Fig. 1).

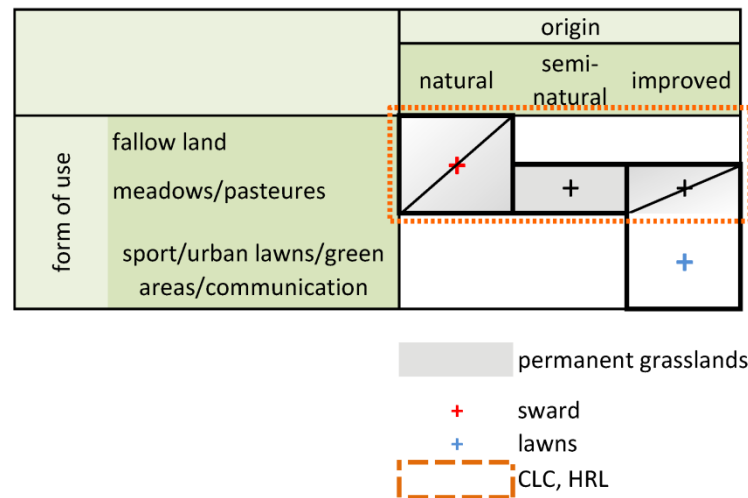


Fig. 1. Grassland typology framework. Grasslands types mapped by CLC – Corine Land Cover, HRL – High Resolution Layers

Generally, the grasslands in Europe differ regarding their origin and agricultural use: they can be natural, semi-natural (established on areas historically deforested) and improved (resulting from plowing and sowing limited number of grass varieties) [14]. They create fallow lands (e.g. mountain swards), are used for hay production or as pastures and can be part of green infrastructure. Grasslands used in agriculture (meadows/pastures) can be divided into permanent grasslands (in Polish trwałe użytki zielone, TUZ) which exist longer than 4 years and can consist natural, semi-natural and improved grasslands, and the second group, the temporary grasslands formed by temporary grasslands existing shorter than 4 years [15]. Traditionally in Polish biological and ecological literature, the grasslands are divided into those with relatively high, dense vegetation: meadows (grasslands mowed for hay production) and pastures, as well as the second group with relatively short, sparse vegetation called “murawy”. The term Polish “murawy” is used both for natural swards (e.g. in high mountains or on rocks) as well as for swards, which is improved grasslands used in urban greenery and for sports [16].

The diversity in the purposes of maintaining meadows causes large differences in their size, location in relation to urbanized areas and in the methods of collecting data on them. As result, from different maps/databases, varied kinds of information can be derived. The characteristics of data sources used are listed below.

Data sources

Corine

The first data source was Corine Land Cover (CLC) digital maps, which gathered information about land-use and land-cover basing on the data from satellites. It consists of an inventory of land cover in 44 classes. CLC uses a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena. In this study, we used data from Corine Land Cover 2012 and 2018. The CLC 2012 based on data from IRS P6 LISS III

and RapidEye dual date satellite imagery, while CLC 2018 used data from Sentinel-2 satellite and Landsat-8 for gap filling [17].

From the 44 land-use types covering European landscape, we chose two: (1) semi-natural grasslands and pastures (CLC code 231) which include also large green areas at military training grounds and (2) natural grasslands (code 321), including grass-dominated areas mainly located on high altitudes or areas with too harsh conditions for forest development. Because of the smallest mapping units size, the CLC maps do not show green urban areas and grasslands related to a communication infrastructure (road verges) and rivers (embankments) [12, 18].

High Resolution Layers

The second source of data was Copernicus Europe's eyes on Earth. We used High Resolution Layers (HRL), created from the satellite photograph of Sentinel-2A, Sentinel-1A and B, and Landsat 8 OLI. We used map of natural and secondary grasslands, which are defined areas covered by unless 30% of herbs and grass species. The coverage of trees in these areas could not exceed 10%. To these maps also grass-dominated heathlands, grey dunes vegetation, and salt meadows, semi-arid steppes, and urban grasslands together with green areas at military training grounds are included [19]. In this study, we used HRL maps in resolution 100 m. This map also did not show a green infrastructure.

Topographic Objects Data Basis (BDOT10k)

The database was developed in Poland in the years 2012-2013 and includes information from Land and Property Register, Geodesic Records of the Area Utilities Network, State Border Register, State Register of geographic names, orthophoto maps, and Digital Terrain Models. This data are supplied by field records and are constantly updated. The BDOT10k consists of information regarding topographic objects, with accuracy corresponding to map in 1:10 000 scales [21]. In the article data of grassland vegetation cover, which shows all types of areas covered by vegetation with grasses domination, including green infrastructure were used. However, this data did not allow distinguish different grasslands types.

Statistics Poland

The Statistics Poland (formerly known as Central Statistical Office) is Poland's chief government executive agency charged with collecting and publishing statistics related to the country's economy, population, and society, at the national and local levels. Statistics Poland delivers data on the area of permanent meadows and pastures used for agricultural purposes (so-called TUZ) for years: 1995, 2005, 2011 and 2015 [21].

Results

In Lower Silesia, the area of permanent meadows and pastures used for agriculture (in Polish: TUZ) has decreased two-fold over the years 1995 to 2015 (GUS, 1995, 2015) (Fig. 2).

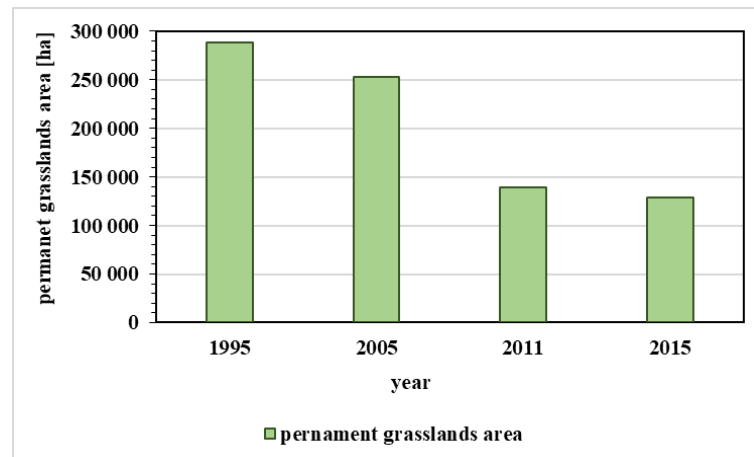


Fig. 2. Changes of permanent grasslands area in Lower Silesia (in Polish TUZ)
Source: own study based on GUS data 1995, 2005, 2011, 2015)

The different data sources used for calculation of grassland areas over Lower Silesia voivodship reveal different results. The area of grasslands ranges from 5.8% to 16% of the total area of the Lower Silesia (Tab. 1). The largest difference in area occurs between the data from Corine Land Cover, where the area of meadows and pastures varied from 115 497 ha (CLC 2012, Fig. 3) to 125 498 ha (CLC 2018, Fig. 4), and the data originating from BDOT10k according to which the area of grasslands is equal to 318 403 ha (Fig. 5). In turn, according to data from Pan-European High Resolution Layers (2015) the grassland area is 156 362 ha (Fig. 6).

Tab. 1. Grasslands area in the Lower Silesian voivodship according to different data sources

Database	Grassland area [ha]	% area in the Lower Silesian voivodeship
Corine Land Cover (2012)	115 497	5.8
Corine Land Cover (2018)	125 497	6.3
Pan-European High Resolution Layers (2015)	156 362	7.9
BDO10k (2019)	318 403	16.0

Source: own study based on data from Corine Land Cover (2012), Corine Land Cover (2018), Pan-European High Resolution Layers and BDOT10k)

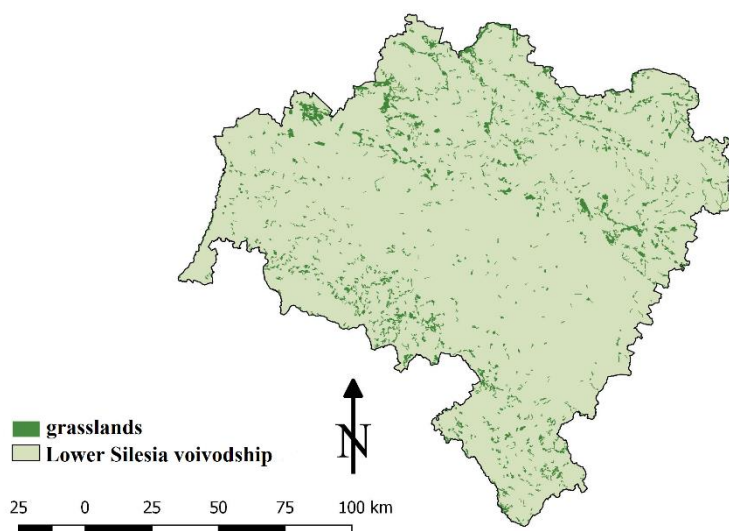


Fig. 3. Distribution of grassland patches (dark green) according to Corine Land Cover (2012) in Lower Silesia voivodship

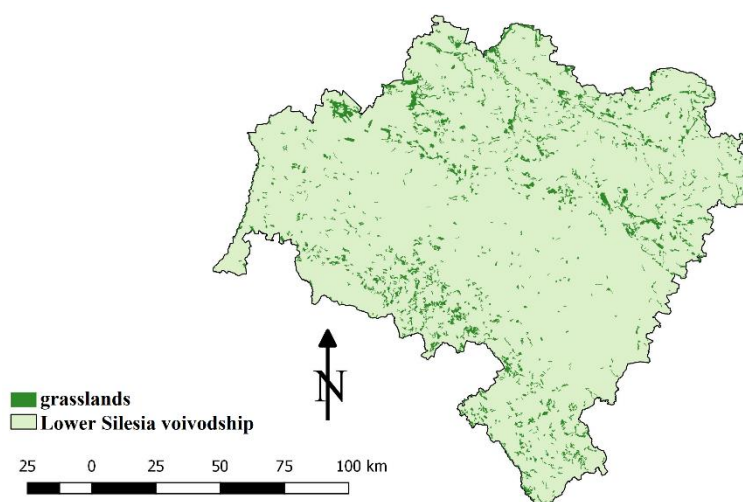


Fig. 4. Distribution of grassland patches (dark green) according to Corine Land Cover (2018) in Lower Silesia voivodship

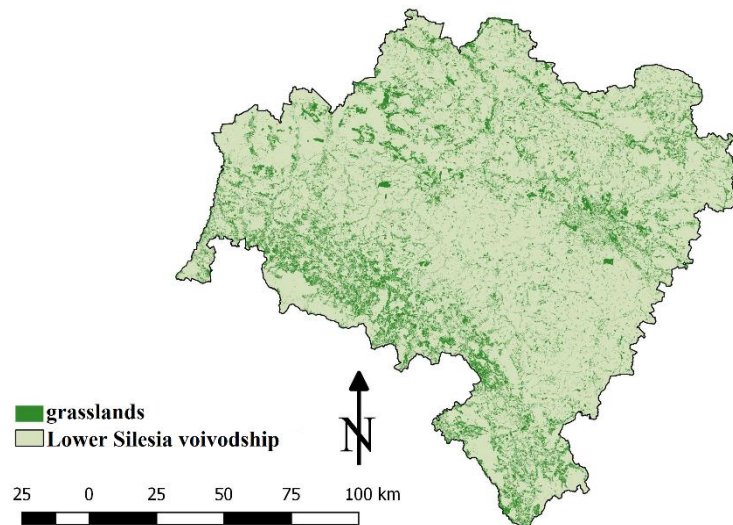


Fig. 5. Distribution of grassland patches (dark green) according to BDOT10k (January 2019) in Lower Silesia voivodship

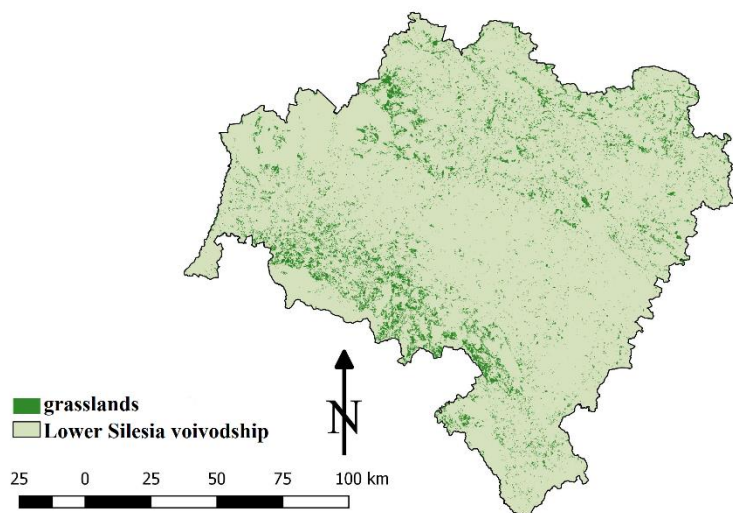


Fig. 6. Distribution of grassland patches (dark green) according to Pan-European High Resolution Layers (2015) in Lower Silesia voivodship

Discussion

There is considerable difference in grassland area assessment regarding applied methods of grassland mapping. The different sources can give results that varied more than 100%. Especially pronounced is the difference between CLC and BDOT10k. The difference resulting from two sources: (1) different definitions of grasslands and (2) different map resolution. As was shown before the definition of grasslands in the BDOT10k database is broad and includes all types of grasslands, while the two types of land use derived from CLC not include urban grasslands. Moreover, the two databases differ firmly in map resolution, which caused that, due to generalization, the small grassland patches are not included in CLC. The difference in map resolution caused also discrepancy between grassland areas calculated from CLC and HRL.

It is found that the CLC underestimates the grassland cover by 37% in scale of European Union, comparing to new satellite data [22].

Theoretically, the ground survey should provide more precise information on grassland areas. Unfortunately in Poland collected are information regarding permanent grasslands used in agriculture (in Polish: TUZ), and the data did not show shape, area, and location of particular grassland patches [12]. Additionally, the data have also two flaws: (1) it seems that they overestimate agriculturally used grasslands area [23] and (2) are publicly available up to 2015. Moreover, the data from ground surveys are usually high- quality, but not feasible for large scale monitoring [24]. Unfortunately, there is a problem with using remote sensing for grasslands mapping, comparing for example with forests. The particular challenges are the small spatial extent of such habitats, their spectral similarity, and the high spatial, structural and temporal diversity of the vegetation composition [25]. It needs not only high-resolution data but also intra-annual time series for the discrimination of habitats via the distinction of different vegetation growth phases. The capacity to differentiate individual grassland habitat classes using remote sensing data is not reported [25]. Fortunately, results of the classification of data from new satellites allow increasing the accuracy of grassland mapping [22].

The maps and databases used in this article, are the same over entire country. Therefore the result can be extended over entire Poland. They indicate that there is an urgent need for high-quality map of grassland vegetation for Poland, which allows distinguishing different types of grasslands (e.g. semi-natural grasslands, swards, improved grasslands, green infrastructure). The results reveal also large area covered by so-called green infrastructure consisting of urban lawns, road verges and embankment vegetation. The results suggest that in Lower Silesia the area of green infrastructure dominated by grasslands equals the area of agriculturally used meadows and pastures. Considering the value of green infrastructure for biodiversity conservation [10] and results of this study it can be advocated that more attention should be paid for the green infrastructure as potentially substituting ecosystem services provided by semi-natural grasslands. It seems to be especially important considering decrease area of permanent grasslands observed here.

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MOTIVES FOR PARTICIPATION IN PHYSICAL ACTIVITY OF STUDENTS OF THE UNIVERSITY OF THE THIRD AGE IN SIEDLCE

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Abstract:

The aim of the study was to identify the motives that affect participation in physical activity of students of the University of the Third Age in Siedlce, hereinafter referred to as UTW. The conducted research used the diagnostic survey method in which the research tool was a questionnaire, with 82 respondents examined. The statistical calculations were performed with the Statistica 13. PL software, which included an analysis of the discriminant function. The obtained results showed that most common free time activities of UTW students were meetings with friends and self-education. The forms of physical activity that the subjects engaged in most frequently included walking and team games such as basketball. Respondents declared that their participation in physical activity had a positive impact on their well-being. The main motive for participation was the desire to oxygenate the body, enjoy a pleasant experience of being in the fresh air as well as to boost the lust for life.

Key words:

University of the Third Age, seniors, physical activity, motives, spare time

Introduction

Aging is now one of the main health and social challenges. In 2050, people aged 60-79 will probably account for a quarter of the total population of the European Union [1]. By 2035, the share of people in the retirement age will amount to 26.7% of the entire Polish population, i.e. approximately 9.6 million [2]. Physical activity is of great importance for everyone, regardless of age. It consists of man's activity involving physical work that causes energy expenditure. Work-related physical activity, especially in the case of manual labour, is extremely diversified, compared to that conducted for pleasure [3]. Physical activity involves performing a variety of tasks at home, moving from one place to another, doing sport and recreational activities, as well as professional work. Physical activity in seniors reduces the risk of atherosclerosis and cardiovascular diseases. What is more, it has beneficial effects on the health of those already affected. This form of

spending leisure time lowers the risk of osteoporosis and fractures at an old age. An active lifestyle reduces muscle atrophy and influences preservation of the motor function [4, 5]. Relevant literature reports that intentional and conscious physical activity exerts an impact on our mental well-being, i.e. mental health, since it improves our health and increases the quality of life [6, 7]. According to Śniadek and Zajadacz [8], physical activity is associated with undisturbed aging. However, the lack of physical activity has a negative effect on our health condition, morbidity and mortality [9]. Physical activity of elderly people is in many cases limited to daily activities such as cooking, cleaning or shopping [10].

One of the key psychological concepts in the 21st century is motivation in many areas of human life, also the one related to physical activity [11]. The concept of motivation is used to determine the factors stimulating action [12], physical activity as well. Elderly people are aware of the benefits of physical activity, hence the most common reason therefor is the care for health [13]. A great number of seniors attend universities of the third age which provide continuous education for the elderly. In face of a growing number of people in the retirement age, such institutions offer this age group with an opportunity to use their time in a productive manner [14]. Data provided by the Central Statistical Office [15] showed that in 2018 there were approximately 650 universities of the third age in Poland with 113.2 thousand students, including 95.4 thousand women.

The aim of the present study was to determine the motives for participation in physical activity of students of the University of the Third Age in Siedlce as well as the manner in which they spent their free time. Moreover, an attempt was made to establish pastimes and physical activities that respondents most often performed in their free time as well as the effect physical activity exerted on their everyday life.

Materials and Methods

The study was performed with the use of the diagnostic survey method based on author's questionnaire with 9 closed questions, with 4 used in the analysis. The survey was conducted in March 2018, and included 82 students of the University of the Third Age in Siedlce. A five-point Likert scale was employed to measure respondents' attitudes. The subjects were classified into two age groups, embracing 59-year-olds and 60-year-olds and over respectively. Statistical analyses were conducted with the Statistica 13.1 PL software, including discriminant function analysis. The discriminant function was applied to calculate coefficients, which were determined with respect to each of the study groups. Before the analyses were carried out, multivariate normality had been examined by checking each variable for normality of the distribution. An assumption was made that the variance matrices were homogeneous in both of the groups. The standard deviation was not taken into account due to the large numbers of respondents in individual study groups. Differences in the mean values whose probability of randomness was less than $p < 0.05$ were deemed as statistically significant.

Results and Discussion

As evidenced by the size of the classification function, UTW students declared that most often they spent their leisure time with friends and acquaintances. However, no significant differences were found between the two study groups. Similar results were obtained by Omyła-Rudzka [16] who established that people in the retirement age devoted most of their free time to watching television and meeting friends and acquaintances both at home and outdoors. The time spent on studying and playing with grandchildren was significantly higher among the respondents at the age of 60 or over, compared to the group of 59-year-olds. Also the amount of time devoted to listening to music and reading newspapers was greater in the subjects aged 60 or more, and these differences were significant. On the other hand, the group of younger subjects preferred watching television. It should be noted that the discriminant function model included seven out of fourteen activities subject to the analysis in question (Tab. 1). The performed surveys showed that older people most often exhibited receptive activity, i.e. they tend to do home-based activities such as watching TV, listening to music or reading, which was confirmed by Koprowiak and Nowak [17] and Gosik [18]. Undoubtedly, such forms of spending leisure time are pleasant and do not require much effort, hence they are conservative methods that are mainly aimed at rest.

Tab.1. Free time activities of students of UTW in Siedlce

Spare time activities	Model of discriminant function		Classification function	
	Wilks' lambda: 0.242 F (8.73)=28.88 p<0.001*		Age of respondents	
	Wilks' lambda	F value	Up to 59 years of age	60-year-olds and over
Fun with grandchildren	0.245	91.523*	2.86	5.77
Learning	0.304	18.603*	4.50	7.61
Listening to music	0.281	8.932*	0.80	2.98
Needlework	0.267	1.361	5.91	6.57
Reading newspapers	0.287	8.234*	0.70	2.28
Watching television	0.263	6.547	3.23	1.99
Meeting friends	0.248	1.848	7.35	6.23
Constant			26.17	37.40

* significant differences at p <0.050

Source: Own study based on research material

The discriminant function model included four out of ten forms of physical activity envisaged for the analysis, with strolls having the highest value of the classification function. It is a form of activity that has a positive effect on people's mental health [19]. Relevant literature provides data that walking is the most common form of activity among older people [13,20] and has a beneficial impact on mental health. This is probably due to the fact that walks do not require financial resources or any special technique. Playing basketball was of great importance among the forms of physical activity preferred by UTW students, but no significant differences were found between the studied groups. The model in question also included playing football and gymnastics

(Tab. 2). What is more, it needs to be emphasised that the study group of 59 year-olds significantly more often did gymnastics than the older respondents.

Tab. 2. Forms of physical activity most often performed by UTW students in Siedlce

Forms of physical activity	Model of discriminant function		Classification function	
	Wilks' lambda: 0.757 F (4.59)=4.40, p<0.003*		Age of respondents	
	Wilks' lambda	F value	Up to 59 years old	60-year-olds and over
Gymnastics	0.763	11.923*	1.62	0.95
Basketball	0.721	8.1588	12.35	11.23
Football	0.782	0.974	2.35	2.41
Walks	0.7.54	1.164	17.09	16.62
Constant			50.65	46.8

* significant differences at $p < 0.050$

Source: Own study based on research material

Physical activity had a decisive impact on the improvement in the well-being of UTW students, which was confirmed by the size of the classification function in the created model of the discriminant function. The obtained results were in line with Mazurek's reports [5], according to which low levels of physical activity caused worsened well-being. Improved physical fitness in both groups and lower weight in the group of 59 year-olds were associated with significantly lower mean values in the model (Tab. 3). Regardless of the age of the respondents, physical activity had the least impact on improved body condition and weight loss in the group of 60 year-olds and over. It should be noted that none of the types of changes observed showed significant differences between the two groups of respondents.

Tab. 3. Changes in the functioning of UTW students in Siedlce as a result of participating in physical activities

Type of changes observed by respondents	Model of discriminant function		Classification function	
	Wilks' lambda: 0.455 F (18.592)=5.886 p<0.001*		Age of respondents	
	Wilks' lambda	F value	Up to 59 years old	60-year-olds and over
Lower weight	0.685	6.456*	1.33	0.22
Better mood	0.654	5.356*	32.29	33.92
Better physical condition	0.623	1.950	1.59	1.96
Better body shape	0.671	1.038	0,11	0,51
Constant			26.17	37.40

* significant differences at $p < 0.050$

Source: Own study based on research material

The main motive for participation in physical activity among UTW students was the desire to oxygenate the body. Also, a high value of the classification function in the created discriminant function model was observed with respect to pleasure and satisfaction related to physical activity and a greater lust for life as a result of participation in a variety of sports and recreational activities. What is more, the study subjects also noted an improvement in their physical condition and appearance, increased appetite, and the modern fashion for physical activity. Similar results were obtained by Dąbrowski [21] whose research showed that the key motive for physical activity among UTW students was a desire to improve or preserve health. Positive impact of physical activity on mood enhancement, longevity and overcoming own weaknesses was reported to be less significant.

In the study group including subjects aged 60 or more, nearly all of the motives subject to analysis encouraged the respondents to physical activity to a significantly higher extent (Tab. 4). However, no significant differences were found in the case of longevity solely.

Tab. 4. Motives influencing participation in physical activity of UTW students in Siedlce

Types of motives	Model of discriminant function		Classification function	
	Wilks' lambda: 0.455 F (18.592)=5.886 p<0.001*		Age of respondents	
	Wilks' lambda	F value	Up to 59 years old	60-year-olds and over
Encouragement	0.378	13.308*	4.65	6.97
Improving physical condition	0.370	16.765*	9.77	12.68
Oxygenation of the body	0.413	26.543*	44.87	51.52
Greater lust for life	0.404	24.334*	13.86	16.91
For pleasure	0.398	22.237*	26.49	31.38
Greater appetite	0.419	6.256*	6.26	7.83
Better appearance	0.356	5.927*	7.35	8.56
Fashion for physical activity	0.378	8.031*	5.10	6.67
Better mood	0.415	8.219*	4.40	6.87
Overcoming weaknesses	0.398	4.542*	3.23	4.55
Longevity	0.391	2.698	2.85	3.71
Constant			26.17	37.40

* significant differences at $p < 0.050$

Source: Own study based on research material

Conclusions

1. Meetings with friends and acquaintances as well as walks were the activities that were most often performed by the students of UTW in Siedlce, hence such activities should be offered to this age group as much as possible.
2. By far the most noticeable changes resulting from physical activity were improved well-being in all the respondents regardless of age group, i.e., similarly to the above mentioned conclusion, physical activity should prevail in leisure time activities of the study group.
3. The main motives for participation in physical activity were the desire to oxygenate the body, enjoy a pleasant experience and satisfaction from taking part in physical activity as well as to boost the lust for life, namely the factors related to active recreation and concentration on pleasure.
4. Higher motivation for taking part in the physical activities carried out as part of UTW classes was observed in the study subjects aged 60 and over, which was possibly due to the desire to be fit until old age and to live a healthy life, which is influenced by an active lifestyle.

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THE ROLE OF THE NANOSTRUCTURES IN THE SYSTEMIC TREATMENT

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Abstract:

The essence of any cancer therapy is to destroy as many cancer cells as possible while protecting healthy tissue and minimizing potential complications. This purpose is not always achievable, especially for the systemic treatment (chemotherapy, hormonotherapy and immunotherapy). The use of nanostructures is a chance to overcome these limitations. The purpose of this article is to present the potential of application of the selected nanostructures in the systemic treatment (targeted therapy).

Keywords:

nanotechnology, nanostructures, systemic treatment, targeted therapy

Introduction

The essence of any cancer therapy is to destroy as many cancer cells as possible while protecting healthy tissue and minimizing potential complications. As years of experience show, this goal is not always achievable especially for the systemic treatment (chemotherapy, hormonotherapy and immunotherapy).

The important factors, which determining the qualification of patients for the systemic treatment, are the stage of the disease (the cancer), histopathological diagnosis and general condition of the patient. Chemotherapy is often used in patients with advanced and disseminated cancer. Because the most of currently used chemopharmaceuticals are characterized by low specificity and systemic effects, so they have a negative impact not only on cancer cells, but also on healthy tissues.

The commonly observed complications are: bone marrow deficiency (neutropenia, thrombocytopenia, anemia), damage to the nervous system (neurotoxicity), myocardium (cardiotoxicity) and pulmonary parenchyma. The patient must be informed about the risks of therapy and possible side effects. Therefore, he may refuse the treatment.

To solve the problem of toxic effects of the systemic treatment on the body, the reserchers looking for the new forms of drug distribution using the nanostructures, such as liposomes, gold nanoparticles, carbon nanotubes and dendimers.

Methods of production and division of nanostructures

Nanostructure is the natural or artificial form of the organization of matter, made up of atoms, particles or clusters, which dimensions are limited to nanoscales (where the size does not exceed 100 nm). The material built or produced using by the nanostructures is called the nanomaterial. Sometimes in literature we can meet with interchangeable use of these terms [1, 2].

The methods of producing artificial nanostructures are divided into three groups:

- top-down methods- the starting material (in the macroscale) is reducing into smaller parts (in the nanosce), using physical processes,
- bottom-up methods- manipulation of the individual atoms or molecules and combining them into larger material structures, using chemical processes
- hybrid methods [1, 3, 4].

Targeted therapy

The essence of the targeted therapy is to develop a way of distributing the drug in the body so that it is released directly at the site of the disease. It this purpose, it is necessary to find a suitable carrier, which has such features as:

- ability to penetrate into the cells (including overcoming the blood-brain barrier),
- biocompatibility,
- non-toxicity,
- easy attachment of the active substance (via functional groups located on the surface of the carrier) while maintaining its medicinal properties,
- increasing the half-life of the active substance,
- increasing the specificity of the active substance against specific cells and tissues.

The nanostructures meet most of these conditions, although in the some cases it is necessary to carry out the functionalization process. The carrier-drug combination is a so-called conjugate [5, 6].

Taking into account the mechanism of the action, targeted therapy is divided into:

- passive therapy (Fig. 1), using the phenomenon of the increased permeability of blood vessels, supplying nutrients to the cancer cells. The nanoparticles connected with the drug freely penetrate the cell or are absorbed by the process of endocytosis.
- active therapy (Fig. 1), using a combination of nanoparticle, drug and ligand. The ligand is usually a substance with a strong affinity for tumor cell membrane receptors or a compound for which these cells have an increased demand, for example glucose or folic acid [5, 7, 8].

In special cases, when the carrier is a nanoparticle with magnetic properties, the displacement of the conjugate depends on the strength of the external magnetic field. The substance will stop at the target site when that strength is higher than the linear blood flow [5].

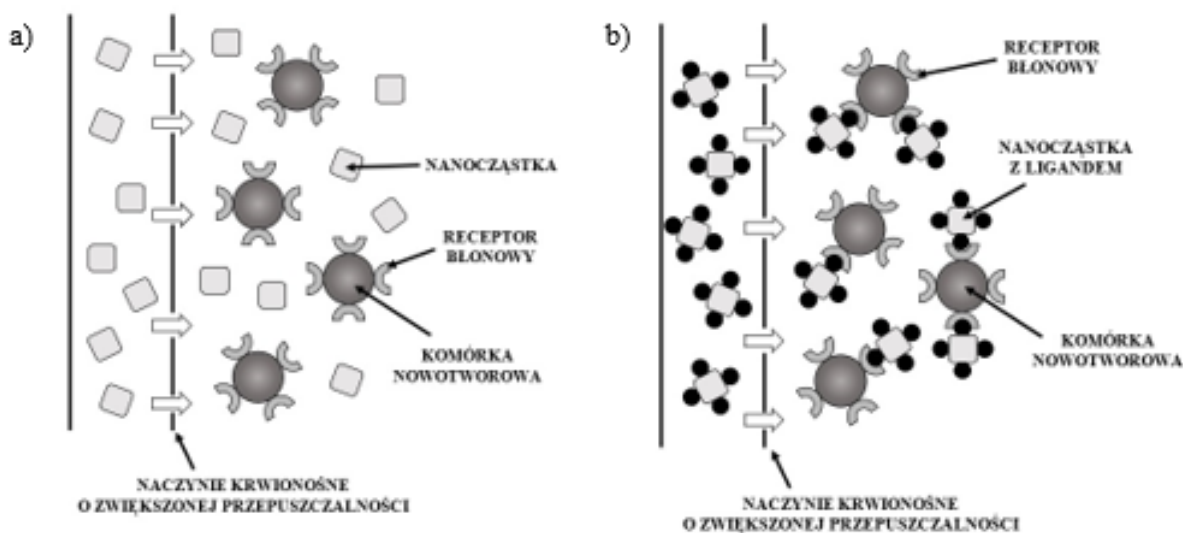


Fig. 1. The targeted therapy mechanism: a) passive, b) active

Source: own study

Nanostructures that can be used as drug carriers in oncology are among others liposomes, gold nanoparticles, carbon nanotubes and dendrimers.

Liposomes

The liposomes are spherical nanoparticles, composed of a double lipid layer surrounding a centrally located water space. The drug or active substance is located in this space, and its release occurs as a result of the liposome degradation under the influence of the low pH of the tumor microenvironment.

Currently, The use of multi-walled carbon nanotubes as the carrier for doxorubicin has contributed to increasing the distribution of this chemopharmaceutical into the cancer cells (specifically breast cancer). This caused an improvement in the activity of the therapy - the greater toxicity of the conjugate compared to the unbound drug [11]. the liposomes are used as a carrier for doxorubicin in the treatment of breast cancer, ovarian cancer, multiple myeloma and Kaposi's sarcoma. The studies have shown that the conjugate has an increased accumulation in the tumor area compared to the drug in unbound form. This increased the effectiveness of the therapy while reducing the side effects [5, 7].

Gold nanoparticles (AuNPs, GNPs)

The nanoparticles are formed by reducing the dimensions of the starting material, in this case gold, in all three directions of the coordinate system.

The research in this area, has shown the usefulness of GNPs as the carrier of the oxaliplatin. This chemopharmaceutical is a derivative of the cisplatin and is used in the treatment of the

colorectal cancer. Unfortunately, the high neurotoxicity and the negative impact on the patient's well-being (nausea and vomiting) significantly limit its applications. The use of an combinations the oxaliplatin with GNPs (functionalized by the polyethylene glycol) allowed to reduce the side effects and increase the effectiveness of the therapy (about sixfold) [6].

Carbon nanotubes (CNTs)

The nanostructures, which take the form of a cylinder constructed of coiled graphene layers, are called carbon nanotubes (CNTs). Due to the number of the layers, they are divided into:

- single-walled (SWCNTs), which composed of single graphene layers,
- multi-walled, which containing many concentrically arranged graphene cylinders) [9, 10].

The results of the studies have shown the usefulness of using the nanotubes as transport systems for such compounds as:

- paclitaxel

The conjugate resulting as the combination of paclitaxel and SWCNTs was characterized by the greater solubility, longer residence time in the blood circulation system and better uptake by tumor cells, compared to the drug in the unbound form. This factors affected to the increased in the accumulation of the drug in the tumor area [7, 11].

- cisplatin

The studies on cisplatin (DDP) and single-walled (SWCNTs) conjugates have shown the existence of a directly proportional dependence between the conjugate concentration and the tumor cell survival. Although the effectiveness of the drug in unbound form and the conjugate was comparable, the treatment with DDP-SWCNTs showed the less toxic systemic effect. Therefore, the conjugate induced the fewer side effects [11, 12].

- carboplatin

The work in this area has shown, that the use of carboplatin-carbon nanotubes therapy contributed to significantly slowed the growth of cancer cells in the blood [11, 12].

- doxorubicin

The use of multi-walled carbon nanotubes as the carrier for doxorubicin has contributed to increasing the distribution of this chemiopharmaceutical into the cancer cells (specifically breast cancer). This caused an improvement in the activity of the therapy - the greater toxicity of the conjugate compared to the unbound doxorubicin [11].

Dendrimers

Among the nanostructures discussed, the dendrimers are characterized by the most interesting structure, in which can distinguish a multifunctional center (core) and a arms extending from it, so-called dendrons. Between dendrons are located the free spaces, so-called cavities, which can be used to encapsulate the active substances. There are many types of dendrimers, including polyamidoamine (PAMAM), poly(propylene imine) (PPI), polyether or carbosilane (DBD) [1, 13, 14, 15].

The results of the studies have shown the usefulness of using the dendrimers as transport systems for such compounds as:

- methotrexene

In the research used the combination of the methotrexate and the PAMAM dendrimer with modified surface functional groups (acetylated). Moreover, for making the conjugate, as the ligand was used the folic acid and as the fluorophore- the fluorescein. The results have shown the increased accumulation of the conjugate in the cancer cells, especially in the cells with overexpression of the folic acid receptors. Further the significant inhibition of tumor growth was observed [13, 15].

- cisplatin

The use of the PAMAM dendrimers as the carrier of cisplatin contributed to the increase of the drug accumulation in the cancer cells, which in turn contributed to reducing the toxicity effects of the therapy [7, 14, 15].

- doxorubicin [7, 15],

- 5-fluorouracil (5FU) [15],

- gemcitabine [16].

Summary

The research results on the use of the nanostructures as the drug carriers in the systemic treatment have shown, that this solution is very useful. In the most cases, the therapy using the conjugates was characterized by the greater effectiveness and the less toxicity.

The cited examples are a small fragment of the possibilities, which arising from the applications of the nanostructures in medicine. They can be also used as carriers of the contrast compounds or themselves fulfill this function. The nanostructures that combine the diagnostic and the therapeutic functions (so-called multifunction nanostructures) are the application peak. In addition, the researcher are working on using the nanostructures in radiotherapy as radiosensitizers -the compounds, which increase the sensitivity of the cancer cells to the ionizing radiation.

Undoubtedly, in the future the nanostructures, thanks to their specific properties, will contribute to the improvement of diagnostics, treatment, monitoring and prevention of many diseases.

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POLITICS INCLUDED IN SONG LYRICS OF THE „PIDŻAMA PORNO” (PORN PYJAMAS) BAND

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Abstract:

Music communicates to hearers its content using appropriate channels. For many years there has been a close connection between the music and political scenes, but not only through songs created or played on the anniversary of national holidays but also by manifest artistic political views. In America The Beatles were the best way to explicit governmental opinions. In Poland, rock music appeared firstly in church rituals. On 14 January 1968 there has been first ever in Poland rock Mass, took place in Podkowa Leśna: *The Lord Is My Shepherd* with lyrics by Kazimierz Grześkowiak and music by Katarzyna Gertner. The Mass performed Czerwono-Czarni music band [1]. This article focuses exclusively on the political content of Pidżama Porno's (Porn Pyjamas) band song texts. It's a group formed in 1987 by Krzysztof Grabowski and Andrzej Kozakiewicz. In 1989 they recorded their first material entitled *Ulice jak stygmaty*. After a few interruptions in its activity, Pidżama Porno is concerting and recording to this day.

Keywords:

policy, government, political views, Krzysztof Grabowski, Pidżama Porno

Introduction

Music is one of the fields of art and belongs to the area of social culture. At the same time, musical compositions such as anthems, oratorios, patriotic songs, so-called agitated songs as a medium convey social and political content. They have a great potential for social impact due to their features. Music, as a medium, communicates to the audience captivating and relevant content through easily accessible forms. It affects the recipient through: the tones of sounds, the connection of words and music, as well as the author and the performer [1]. The use of music in political and social communication has a rich history. The review of the subject literature getting to know the most important titles taking up the matters: E. Wrześniewski, *Muzyka w kształtowaniu polskiej kultury politycznej w latach 1918-2010* and M. Białas, *O specyfice muzyki politycznej*. Complete bibliographical address contains section of the Literature.

The most complete expression of politics was gained in America. There, in the 1950s

rock'n'roll music appeared, which with its lively expression and simplicity of the melody had a great impact on young people, particularly through the musical phenomenon, which was then The Beatles band. In 1965, the British queen handed the Order of the British Empire to the members of the band, and a year later the musicians almost led to riots when, during a visit to Manila, they did not accept the party invitation issued by President Marcos [1]. In Poland, there were few bands recording songs that don't fall out of the music charts, in the example: Niebiesko-Czarni, Skaldowie, Czerwone Gitary, Trubadurzy, Breakout, No To Co. Exactly the same year the main character of this article – nicknamed Grabaż - was born in Poland.

For nearly four decades, Krzysztof Grabaż Grabowski has been continuously active on the Polish music scene. He is the leader and co-founder of "Pidżama Porno" (Porn Pyjamas) band (founded in 1987) and „Strachy na Lachy" (Empty Threats - the band was founded in 2002). An analysis of Grabowski's political artwork and the metaphors it contains is the right reason to begin this article.

The musician grew up in Piła, from where he moved to Poznań. He made his debut in 1984 in Jarocin with the band „Hands Up" and for many years was associated as a presenter with Radio „S" - current Radio „Eska". In one of the interviews, Grabowski was compared to a „rock Jacek Kaczmarski" who was Polish singer and lyricist, known mainly for his songs on historical and socio-political subjects. Although at first he was not satisfied with this comparison, after years he appreciated the artist and reached for his works. He understood that over the years of his own artistic practice he also became the voice of a generation that wanted change.

From the beginning, Grabowski's activity was dominated by the political situation in Poland. The musician openly criticized the contemporary political reality without the fear of consequences. Despite the passage of decades, Grabowski still often comments on the actions of politicians, often addressing words of criticism to them. In August 2017, in an interview for Kajetan Kurkiewicz at „Gazeta Wyborcza" he said: „This is a game called: „It is beyond the mind." And you can't say „Check" because the other party's invention is inexhaustible. As far as I am concerned it is not a drama that PiS rules. This is normal in democracy. But history rarely records the cases where someone destroys everything. Now, it was not only about the courts but about the whole. The way these laws were proceeded was shameful. I took it as a spitting in my face" [2].

The theoretical background of this article are theories of mass communication, with a particular emphasis on the theory of Harold Laswell, which captures the act of communication in five fundamental components: 1) Who speaks? 2) What does he say? 3) What channels does he use? 4) To whom does he speak? 5) With what effect does he speak?

Due to the willingness to present important events in the history of contemporary Poland and their impact on the music scene and the work of Krzysztof Grabowski, the genesis of the song lyrics will be highlighted. Interviews with musicians and their biographies will also underline the most important thesis in the article.

In the article below, I will use a method of analyzing theoretical problems related to political music, I will use the monographic method, which will help me to describe in detail the work of Krzysztof Grabowski. The main research method will be content analysis - song lyrics.

I will analyze the lyrics of the songs that were on the CDs: *Ulice jak stygmaty* - *Streets like*

stigmas, Futurista, Złodzieje zapalniczek - Lighter Thieves, Ulice AK stygmaty – absolutne rarytasy - Streets like stigmas - absolute rarities, Styropian - Styrofoam, Marchef w butonierce - Marchef in a buttonhole, Bułgarskie Centrum - Bulgarian Center.

I consider the most important bibliographic items for the following text: *Someone. Auto-bio-Grabież* (Krzysztof Gajda, Krzysztof Grabowski, InRock Publishing House 2010), the interview with Krzysztof Grabowski *Minery Form* („Tylko Rock" 1999, No. 8 (96). In the article, I also use information found on the following websites: PWN Encyclopedia, Lubimyczytac.pl, NN Theater, NGO Portal, UN Information Center in Warsaw.

Politics included in song lyrics of *Streets like stigmas* album

The first political song of Pidżama Porno is *Lewą Marsz* (*March with the left*), which is originally a poem by Vladimir Majakowski, who was Russian poet and dramatist [3]. Krzysztof Grabowski reached for the poem in 1988, when the Orange Alternative [4] appeared - an anti-communist social movement, which was founded in Wrocław in the early 1980s on the initiative of the local opposition. The actions of Orange Alternative members were designed to expose the system's absurdities through parodies. The regime was very weak at that time and the youth decided to fight communism with a sense of humor and a surreal joke, singing a revolutionary song with the lyrics: *Nobody will defeat the communism!* Grabowski: „I think the sense was similar to the Michnik's *International song* from 1966. We also sang the *International song* at our concerts. Because these were very good lyrics. I think that *March with the left* fulfilled its role, in the pure nonsense meaning, in which this trick was understandable to contemporary audiences. The song had a revolutionary melody line, a revolutionary chorus, so if we opposed to "Reds", it came out a good counter-revolutionary piece" [11]. In November 1965, Adam Michnik was one of the students of the University of Warsaw, prosecuted by the university disciplinary jury on suspicion of supporting the criminal group of Karol Modzelewski and Jacek Kuroń, who were imprisoned at that time. During the process, Michnik sang the French anthem along with Wiktor Nagorski and Maciej Czechowski. It was an outcry against repression by the government of that time [12].

The next song is: *Kiedy praży się Paryż* (*The flare-up of Paris*). It was a reference to the richness of culture, its spiritual and intellectual heritage. In this case, however, it was a game of imagination, a projection of ideas about Paris, where Grabowski had never been to, and the inspiration was taken from Bruno Jasieński's novel *Pałę Paryż* (*I burn Paris*). It is a novel from the interwar period that caused a scandal in the French capital. Authorities demanded that Jasieński be expelled from the country [13].

Porządek panuje w Warszawie (*Order prevails in Warsaw*) was inspired by the words of Horace Sèbastiani from the Ministry of Foreign Affairs in France [6], who, after the capture of Warsaw by Ivan Paskiewicz [7] did state: *Order prevails in Warsaw*. The song is a critical description of totalitarianism, an announcement of the anti-communist revolution, because: „nothing will be forgotten (...) the cannons will explode and people will open the windows". The protagonist of Grabowski's lyrics is tired of everyday life, in which „cannot salvo can be heard constantly one by one, here and now the front line runs" and ironically pronounces that „order prevails in Warsaw (...), in Gdańsk (...), in Silesia, the whole Poland is so peaceful. ". Grabowski

explained that „blue postmen" are policemen, „spontaneous flag hoisting" means the day of Labour Day. Grabowski today believes that this is one of the songs that never lose their relevance, because the political system can change, but the pressure of power on citizens will not. Anna Fechner wrote about this song: „The social and literary immortality of the given song thus stems, to some extent, from its courageous and open opposition to the official authorities, as well as from its reasonable distrust or caution about politics as such and - automatically - all its representatives, which is after all, as it has been emphasized many times, the condition of conscious and reasoned existence" [14].

Bal u Senatora '85 (The ball at the Senator's '85) brings to mind Adam Mickiewicz's *Dziady (Forefathers' Eve)*. The ball scene at the Senator's plays an important role in Mickiewicz's work - since it takes place on a historical and metaphysical level [15]. The senator in *Dziady* was Nikolaj Nowosilicow, who together with his subordinates played an important role in the Mickiewicz scene. The conformism of the society was shown here, because no one objected to the Senator [15]. On a historical level, the ball scene showed the brutal methods of operation of the Russian oppression apparatus, deprived of all human acts. It can be said that the ball was used to emphasize the ruthlessness of the executioners, who treated death as fun, however, Polish patriots were also present there, considering the murder of the Senator [15]. In the metaphysical scene took place the prophecy of priest Piotr who during the interrogation was hit in the face and predicted the imminent death of the Doctor and Pelican. The doctor did die after being struck by lightning [15].

Grabowski explained the inspiration by *Dziady*, claiming that it seemed to him that the historical context of the writing by Mickiewicz was similar to the context in which the *The ball at the Senator's '85* was created, as it was a time when Poles were also under regime, the enemy „in some way conformed and collaborated". Grabowski explains the genesis of the title as a literary abbreviation and a clear introduction to the mood, and the theme of the song. „Very often, I would use quotes, crypto quotes, making syntheses, mental shortcuts, signposts, keys, clues, hints. I would imply such an interpretation", he summarized years later [11].

In the lyrics of *The ball at the Senator's '85* also appears a historical and metaphysical meaning, as in Mickiewicz's. Historically, this is a rebellion against the communism prevailing in the country, its strategy of governing and accepting society. It is a song written with "regret that this revolution swells, thickens and does not want to burst." The lyrical subject says that „instead of windows, bars have been put in place" and everyone must „pretend they are made of gold", defend themselves from being „shot" and they are shot „for thinking independently." The metaphysical level also depicts a prophecy of the future, which is the fall of communism. In the original version, the song lyrics were several pages long and combined with Władysław Broniewski's poem: *Bagnet na broń (Bayonet on a Rifle!)*, which made the song last over twelve minutes [11]. Perhaps Krzysztof Grabowski, extending the text of *The ball at the Senator's*, inspired by the works of Adam Mickiewicz, reached for the poetry of Władysław Broniewski because Broniewski considers himself to be a continuator of Mickiewicz's works.

Trzymając się za ręce (Holding hands) is another testimony of the loss of man in a system in which ordinary life has long been impossible to live, and one cannot trust even the loved ones. The lyrical subject is against reality, he wants change, he wants the *foreign ground verge to be removed*. The song has a reference to Uncle Tom's Cabin novel [16] and to Russia - both are to be

a symbol of freedom. An interesting fact is that Grabowski, when asked about the story behind the song, admitted that he wrote it for a female friend from Poznań, Dagmara, for her name day or birthday, and the verse about Lenin that appears in the lyrics he explains as a joke, „a childish text", written so that „the sentences get on well with each other” [11].

Tak jak teraz (As it is now), it is the protagonist's dream about living in a better reality. In this dream: „no one sang about the murders, no one talked about lies, no one hurt his hands on the wires and no one give testimony." The subject confesses that he now no longer knows whether it was a dream, „someone mocked him." He felt so good in the dream that it was „hard to believe". „As it is now, I would like it always to be" - he says and adds that he could be calm even for a moment, „he was not afraid of day or night anymore, he was not afraid of shouting, yet he was afraid to open his eyes". It is a picture of an idealized world, dressed as a tale of a dream that just ended [11].

In *Terrorystka Frania (The Terrorist Frania)*, a reference to the anarchist organization „Freedom and Peace" [17] has been used, and it is in the phrase “Black Europe” - because this color was the flag of the organization. It is a song, originally written in honor of Fanny Jefimowna Kapłan. On August 30, 1918, a 19-year-old Kapłan led the assassination of Vladimir Lenin. Kapłan fired the Browning pistol with curare poisoned bullets three times, injuring the politician in the left shoulder and lung. However, the third bullet hit a woman talking to Lenin, injuring her fatally. Kapłan voluntarily surrendered to the pursuing services. Transported to the Cheka headquarters she answered all questions. Apparently, Lenin decided to spare the woman's life, but on September 3, 1918, the Kremlin protection commander, Malkow, received an order to kill Kapłan, without the court and sentence [8].

Katarzyna ma katar (Catherine has a runny nose) expresses dreams of freedom. The title protagonist is a personification of Russia, which is in trouble in its structures. This is illustrated by giving its name - Katarzyna and describing her illness. Well, Katarzyna - USSR – „has a runny nose, shakes throughout (...) spreads bacteria and infects". For Poles, it is hope: „May she not survive the winter, let's drink to Katarzyna's health." In 1999, Grabowski admitted that it was a very universal song: „A certain Katarzyna once ruled this country. I wrote the lyrics in 1987th. Gorbachev ruled, there was Perestroika, ice was melting. And if in the East the ice was melting, it meant that Katarzyna was weakening. Hence the runny nose, which is also a metaphor. It is quite a clear allusion. But today everything can be related to Katarzyna. The whole world can be Katarzyna. Because today the whole world has a runny nose. Just look around” [11].

Wojna nie jest twoim stanem naturalnym (War is not your natural state) criticizes national liberation surges. The song is based on the fact that wars are a consequence of politicians' actions („War is not your natural state, although some want to convince you of this"), and there is no excuse for them, even if they break out for noble reasons, because: „It is not enough to put on white gloves to keep your hands clean enough. This game is too absurd, too much, too much, too much of reservation in it". Finally, the lyrical subject points out that we are all the same on Earth - we think and want the same, only the language in which we speak differs.

Świńska procesja (Swine procession) was created shortly after Grabowski's brother-in-law's name day, after when the Security Service came to the apartment and confiscated the printer that was sitting under the bed. It was the musician's first eye contact with the security service. „A sick,

absurd phenomenon. They tried to question us, listed various facts from our lives and tried to create the impression that they knew everything. They must have known that from somewhere. Today this piece could relate to this PiS mayhem: „night of flying files, night of open archives" [11].

List do żołnierza (A letter to the soldier) is a protest against violence in the name of patriotism. The lyrical subject points out that soldiers are manipulated, transformed into killing machines. Fear is incorporated in them, everything – „even eating and defecating" - must be done on order. Indoctrination is taking place so that a soldier who has a task to perform does not have time to ask unnecessary questions. The inspiration to write the song was the story of Michał, a friend of Grabowski, guitarist of the Reżim band. He tried to get into university so as not to go to the army, but he was not admitted to the university. He was therefore called in. In actions of desperation not to take part in the recruitment, he poured boiling water on his legs. He was taken to the emergency room. There, the trousers were removed from his legs along with the flesh. In his autobiography, Grabowski cited the further history of his friend: „The worst thing about his tragedy was that when he was somewhat treated, they took him to that fucking mess. What a guy he was! Punk rock was his whole life. He would write with various rebellious bands, he was 100% engaged in it. He impressed us with his attitude. He was friends with Remi, our drummer. They were the same age, it was easier for them to get along. Michał wrote letters to him from the army. When we visited Remi, he read those letters. Under their influence I wrote a song that was the answer to Michas. And this is where the Letter to the soldier came from, how fucking it is to be in the army. And he wrote about it. We were terribly afraid of this mess. So when the holiday playing was over, I started learning solidly so as not to share his fate" [11].

The album is closed with *Welwetowe swetry (Velvet sweaters)*, which are a kind of experiment, because Grabowski was writing lyrics not for his music for the first time. The words were created in opposition to the slogan: *Polish road to socialism* [11]: „Dzień w którym powstaną barykady / Ja po tej, ty po tamtej stronie / Dzień w którym rozlegną się strzały / I staniemy się bardziej czerwoni /.../ / My nosimy welwetowe swetry / Nasz kolor czarno-czerwony /.../ / Lecz my nie będziemy pokorni/ Nie będziemy bezsilni i bierni / Weźmiemy co będzie pod ręką / I staniemy po stronie rebelii /.../ / Gdzie wtedy schowacie swe twarze?" . English interpretation: „The day barricades are to be built / Me on this, you on the other side / The day the shots will be heard / And we will become more red / ... / We wear velvet sweaters / Our black and red color / ... / But we will not be humble / We will not be powerless and passive / We will take what's at hand / And we will stand on the side of the rebellion /.../ / Where will you hide your faces then? "

Politics included in song lyrics of *Futurista* album

For the second time, Grabowski reached for Majakowski's work, this time writing words to *Strzelaj lub emigruj (Shoot or Emigrate)*. The musician says that this is an ahistorical, biased song. He came to the conclusion that "the revolution must swallow a cutlet to calm down. Like the ancient Olympics in Rome - it took a few to be killed to make the people calm and engaged. Meat eats meat. Here is such a sentence: " How many times does an empty hook build the barricades." Then there were empty hooks and they slept after all. So I generated a plot: a desperate people reach for an eagle, which is the Polish coat of arms" [11].

The last phrase is an expression of Grabowski's disappointment with the working class. In his imagination he projected a group of people who desperately tears the national coat of arms and capture the eagle to roast it and bite its legs [11].

Kilka zdań o Hitlerjugend (A few words about Hitlerjugend) is the first anti-fascist song in Grabowski's work, in which he once again expresses his opposition to violence: „Najpierw przeczytaj sam / „Mein Kampf” / Zanim postanowisz być faszystą / Możesz jeszcze uratować siebie / Nim zostaniesz / Zdalnie sterowaną dziwką (...) / Macie tępe mordy i wydaje się wam, że / możecie zmieniać świat środkowym palcem/ Nie zmieniacie nic i gdy patrzę na was / Odbija mi się zeszłorocznym smalcem (...) / Gdy obijasz mordę komuś / W oczach masz coś z durnia / I coś z Huna / Mówisz, że odczuwasz satysfakcję / Dla mnie gorsze to niż trąd / I gorsze niż komuna (...) / Wasze pięści szybsze są niż myśli”. „First read „Mein Kampf” / Before you decide to be a fascist / You can still save yourself / Before you become / A remote controlled whore (...) / You have stupid gobs and you thank that / you can change the world with your middle finger / You change nothing and when I look at you / It burp out the last year's lard (...) / When you slap someone's face / You have something of a moron in your eyes / And something of Huna / You say you feel satisfaction / For me it's worse than leprosy / And worse than the commune (...) / Your fists are faster than your thoughts”.

As the musician said, the song was inspired by the reality at that time. Aggressive nationalists were present at every demonstration. The first independent stage concerts took place on invitation only- so that the skinheads would not come there. He also said that skinheads, then the first wave of Polish fascists, were most often outcasts from the punk community [11].

Permanenna rewolucja (The Permanent Revolution) was written in 1989, when the Round Table Talks began. It was the last song that Pidżama Porno performed in Prague, then the coup began [11]. In 1939, the Nazis murdered leading Czech student activists. To commemorate them, International Student Day on 17 November was established. On that day, in 1989, a peaceful demonstration was organized in Czechoslovakia, which, however, turned into an anti-regime rally. Nearly 50 people were pacified by the militia (the police). This intensified the protests that lasted until November 26. Their effect was the surrender of power by the government. Today, those events are called: „Velvet Revolution” [20]. Grabowski compares the Revolution in the song to young girls who wear short dresses in the spring. Grabowski: „This is one of the most beautiful things in the world - the moment when girls leave their coats, overcoats, jackets and proudly present bare necks, shoulders, exposed breasts ... I then love swallowing saliva and closing my eyes”. [11]

The inspiration to write another political song *Bal u Senatora '93 (Ball at the Senator's '93)* was the disappointment of Poland after the fall of the commune. It turned out that, despite the change in the system, alongside privileged rulers, people still lived in poverty, and the only difference was that injustice, poverty, and illegal interests were developing within the pseudo-democratic institutions of a sovereign state of law: „Huge fat ladies serve the MP gentlemen, no one has anything to say here, although everyone is screaming out loud, history has forgotten us, poverty is calling us by name, although we have already sold everything that could be sold, we say nothing”.

Grabowski later said that: „the difference between the balls in 1985 and 1993 is that those who with their bare hands tried to knock down the palaces, participate in the ball at the senator's.

It is a kind of bitter reflection, a sad observation. If the situation in which we live is described in "The ball '85", then here is the ball after the victorious battle, where there are also people for whom this war did not end" [11].

The text of the Senator's Ball '85, as already mentioned, refers to the situation in which society is operating in a totalitarian state. It has to pretend that the "bars are made of gold", independent thinking is not allowed. But "the ball is now halfway" there, "the farce in the service of doctrine is over" - so there is a long-awaited rebellion on the horizon. However, in the Senator's Ball of '93 we see a theoretically different image of the society. It seems that all of them find each other well in the new conditions, but the façade hides anger towards social unevenness: "Już nawet sam pan prezes wlażł na stół/Nie milkną brawa i toasty/Ostro popili sobie kumple z podziemia/Ściągają bohaterów maski/Wiemy dobrze o co toczy się gra" – "Even the president himself is on the table / The applause and toasts won't stop / They drank a lot of underworld buddies / They're pulling down the mask heroes / We know exactly what the game's about." Once again, there is the proclamation of a revolt: "Powoli zbliża się nasz czas/Coraz mocniej swędzą ręce" - "Our time is slowly approaching / The hands are itching more and more."

Między czarnym i czerwonym (Between black and red) tells about the turn of 1989. It was so eagerly awaited and it turned out that despite being theoretically different, the principles of its functioning remained the same: „Jest takie miejsce w kiblu na starym / Gdzie rym ma kres / Kończą się wagary (...) / Między czarnym i czerwonym / Nie sposób czuć się dobrze / Między czarnym i czerwonym / Bardziej kurczy się ma postać / Jednak nie strzelę sobie w łeb / Nie skoczę w dół z wieżowca / Między czarnym i czerwonym / Będę odwracał łeb do słońca / Ostatnią resztką sił - do samego końca (...) / Widzę kilku gości w czerni / Nieomylni pewni i pazerni / Gawiedź u ich stóp mętna, czerstwa i tępa / Pociągi stąd do wieczności omijają nasze stacje / Chociaż krzyże wiszą niżej / Fermentują się frustracje”. „There is a place in the toilet in the old square / Where rhyme has an end / Truants go to an end (...) / Between black and red / It is impossible to feel good / Between black and red / My body is shrinking more / However, I will not shoot myself in the head / I won't jump down from the skyscraper / Between black and red / I will turn my head to the sun / With the last remaining strength - until the very end (...) / I see some guests in black big-headed, confident and Grendy / Their chat is cloudy, stale and bunt / Trains from here to the eternity do not stop at our stations / Though the crosses hang Lower / Frustration is fermenting". A few years later, in his autobiography, the musician expanded the interpretation, saying a lot of anti-clerical issue: „It has always been associated with my total dissonance. There was a time when I went to church and yet I was tired of all this. All this morality, word for Sunday, sermons, chased me away faster than ZOMO from demonstration. On the other hand, I was born in Poland, I live in Poland, and I can't say that I cut myself off from religion as such and believe that God doesn't exist. It is a matter of some young man's struggle with the phenomenon of a God being. It is not a matter of faith but of sharing doubts with the Almighty! The church has always been a place that rejected me from God. When I would go to confession, I felt great - at the time I was venting out my sins. I felt strangely light until the priest opened his gob. There were short moments of elation that lasted seconds - when I felt absolutely free, clean. The moment the priest spoke, the euphoria was gone, like a cigarette stubbed out in an ashtray. And this song is a consequence of all of that" [11].

Grabowski believes that this is a religious song and does not offend God, while oppressing beings and institutions that interfere with relations with the Almighty, whose presence he experienced many times in his life. The musician continued explaining his anti-clericalism in the following way: „On the other hand, if we look and treat things historically, then of course: the Church was conducting its specific political game and at the time when it was convenient, it was able to take Masons, the secular left, under its roof, it could also make such compromises. However, after the victory it achieved, because 1989 was the undoubted victory of the Church, consistently, step by step, took whatever it found its own. It became something untouchable, standing above the law and common sense, completely disregarding people who do not adhere to this worldview” [18]. The term „czerwone manto" (the red cane) that appears in the song refers to the winning election for post-communists: „All my story in this song was that I was neither black nor red. I was between a rock and a hard place, or between two rock blocks that clashed constantly, and my living space could only fit in these narrow corridors” [11].

Politics included in song lyrics of *Lighter thieves album*

The song of Pyjamas Porno with a rather interesting but somewhat perverse title is *Ksero z kota* (*Photocopy from a cat*), from the album *Lighter Thieves*. It concerns the political situation, so why the cat in the title, especially since it does not appear even once in the song's lyrics? „It was such a moment that probably a photocopier came to work, so everything that could be photocopied was photocopied. I suspect that at some point I imagined what would happen if I photocopied a cat. I had a song written, a punk counting song, and I missed the title. I illuminated A photocopied kitren in my mind and so it stayed in the song" [11]. In this song, Grabowski points to the double morality that prevailed among Poles after the system change: „Those who are here now are no different / Those who are now (...) are no different when they laugh in the eyes of morons" [11].

Czas czas czas (*Time time time*) is, according to Grabowski, the last of his songs, which called for setting close ranks and not letting be manipulated („Either one of us or someone from them (...) We are an alive mercury, this is our time").

Czekając na trzęsienie ziemi (*Waiting for the earthquake*) is a story about expectating a rebellion, it concerns people who, sensing a revolution, are starting to behave like animals: „This earth is shaking under your feet, this earth is shaking under your feet."

The album *Lighter Thieves* closes the song *Nasze nogi są jak z gumy* (*Our legs are like rubber*), which was created shortly after the Chernobyl disaster („Here it is so psychedelic, we are mirrored in a puddle / The first rain has just fallen this spring, our legs are like rubber"). Grabowski recalled years later that at that time no one was really aware of the peril. The communists blocked the information without warning about the dangers that are associated with the Chernobyl explosion [11].

An attempt of Grabowski's reconciliation with the world can be found in the song *Spokój w głowach* (*Peace in the heads*). A direct impulse for the creation of the song was the fact that Poles already lived in a country where they no longer had to worry about everyday life. The song's lyrics are the musician's attempt to define himself towards God, which contradicts his earlier statement that one religious manifesto is the song *Between Black and Red*. In *Peace in the heads* Grabowski

says: „Niczego nie jest mi szkoda, nic z tego, czego jeszcze mi brak / Wystarczy, gdy kocham, huczy las i wieje wiatr / I także to że co nos zasypiamy twarzą w twarz (...) Dzwon na góry świętej szczycie / On bardziej realny niż myślicie”. „I don't regret anything, anything that I still lack / It's enough when I love, the forest bustles and the wind blows And also, that we fall asleep face to face (...) The bell on the holy mountain's peak It's more real than you think "

Politics included in song lyrics of *Streets Like Stigmas - Absolute Rarities* album

The album *Streets Like Stigmas - Absolute Rarities*, includes the song *Grudniowy Blues o Bukareszcie* (*December Blues about Bucharest*), previously played by Pidżama Porno at concerts. It refers to the Romanian Revolution in 1989 [20], as Grabowski said, „the last act of the end of communism in this part of Europe, and the most spectacular" [11]. Outbreak of the Revolution, Grabowski calls in the song: „The end of fatalities time." He says that „what he did not believe became possible" and the night of 22 December - was „different from previous nights": „(...) Noc podczas której zasnąć strach / Na sekundę zmrużyć oczy / Ciągłe żywe barykady wypełniają przestrzeń nieba / Patrzą w oczy lufom dział / Czując ich oddech / Nazajutrz nic nie było pewne jeszcze / Pijany gniew przez ból wykrzykiwał pieśń / Grudniowy blues o pewnym mieście / Pieśń co zżera strach / i wyważa drzwi kuloodpornych Dacii / Pieśń co dała bunt i rodzi się z sumienia / że tak długo mogły kwitnąć kwiaty / posadzone ręką więźnia”. „(...)A night when falling asleep is fearful / Closing your eyes for a second / Still live barricades fill the sky / They look into the eyes of the gun barrels / Feeling their breath / The next day, nothing was certain yet / Drunk anger cried out the song in pain / December blues about a city / Song that swallows fear and forces Dacia's bulletproof doors / The song that raised the rebellion and is born of conscience / that the flowers blooming for so long could be / planted with the prisoner's hand".

The *December Blues about Bucharest* song is about the three days of the Revolution. Grabowski said that the story behind it was amazing to him. A year earlier, together with his wife, the guitarist of Pidżama Porno - Andrzej Kozakiewicz and his girlfriend, he was in Bucharest: „In the middle of the day Kozak and his girlfriend were taken from the streets by Securitate (...) My wife and I were taken too (...) People on the streets looked like rats starved and chased into the dead end. And a few months later I saw the same people on TV on the same streets, but in a completely different situation. It was an amazing strength [11].

The death of Ceaușescu and his wife as a result of December events, Grabowski sums up in the song as „ending the night, lessening the storm". Although: „there is the trouble with the dawn, the most important thing is that the reptile has already lost its venom, rat heads are falling off with the noise." In his autobiography, the musician broadly commented on the events in Romania in 1989: „To be accurate with the facts: the Polish television did not show the execution itself, only fragments of the trial; Elena and Nicolae sat in the school bench, and the effect after the execution was later shown. I felt like a Chekist, a student of Dzerzhinsky. I knew it was a historical necessity. For this revolution to succeed, the people had to give a clear signal to all who hesitated. Because there the fighting lasted for three days (...) Practically, Ceausescu's marriage execution determined the victory of the Revolution. We say today that Romania was a communist country. It was to some extent. It was an absolute monarchy (...) You don't know what would've happened if they had not

been shot and all had dragged on for a week... History could've gone differently. They were the most Byzantine and most hated of the dictators of Eastern Europe. Ceausescu didn't yet believe he had lost in the court. Virtually all his testimonies were threats that: „as soon as I get out of here, armies will come and I'll show you yet. It will all be leveled to the Grodnu... It was then the game for the highest stake”. [11].

Politics included in song lyrics of *Styropian* album

The song *Anti Fa* can be found not only on the *Styropian* album, but also on the first release from the series *Muzyka przeciwko rasizmowi* (*Music against racism*) [20]. The term itself is the German name for anti-fascist demonstrations. Grabowski believed that as a child of a woman who was born in a concentration camp, he was obliged to speak against such phenomena [11]. This is the fragment of the lyrics: „Mijamy się nie widząc wzajem / Czego innego wypatrując w dali / Lecz kiedy blisko siebie przechodzimy / To słysząc jak serce drugiemu wali / Niechaj wszyscy co się wstydzą / Pokonają w sobie strach / Niechaj wszyscy co nas widzą / Zaśpiewają z nami wraz / Zróbcie to teraz, zróbcie to zaraz / Zróbcie to teraz, zaraz, już! Już! / We are, we are, we are, we are in the same / we are, we are, we are in the same gang”: „We pass each other without seeing each other / Searching for something else in the distance / But when we pass next to each other / The hearts can be heard pounding / Let everyone who is ashamed overcome their fear / Let everyone who sees us / sing with us / Do it now, do it right now / Do it now, now, now! / Now! We are, we are, we are, we are in the same / we are, we are, we are in the same gang. ”

Grabowski took *Szalone lato* (*Crazy Summer*) from „Wędrówki w lud” (Wandering into the People) in nineteenth-century Russia. He said: „Arristocratic Youth”, the more progressive, came up with how you could change the order in Russia. (...) There were escapades of young, educated, well-born Russians in the countryside, where attempts were made to raise awareness among the peasantry (...) Of course, it was broken very quickly by the security, while the very idea appealed to me - bringing new thoughts. (...) [Islands where the wind brings freedom are] the Liberty Islands” [11].

Politics included in song lyrics of *Marchef w butonierce* album

The *Marchef w Butonierce* (*Marchef in Buttonhole*) album starts with the song *Twoja generacja* (*Nienawidzę twojej generacji*) (*Your generation <<I hate your generation>>*). At the beginning of his fixation with punk, Grabowski became fascinated with the songs with a word „generation”: „And so this <<generation>> followed and followed me... There was the CRACKER band and sang: "I hate my generation ". That's where I got the idea. I changed „my" to „your" generation, which is younger, of course. It was 2000 when I was writing this song" [11].

What do each line of the song mean? „Rock and roll is dead, rock is dead" refers to the period when, according to Grabowski, „rock went to the dogs." „Your generation, the curse of hairdressers" refers to „the mass outpouring of young people who had their hair taken off permanently." „Young policemen, young fans / morons versus morons" relates to the story of Przemek Czaja from Słupsk, a thirteen-year-old boy murdered by policemen [11]. „Unpleasant fish

in the name" refers to the media ignoring Pidżama Porno. At the beginning of the new millennium, Grabowski's band was very popular in some circles, comparable only to the KULT band. However, there was no mention of the band in the media. The „pale tree" with which the „unpleasant fish" haunts Grabowski is Grzegorz Brzozowicz. Grabowski says that: „when it comes to the literary convention, it is a basin, I often used it. (...) You've made music, separate verses, pre-choruses, choruses, possibly some codes and pour into these words. On the basis of such a pour, a stream of consciousness, this text was created" [11].

The recipient of the title song of the album *Marchef in buttonhole* is a single person. The song says that: „you still have this catch, power, this strength, dare, that in the dense capitalist forest you are able to be strong enough not to die there (...) The next verse began with illumination. I saw the text on a non-existent fence: „I live only to fucking beat the Varsovians"... Sometimes I like to come up with slogans on the walls. Sometimes I borrow them from the walls for my songs. I had to explain this sentence for a long time, and most of the lines from this verse, too. (...) One of Poland's diseases is that it is Warsaw-centered. When watching the main news on individual channels, most of it is limited to news from Warsaw. Yes, it is, and it probably will be for now. This created such an illusion that everything valuable in the country is focused in the capital. I allowed myself to disagree (...)” [11]. Grabowski continues: „The phrase: And the most commercial is a police dog „was a kind of buffer for our safety in this matter. I thought so. I was stupid. And: „The famous bards are only in Krakow - this was about Świetlicki and Maleńczuk, who were recognized, respected, not me. „Confession Cafe" - it is known that in Krakow, social, literary and artistic life went on, goes on and will go on in pubs (...) "And the one who here the longest has oxygen in the back of the stage" - it's such a playful flick at Kazik Staszewski (...) Show me a guy who releases three CDs a year, and it was a time when Kazik didn't seem to put on a condom at all, because wherever he looked, he immediately fertilized something and something came out of it. Not only that Kazik could play a four and a half hour concert!!! For every artist who has ever stood on stage, four and a half hours is absurd eternity. It's as if you did seven hours of hard work in a mine, and turned down centrally on your ancestor (...) There was a rumor around Poland that during the plays Kazol from time to time goes to the backstage room, inhale a dose of oxygen and goes back to the stage and goes on with performance” [11].

Chłopcy idą na wojnę (*The boys are going to war*) is an anti-war song and a bow towards Jasieński *March with the left*. The historical background of the song is the war in former Yugoslavia. The conflict in Bosnia and Herzegovina dates back to 1991 [19]. This is another song in Grabowski's work, the final form of which was poetry: „There is a poem by Brunon Jasieński that goes something like this: Tratatatam, tratatata / here and here and there / one, eight, four hundred and four / Ladies have socks on their feet. It's a song that knocked me down and heavily influenced the final form of the song" [14]. The piece is composed like a folk song and a fragment of the lyrics goes: „Na mszę dzwony grzmiały dostojnie / Chłopcy idą na wojnę / Czyszcą orderzy tłuste generały / Chłopcy idą na wojnę / Pchają puste brzuchy panny dorodne / Chłopcy idą na wojnę / Maszerują wystraszone łyse pały / Chłopcy idą na wojnę”: „The bells sounded at the mass/The boys are going to war

They clean medals fat generals/The boys are going to war/They push empty bellies good-

looking ladies/The boys are going to war/Scared bald heads are marching/The boys are going to war". War brings death. For some time: „the presence list is still accurate, although this bad dream is lurking", but finally: „boys are not here, plants have grown on them (...) their names have been washed away from the graves by rain".

Idq brunatni (The browns are coming) has its origin in Grabowski's journey by car. He noticed the following warning signs: „Pedestrians", „School". The musician immediately had imagined that if he'd been a skinhead, he could consider the children of the signs as Black people and also thought how the skinhead could destroy such a road sign. The assumption was to be an anti-fascist song [18]. „Think for yourself, what is wrong here today," Grabowski says, probably to fascists, citing earlier a few insults which they most often threw at hated nations: "Dirty nigger, circumcised shame, bad photocopy".

Babilon (Babylon) was originally to be found on the Styrofoam album. This city seems to be a giant stand, difficult to defeat and equipped with new types of weapons that are offensive. Therefore, Grabowski thought that if we wanted to fight it - and it is worth to fight it - then we also need to improve ourselves. The song is an appeal, a call for the progression of ourselves, the environment, each and every one, to reject orthodoxy, blindness and move vividly forward: „Don't treat me like a fool (...) Let's not confuse absurd with evil and physiology with sex." This is, according to Grabowski, the only chance - investing in oneself, taking on new challenges. "History knows only one case when David defeats Goliath, but this is only in the Bible, life is completely different. Sometimes these miracles happen in football when the favorite team drinks hard before the match. Then there is a chance for some surprise" [11].

Politics included in song lyrics *Bulgarian Center* album

Not everything that is positive is legal is Grabowski's favorite song from the *Bulgarian Center* and in his opinion the most underrated. It concerns the issue of legalization of drugs, although the text seems to describe the state of intoxication: "And above our heads are clouds, clouds, smoke, mushrooms, clouds and we can still see the shape of things, the sides of colors (...) I see you going high (...) we see differently today and we hear broader". Grabowski seems to be a supporter of legal access to stimulants: „The consequences caused by legal stimulants are comparable to those caused by drugs (...) There is a kind of curiosum in Poland - a stoned with vodka politician caught during a car ride, has a chance of rehabilitation, a politician stoned with weed is finished (...) I hate it when someone thinks for me. Being an adult and wanting a pot, I get stoned anyway. It's not the country's fucking business. My constitutional right is the decision: yes or no. I say this at a time when adventures with this part of human weakness are behind me and it was my decision, not the state officials. Neither the police nor the court, nor the government, nor the parliament, nor the minister of justice, or even Mr. president" [11].

Summary

Following Maciej Białas, it can be assumed that political music is focused mainly on communicating the worldview. Although it is difficult to pinpoint it precisely, Białas mentions the

following political music forms: „national anthems, national, patriotic and church songs relating to nationality, national and heroic operas; symphonic poems raising national consciousness; overtures and symphonies with ideological and program content; works dealing with national events, commemorative musical works dedicated to various political events: "mourning", victims of war activities, commemorating victories, affirming values corresponding to the aspirations and concepts of the political auditorium: parademarschen, revolutionary and rebellion songs; revolutionary hymns and operas; operas calling for political battle, faithful-servile operas, cantatas, hymns; cantatas in honor of political leaders; panegyric operas, songs fulfilling ideological and agitation objectives; mass songs with comprehensible political lyrics (easily „absorbed" by the working class and peasants); working class's songs; war propaganda; battle songs; songs for soldiers, war and guerrilla; military marches; hymns in honor of war heroes and freedom fighters; occupation songs: particles; musical political folklore (musical political leaflets); protest songs expressing opposition to the atrocities of war; chansons de contestation; political rock; folk protest-songs; agitated sung poetry; nationalist and racist works; anarchist songs; songs commenting political events (sung journalism); political chansons as a response to political events; political satirical songs; political cabaret songs; songs with strongly ideological pronunciation, propagating specific ideas (e.g. Masonic); songs expressing political approvals and disapprovals; song arbitrarily "agitated" to spread various political ideas; songs that are entertainment of politicians; communal songs." [23]

In 2007, Paweł Kukiz, when asked about the political nature of music, said for Onet.pl: "It is compulsory for every musician or a public speaker to stand by a certain opinion for the sake of their country and homeland. Anyway, this should apply to everyone. What is the difference between the value of political views of a musician and a doctor, a locksmith or deep-sea fisherman?" [24].

As the result of my research of literature, I conclude that the issues of Polish political music are only relatively studied. I decided to undertake the discussed research problem, because the state of analysis on the subject of Krzysztof Grabowski's work and the political aspect of this work is still a niche area that requires in-depth insight.

I considered the most appropriate construction based on a problem and chronological criterion, respectively. Applying these criteria allows me to characterize this political work of the Pidżama Porno band.

I found it impossible to apply only the problem criterion or only the chronological criterion because, when examining the work of Krzysztof Grabaż Grabowski I perceive the broadness of the the subjects that he mentions in his songs.

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APPLICATION OF RISING PLATE METER FOR ASSESING MOUNTAIN PASTURE PRODUCTIVITY

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Abstract:

Semi-natural species rich grasslands provides a wide range of ecosystem services: from biomass production, through water retention and CO₂ sequestration to biodiversity maintenance. Unfortunately the area of species rich grasslands decreased in entire European Union. To prevent the decrease numerous policies helping in sustaining extensively used grasslands have been developed. Such extensive management needs planning, including also estimation of grasslands productivity. A use of rising plate meter is a convenient methods, but needs calibration. In this study we calibrate the rising plate in a species rich, extensively used mountain pastures, two times in vegetation season (June, August). The results show that the indirect measurements are able to predict 50-62% of aboveground biomass productivity. The results were significant for both measurement terms.

Keywords:

grasslands, herbometer, topographic wetness index, biodiversity

Introduction

Grasslands, mainly hay meadows and pastures, are distributed throughout all biogeographical regions of Europe. Most of them was developed in result of forest clearings and is maintained by mowing or pasturing [1]. Nowadays, the grasslands provides a wide range of ecosystem services. Especially valuable are extensively used semi-natural, species rich grasslands. They are used for food production (milk, meat and honey), control the climate by CO₂ sequestration, mitigate the climatic extremes as floods and landslides. The permanent grasslands control water quality and run-off by water purification (nitrogen absorption via microbial activity) and retention. They can slow down the water runoff by 20% comparing with arable grounds and 50% comparing with urbanized areas. Moreover, the grasslands are repository of genetic resources for medical and ornamental plants [2]. In agricultural landscape semi-natural grasslands provide habitats for a variety of plant species and their pollinators, as well as organisms connected to grasslands by food or habitat dependencies [3].

In Poland the grasslands cover nearly 28 thousand of square kilometers. They consist of unevenly distributed patches with different areas. Mostly the area of grassland patch varied from 0.3 up to 1 km², and 96% of all patches is smaller than 5 km². Most of them is placed 200-500 m apart each other, however areas where grassland patches are placed kilometers from another exist [4]. During the 20th century, the biodiversity of semi-natural grasslands in Europe has rapidly decreased. The industrial development, after the II WW, led to depopulation of rural areas and an increase in human population in cities. The increased demand for food, led to intensification of agricultural production and unification of agricultural landscapes [5, 3]. The intensification of agriculture rely on using of fertilizers instead traditional manuring and sowing of a few high-productive grass varieties. On such improved grasslands a high number of animals is keeping what lead to decrease species richness. Grasslands often are abandoned or converted into arable lands [6, 2].

To prevent semi-natural grasslands degradation and related to it biodiversity loss, the agri-environmental schemes are adapted in European Union. In such schemes the extensive management is promoted, which include, among others, restriction regarding to grassland fertilization and introduction of high productive species [7]. It demand carefully planning of management regarding biomass productivity to ensure stable delivering biomass for cattle [8]. As the most accurate yield estimation method is considered the destructive biomass sampling. However, it is the most labor-intensive method. Alternative approach for estimating biomass in grasslands is the assessment of canopy height, which was frequently found to be positively correlated with aboveground biomass. The sward height is often conducted with a rising plate meter, determining the compressed sward height [9]. Moreover, in ecological agriculture important is also the hay quality as influencing the healthy status of the cattle [10]. The quality depends on species composition of the sward. It should contain not only grass species but also herbs, including species from *Fabaceae* family. The species allow to fulfill the nutritional demands of the cattle, as well as has a preventive, therapeutic and antiseptic effect [11].

The use of rising plate is easy and cheap, but needs calibration for particular grassland type, especially on species rich grasslands [12, 8]. However, such calibration scarcely have been done in Poland [e.g 13,14] and, in case of multispecies grasslands, the results of calibration differ along vegetation season [15, 12, 8]. The aim of the study was to test the possibility of usage of rising plate meter for assessing of aboveground biomass productivity of extensive mountain pastures in different environmental conditions, in two measurements terms. Additionally it was also planned to check the effect of environment and vascular plant species richness on aboveground biomass production.

Material and methods

Study grasslands

The study was performed in field station of Wrocław University of Environmental and Life Sciences, placed in Radomierz (Kaczawy Mts., Silesie, Poland). The station consist of 227 ha of pastures and semi-natural meadows (Fig. 1). The extensively used pastures are placed at altitudes ranged 450-600 m. a.s.l. in diversified land relief (Fig. 2) The average annual temperature

is ca. 6.9 °C (winter -2.4 °C, summer 16.3 °C). The annual sum of precipitation is 960 mm, including ca. 342 mm in summer period [16].

The station breeds 'Charolaise' fattening calves (for age c.a. 1 year). After calving, the number of animals is about 300. In summer, cows and calves are kept in an open system on quartered pastures, without additional feeding. In winter, mother cows and bulls are kept in a semi-open system and fed with silage. After the grazing season, the uneaten fragments of sward are mowed. The dominate and most frequent vascular plant species are: *Agrostis capillaris*, *Arrhenatherum elatius*, *Festuca rubra*, *Trisetum flavescens*, *Festuca pratensis*, *Dactylis glomerata*, *Anthriscus sylvestris*, *Phleum pratense*, *Poa pratensis*.

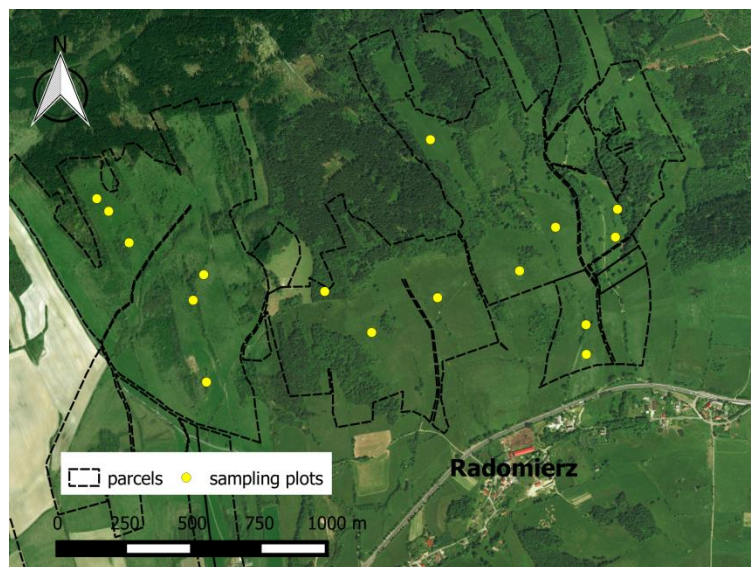


Fig.1. Study area and sampling plots on background of Bing Aerial Maps
Source: <https://www.bing.com/maps/aerial>

Topography

The secondary topographic indices, describing the environmental conditions were conditions basing on digital terrain model (DEM) with accuracy <0.2 m. The DEM was created basing on aerial LIDAR scanning and provided by Center of Geodetic Documentation of Poland [17]. The DEM was used to calculate the elevation and slope. Additionally values of diurnal anisotropic heating (DAH), which reflects amount of solar energy potentially reaching the ground surface were calculated. It depends on slope and geographical exposition and is dimensionless; positive values reflects high amount of energy while negative values – low [18]. Values of topographic wetness index (TWI) were also calculated. The TWI modelled accumulation of water resulting from location within the catchment, the catchment size and slope [18]. The TWI is dimensionless, high values reflect potentially moister soil, while low values – dry areas. All calculation were done in SAGA [19] and QGIS [21] software.

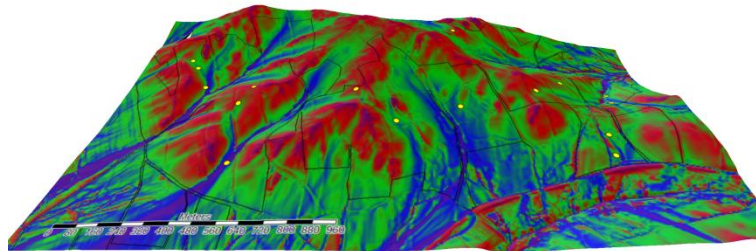


Fig. 2. Sampling plots (yellow dots) location on background of topographic wetness index (TWI) red colors indicate low TWI values, blue - high. Black lines - boundaries off pastures

Sampling design

On pastures area 15 square plots, sized 16 m^2 were fenced. The plots were fenced using electric wire, in April 2019, before the beginning of pasturing. On each plot the number of vascular plants was assessed. From center of each plot, the aboveground biomass was cut at ground level in two squares sized 0.25 m^2 (Fig. 3), in two terms. The first term of cut was done 25 June 2019, the second 19-21 August 2019. During the second term of cut the regrowth occurring on 0.25 m^2 plots cut in first term, was also collected. The cut biomass was packed into mesh bags, dried and weighted in a laboratory.

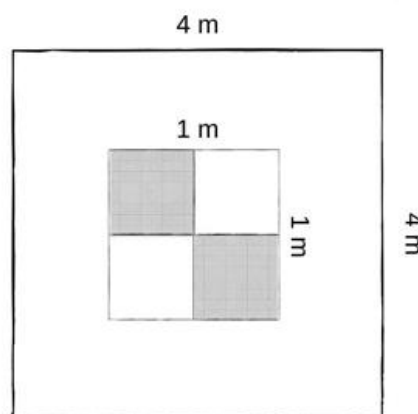


Fig. 3. Scheme off 1x1 sampling plot within 4x4 fencing. White squares- first term of cut and regrowth, dark squares- second term of cut

Rising plate meter

The height of sward was measured in four replications before biomass cut in both terms using a rising plate meter. The rising plate meter (also called herbometer or plate meter) is used for assessment of grassland aboveground biomass production [8, 12, 21]. The measure relay on gently leaving of a round, leigh-weight plate, moving along a calibrated rod. The height at which the plate stopped reflect not only average height of the sward but also its density and elasticity.

After proper calibration the height shows biomass per unit area. The calibration mostly rely on linear regression with weight of biomass cut form sampling plots [8].

Analysis

For analyzed variables basic descriptive statistics were calculated. The differences in biomass production in different terms were checked using Wilcoxon sign rank tests. To examine relation between environment, vascular plant species richness and biomass production the Spearman rank correlations were calculated. The calibration of rising plate meter records to biomass productivity was done using linear regression method.

Results

The descriptive statistics of environmental variables, vascular plant species richness, rising plate meter measurements and biomass productivity are shown in Tab. 1.

Tab. 1. Descriptive statistics of topographic variables, species richness, sward height measured using rising plate meter and aboveground biomass production

	Mean	Median	Minimum	Maximum	First quartile	Third quartile	Standard deviation
Topographic wetness index [-]	6.7	7.0	4.3	11.3	5.4	7.4	1.7
Slope [°]	9.4	9.6	3.7	14.2	6.8	12.5	3.0
Diurnal anisotropic heating [-]	0.0	0.1	- 0.2	0.2	- 0.0	0.1	0.1
Number of vascular plants species [N]	26.4	26.5	19.0	34.0	24.5	28.0	3.7
Sward height- first term [rising plate meter reading]	8.9	8.9	0.0	22.5	1.9	11.3	7.6
Sward height- second term [rising plate meter reading]	7.7	6.1	1.0	21.3	2.4	11.1	6.5
Aboveground biomass of the first term swath [t/ha s.m.]	1.8	1.8	0.4	3.0	1.3	2.2	0.7
Aboveground biomass of the second term[t/ha s.m.]	2.1	2.2	0.8	3.5	1,6	2.6	0.8
Regrowth biomass [t/ha s.m.]	0.9	0.7	0.2	2.6	0.4	1.2	0.7
Biomass of the first term + Regrowth [t/ha s.m.]	2.7	2.4	0.8	5.1	1.9	3.5	1.2

We found that biomass productivity in first term differ significantly/did not differ significantly from productivity in second term (Fig. 4).

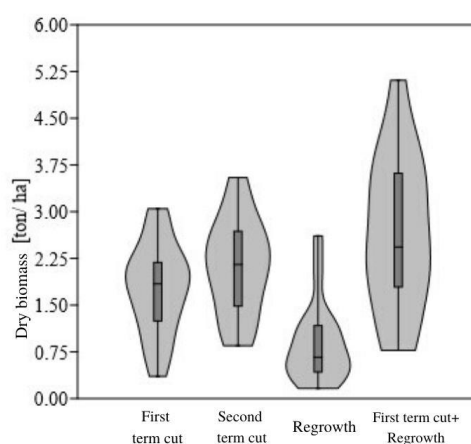


Fig.4. Violin plot of aboveground dry biomass distribution in different terms of cut. Thin line - average, box - standard error, and whiskers - standard deviation

The results shows that the biomass productivity during first term was restricted mostly by thermal conditions (Tab. 2), while both slope and soil moisture did not influence the biomass productivity in studied system. There were no significant correlations between vascular plant species richness and aboveground biomass productivity (Tab. 2).

Tab. 2 Values of Spearman ranks coloration (r , p) between environmental variables and aboveground biomass and species richness

	First term cut	Second term cut	Regrowth	First term cut + Regrowth	Species richness
DAH	$r=-0.669$, $p=0.004$	$r=-0.356$ $p=0.176$	$r=-0.406$ $p=0.118$	$r=-0.655$ $p=0.006$	$r=-0.201485$ $p=0.454$
Slope	$r=-0.116$ $p=0.668$	$r=-0.370861$ $p=0.157$	$r=-0.392936$ $p=0.132$	$r=-0.259014$ $p=0.333$	$r=0.564454$ $p=0.022$
TWI	$r=0.402$ $p=0.123$	$r=0.360559$ $p=0.171$	$r=0.344371$ $p=0.191$	$r=0.401766$ $p=0.123$	$r=-0.106669$ $p=0.642$
Species richness	$r=0.083$ $p=0.760$	$r=0.105$ $p=0.698$	$r=-0.123$ $p=0.634$	$r=-0.001$ $p=0.995$	-

The results of rising plate measurements correlate significantly with biomass productivity both in first (Fig. 5) as well as second (Fig. 6) term. The values of explained variation ranged from 50 to 62%.

Linear regression model of biomass production and both terms height (separately).

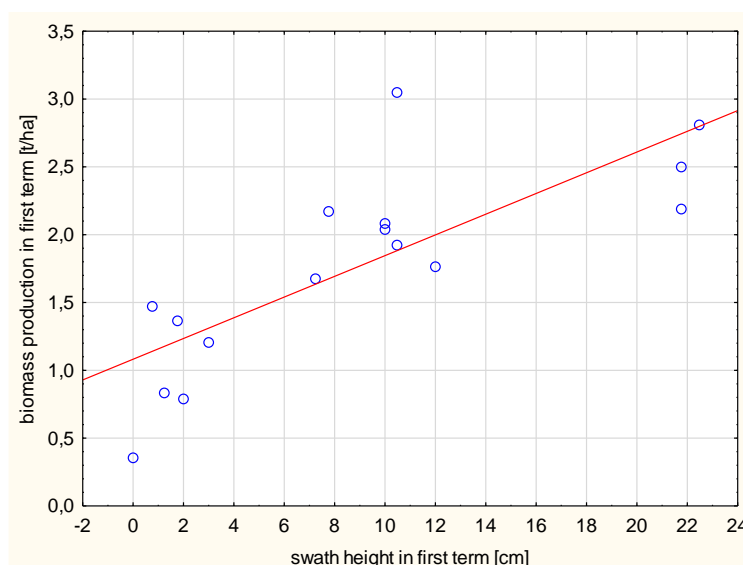


Fig. 5. Relationship between sward height and biomass production in first term
Regression equation: $y = 1.0814 + 0.0764x$ ($r^2 = 0.6214$; $p = 0.0003$)

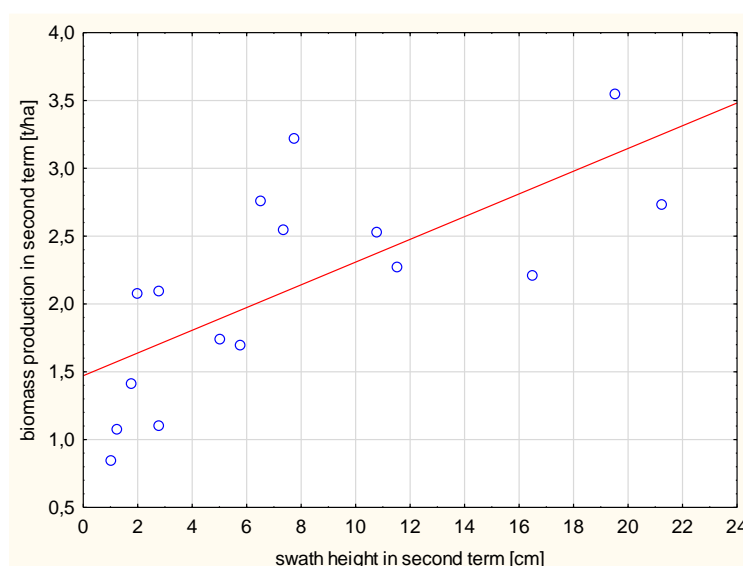


Fig. 6. Relationship between sward height and biomass production in second term
Regression equation: $y = 1.4707 + 0.0838x$ ($r^2 = 0.500$; $p = 0.002$)

Discussion

The annual biomass production on intensive, improved and fertilized meadows in good climate conditions can reach up to 55 t/ha of dry biomass, in first year after the sowing [22]. However average biomass productivity of hay in Poland is around 4.29 t/ha [23]. In submontane area the productivity was assessed in range from 5.72 t/ha up to around 9.9 t/ha [24]. The productivity of mountain pastures is lower and in altitudinal range 550-700 m. a.s.l. reach 4.2–4.7 t/ha of dry mass [25]. Therefore the yield of studied pastures should be considered as rather low. It can be related with species composition: the mountain grasslands dominated by *Festuca rubra*

and *Agrostis capillaris* produces average 3.59 t/ha. [26]. According to data provided by Kasperczyk, Szewczyk and Kacorzak (2008) meadows and pastures dominated by *Festuca rubra* and *Poa pratensis* produces even less – 1.58 t/ha.

The results suggest that the productivity in Radomierz, can be limited by high insolation. Results of other study reveals that the slope exposition can modified biomass productivity of mountain (placed above 700 m. a.s.l) grasslands by 0.8 – 1.0 t/ha dry mass [25]. The high insolation probably caused high evapotranspiration, which restrict the productivity, however we did not found that water availability increase the biomass productivity (Tab. 2).

The results suggest that the rising plate can be used for assessing biomass production of species-rich grasslands. Comparing to destructive biomass sampling this method is less accurate, but much feasible and cheaper [9]. Accurate calibration of the rising plate meter is difficult due to variability in forage management, growth, and species composition [12, 8]. The obtained in this examination explanatory power of rising plate meter (r^2 ranged from 0.5 up to 0.62) is in accordance with results of other examination which, depending from sward species composition, ranged from 0.31 [21] up to 0.84 [27]. The errors in prediction could results from local differences in dominant species composition [15]. Also the accumulation of death biomass can disrupt the results, because the death biomass differ from living regarding resistance to compression [15]. Besides the uncertainty in biomass estimation, the rising plate meter seems to be valuable tool for biomass estimation, especially accomplished by GPS positioning and ultrasonic height measurement device [28]. It can also use for calibration of remote sensing data. The examination of Mazur and Chojnacki (2018) shows that the value of r^2 between normalized difference vegetation index (NDVI) and rising plate meter records was 0.75.

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AN INNOVATIVE, COMPLEX AND PRECISE SYSTEM FOR DYNAMIC, FAST AND AUTOMATIC WASTE WEIGHING, INCREASING THE SAVINGS IN THE PUBLIC SECTOR

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Abstract:

In the time of growing technological progress, the amount of waste generated is significantly increasing. The control of its management is a very important aspect. To increase the effectiveness and the accuracy of waste management, it is necessary to implement an adequate system for their control and monitoring. According to the National Regulation of the Minister of Environment, by the year 2020, the level of recycling, preparation for re-use and recovery of other municipal waste fractions by other methods, must reach 70%. Moreover, the control of waste transport from their collection point to its delivery place which is Regional Municipal Waste Processing Installation, will also be required. To achieve that, it is necessary to close all loopholes in the Waste Management System. Current systems do not give that possibility and are very expensive in implementation. The only possible and low-cost solution is the precise weighing and cataloging the type of collected waste from a given location.

Keywords:

automatic scale, waste weighing, public sector

Introduction

In the time of growing technological progress, the need for goods is significantly increasing, which results in higher amount of generated waste. The management of it is a very important aspect. To increase effectiveness and accuracy of waste management, it is necessary to implement an adequate system for their control and monitoring. The National Regulation of the Minister of Environment from 14th of December 2016 „on recycling levels, preparation for re-use and recovery by other methods of other municipal waste fractions” indicates that in the following years they must meet the increasing recycling rates. Finally, in 2020, they must be at a level of 70%. Moreover, the control of waste transport from their collection to the delivery to a Regional Municipal Waste Processing Installation, will also be required [1, 2]. To achieve that, it is necessary to close all loopholes in the Waste Management System. Current systems do not give that possibility and are

very expensive in implementation. This is mainly due to used devices, which are inaccurated because of their poor adjustment to difficult and dynamically changing external conditions during their usage. One of example is ambient temperature, as well as weighing methods – insufficient elimination of measurement errors, connected to a lack of levelling of vehicles used for waste collection during measurements and using single-point measurements, which makes an accurate measurement of loads with non-homogenous mass distribution. According to the survey, among entities involved in municipal waste collection, the main obstacle in implementing such system earlier was its price. The second factor was a measurement inaccuracy. The only possible, relatively simple and low-cost solution, which would improve a situation on the market, is an efficient and precise solution for weighing and cataloging the type of collected waste from a given location.

Later in this article, Authors show an innovative solution for dynamic, fast and automatic waste weighing.

Municipal waste

According to data collected by the Central Statistical Office, 11.968,7 thousand tons of municipal waste was produced in Poland in 2017, which is 2.7% more than in 2016. This gives an average of 312 kgs of collected waste per capita. The highest amounts were in the voivodeships: Lower Silesia and West Pomerania – 374 kgs per capita, Lubusz – 360 kgs and Silesian – 352 kgs. The lowest amounts were in voivodeships: Świętokrzyskie – 188 kgs, Lublin – 207 kgs and Subcarpathian – 218 kgs. The total of collected glass waste per capita had increased by 3.5% since 2016 at a level of 12.1 kgs. An increase in amount of biodegradable waste had also been noted – 23.3 kgs. A similar situation applied to large size waste and this was the biggest increase from 8.8 kgs to 11.5 kgs (30.6%).

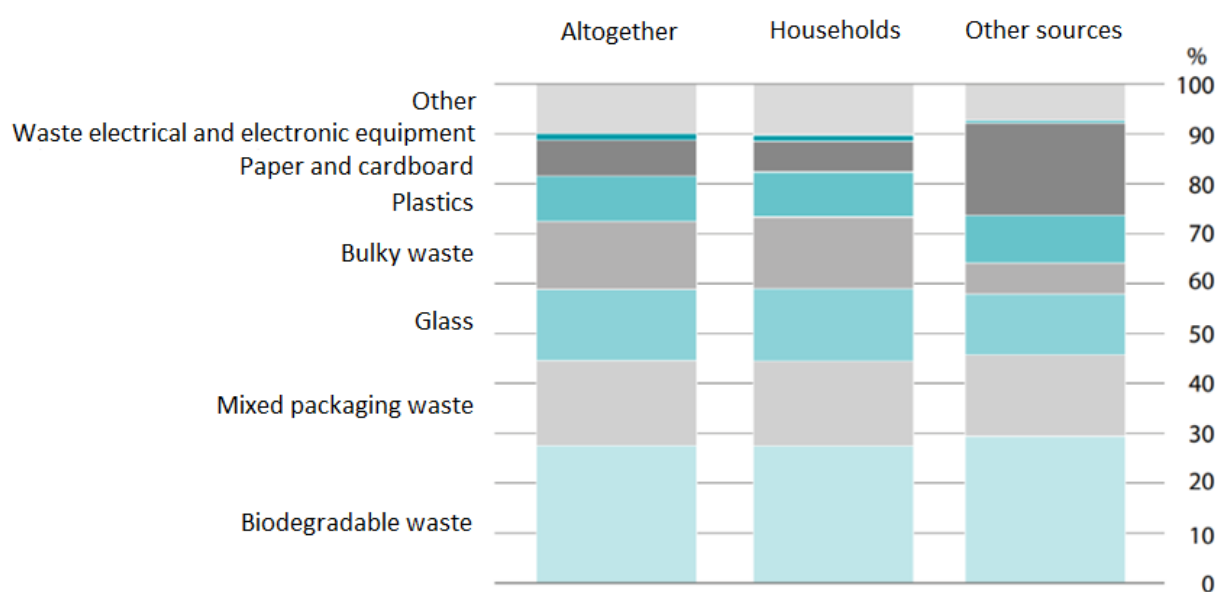


Fig. 1. Municipal waste collected together or selectively in 2017 grouped by fraction and source [3]
Source: Central Statistical Office

As shown in abovementioned data, an amount of generated waste is increasing significantly. This is because of continuous technological progress, which generates an increased need for goods. A constant growth results in increasing financial outlays in context of control of their management, contributing to a decrease in savings of public sector. To correct current situation, it is necessary to implement an efficient and precise solution for weighing and cataloging type of collected waste from given location. According to the survey among entities involved in municipal waste collection (*TARO Sp. z o.o.*, *Sanitras Sp. z o.o.* or *REMONDIS Sp. z o.o.*) the main obstacle in implementing such a system earlier, was its price (*100% of the answers*).

A system for dynamic, fast, and automatic waste weighing

In order to create a solution made for efficient, precise weighing and cataloguing collected waste, TELDAT company initiated a project named *“Innovative, complex, and precise system for dynamic, fast and automatic waste weighing, managing, and monitoring with the use of an innovative hybrid measurement method”*, co-financed by the National Centre for Research and Development. The goal of the project is to develop devices, able to measure the weight in the Y(b) accuracy class, monitor and record it precisely, as well as to account waste producers in the future, based on a weight of different types of waste.



Fig. 2. A model of the weighing device
Source: TELDAT

In this project, an innovative and dynamic method for automatic measurement was applied, based on a hybrid approach, which is measuring the weight of the waste, taking into consideration the deflection by using load cell sensors and an oil pressure sensor. The deflection wasn't yet (*and is still not*) taken into consideration in the existing solutions on a larger scale. This may result in the incorrectness of the measurements. The measurement error related to the deflection of the construction was eliminated by the use of the result correction based on the algorithms developed during the R&D research. Moreover, sensors used to build the model are consistent with the requirements of the OIML R60 standard and were correctly performing the measurements in various environmental conditions and in various places of usage. The use of this type of sensor helps to avoid measurement error related to the low quality of the devices. However, these sensors have the ability to measure in the Y(b) accuracy class only on flat surfaces, hence why it was necessary to develop an algorithm for counteracting the resultant errors.

The developed system for fast and automatic waste weighing consists of a unit displaying the result, a central computational unit, a hydraulic block with the oil pressure sensor, a beam with load cell sensors and a communication module, which is currently under construction. The displaying unit is the point of displaying the weight of the waste on the scale. The central computational unit is responsible for reading and processing data from the sensors, as well as controlling the solenoid valves. The hydraulic block branches the oil flow through the hydraulic system, which gives the possibility to measure the oil pressure in a given point of the position of the piston accurately. The measurement beam, consisting of two load cell sensors, performs the bin weight measurement.



Fig. 3. Demo device (from the left – unit displaying the result and the central computational unit)

Source: TELDAT

To achieve the data needed for analysis and potential changes in construction, laboratory tests were performed, with the use of a climatic chamber, mechanical shaker and a water tank. Tests were including the resistance to different environmental conditions (*temperature range for devices working in difficult conditions*), adaptation to fast temperature changes (*a quick pass from the temperature below zero to above zero and again to below zero, in order to check the resistance of the electronic circuit to condensation*), water-resistance, as well as the resistance to vibration and shock.



Fig. 4. Climatic chamber tests and vibration / shock tests
Source: TELDAT

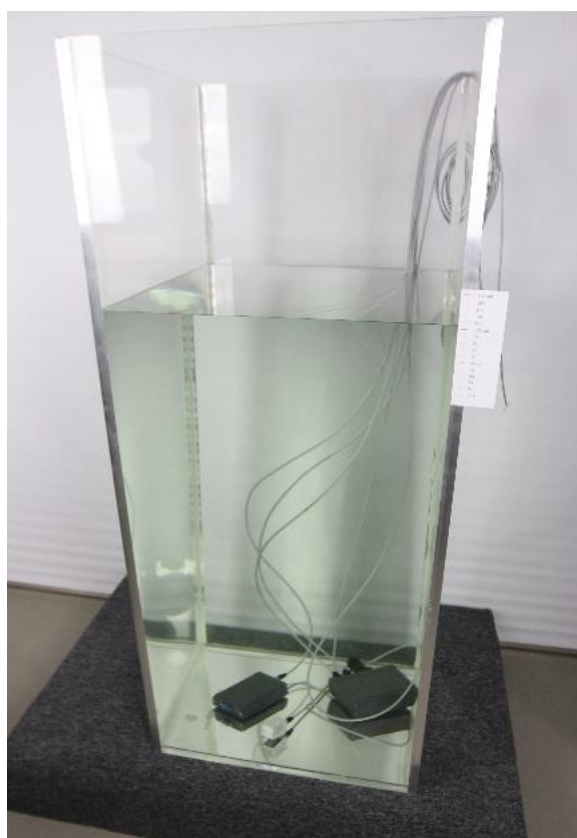


Fig. 5. Water resistance test
Source: TELDAT

In order to verify ability of the devices to work in different environmental conditions, tests were performed in external laboratories, including: Environmental Test Laboratory in the Military Communication Institute in Warsaw, Laboratory of Vibroacoustics, Shock Resistance and Magnetic Fields in the Research and Development Maritime Technology Centre in Gdynia, and the Research Laboratory in the BOSMAL Automotive Research and Development Institute in Bielsko-Biała. The tests were including the adaptation to dynamically changing temperature (*quick pass from the temperature below zero to above zero and again to below zero, in order to check the resistance of the electronic circuit to condensation*), resistance to different environmental conditions (*temperature ranges for devices working in difficult environmental conditions – from -30 °C to +65 °C*), resistance to vibration and mechanical shocks, water, and dust. All devices passed all required tests, which confirmed their ability to work in different environmental conditions and in various places of usage.

A real-life scenario with the use of a vehicle equipped with a dust-free construction had also been performed. Tests included checks in the test area, as well as in 10 different locations, which were selected having regard to the unevenness and slope of the terrain. Reference weights were especially prepared and used in these tests.



Fig. 6. Tests in real environment
Source: TELDAT

This type of system is intended to join: precise, dynamic, fast and automatic measurements with waste monitoring and management. This solution must have a competitive price as well as the accuracy of measurements in the Y(b) class in different environmental conditions and in various places of usage.

Conclusions

All project phases accomplished so far, made it possible to acquire knowledge, basing on which it can be concluded that it is possible to develop a system for vehicles with dust-free construction, able to weigh municipal waste and taking into consideration vehicle deflection. Currently the deflection is not taken into account in available solutions on a larger scale, which results in inappropriate proper measurements. Conducted tests proved that in order to eliminate an error from a vehicle deflection, it is necessary to develop an algorithm counteracting resultant error. Moreover, use of OIML R60 compliant sensors will assure that measurements are correct in all environmental conditions and in various places of usage.

This publication is a result of developed project named *“Innovative, complex and precise system for dynamic, fast and automatic waste weighing, managing and monitoring with the use of an innovative hybrid measurement method”*, co-financed by the National Centre for Research and Development.

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THE IMPACT OF THE TEMPERATURE ON THE OPERATION OF MOBILE DEVICES COMPONENTS

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Abstract:

In the new digitalization era, more and more electronic devices deriving from ICT group appears on the market. They are used to the very broad extent and offer more and more innovative functionalities. According to the Global Digital Report 2018 developed by We Are Social organization the mobile sector makes up the greatest group of devices on the market. With increasing demand on this type of equipment, its popularity in various sectors such as security, defense, education and building rise up. As a consequence, it is necessary to meet all required norms by the equipment and to be resistant to climate changes. Failure to meet above requirements may be related to the fact that the various users utilizing the equipment will not accomplish their operations targets. In consequence, their effectiveness will decrease and the chance of errors will increase. To prevent this practice, it is necessary for mobile devices to be resistant to climate changes and operating conditions.

Keywords:

mobile devices, functional researches, climate researches

Introduction

In the new digitalization era, more and more electronic devices deriving from ICT group appear on the market. They are used to the very broad extent and offer more and more innovative functionalities. According to the Global Digital Report 2018 developed by We Are Social organization; in the current year the mobile sector had the largest share in network traffic. Mobile solutions accounted for 56% of all devices and stationary solutions – 43%. With the increase of popularity of this type of equipment, a demand rises up especially in such sectors like: security, national defense, education and building. The reason for this is the constant pursuit of miniaturization and the greatest possible mobility. Therefore, it is indispensable to meet required standards by the equipment and be resistant to climate changes and operating conditions. Failure to meet above requirements can bear various, serious and dangerous consequences i.e. make device not working and tasks fulfilling impossible or they will be more difficult and more time consuming.

To prevent this practice, it is necessary for mobile devices to be resistant to climate changes and operating conditions. In the further part of this article, devices subjected to functional and climatic tests are presented, as well as modern mobile solutions which meets stringent endurance requirements.

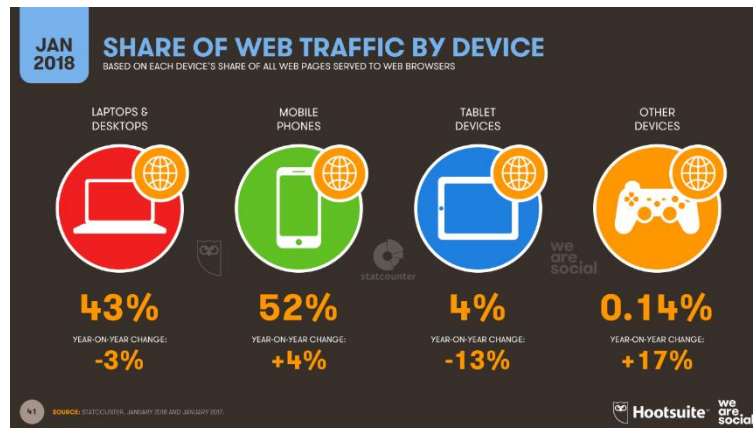


Fig. 1. Percentage share of particular devices in network traffic [1]

Source: We Are Social

Currently on the market there are available solutions able to operate in tough environmental conditions i.e. significantly increased or lowered ambient temperature. The example of such device can be the tablet designed and manufactured by one of the competitive company. The tablet in basic version has an embedded two core processor Intel Core i5, integrated graphics card Intel HD Graphics 615, disc SSD, 128 GB with extension option to 256GB, 4GB RAM with extension option to 8GB. It also has 7" LCD display 1280x800px TFT technology. Li-ion battery ensures 8 hours constant operation. Additionally the device is manufactured in NFC, UHF, RFID technologies and has Smartcard Reader. The tablet has been tested by an independent external laboratory in accordance with the standards MIL-STD 810G and IEC529. The results of the tests are as follow:

- device is resistant to drop from a height of 180cm;
- dust tightness, water resistance IP65;
- operation temperature: $-29^{\circ}\text{C} \div +60^{\circ}\text{C}$.

The other example is tablet designed and manufactured by other competitive company. It is manufactured in technology with Intel Core 7. It is also equipped with integrated graphics card Intel HD Graphics 630, disc SSD, 128GB with extension option to 256GB, 4GB RAM with extension option to 16GB. Moreover has Li-ion battery and interfaces Bluetooth and 4G LTE, 11" touchpad LCD 768px in TFT technology. The tablet was subject to tests according to MIL-STD 810G and MIL-STD-461 standards. It has resistance to dust and protection against water jet (*IP65 classification*), as well as resistance to drop and vibration. However, the manufacturer in his specification did not specify the exact data regarding above resistance. The range of temperature for optimal tablet operation is $-21^{\circ}\text{C} \div +60^{\circ}\text{C}$ [2, 3].

Intel company in its publication in 2013 about the safe implementation of tablets for production in order to increase productivity, presented the possibility of utilization ruggedized tablets for production purposes. This has important meaning because the conditions that mobile devices can

undergo during the production process are as diverse as often unsuitable for serial handheld computers. The utilization of ruggedized tablets will protect the device's stability and protect against falling and damage, which could result in data loss and increase production costs [4].

Functional and climatic tests

Certificates issued for equipment confirms that it is capable to operate in the roughest conditions where the ordinary devices don't operate or are operating incorrectly. Certificates are vital especially when users want to tailor their equipment to harsh operating conditions or special utilization. Certification tests are aimed to check the operation correctness of all equipment components and modules and its performance. These tests have to verify and prove that device operates correctly in determined temperatures and humidity as well as classification of resistance to mechanical damage, i.e.: vibration, shock, flooding. One of the most important stages of endurance tests are climatic tests. Their primary aim is to perform analysis as well as equipment responsibility e.g.: application handling, starting or closing the system at a specific temperature - both negative and positive.

The first tested device was a tablet from the market marked in this document as Tablet 1. It was one of many solutions subjected to test procedure. The device has been tested to confirm its operation at -30°C. The technical specification of the tablet was as follow:

- Processor: Intel Core m5-6Y57 vPro 1.1GHz/2.8GHz;
- RAM: 8GB DDR3L;
- Disk: SSD 128GB;
- Ports: 1x USB 3.0, 1x Audio Out;
- Communication: Wi-Fi, Bluetooth;
- Battery: Li-ion 3320mAh 8h;
- Weight: 540g;
- Certification: IP65;
- Operation temperature: -20°C ÷ +60°C;
- Operating system: Windows 10;
- Others: two cameras with 2Mpx and 8Mpx, GPS, RS-232, microSD.

So, according to device parameters Tablet 1 was tested in condition, over the operational range. In addition to basic functional tests involving the connection of USB devices to the tablet like – mice, keyboard with embedded USB concentrator, hard disk (*WD 500GB USB 3.0*), pendrive usb 2.0, pendrive usb 3.0. In order to check whether the connected devices operating correctly also the climatic tests have been conducted. The results of performance tests under normal, reduced and elevated temperatures are shown in Fig. 2.

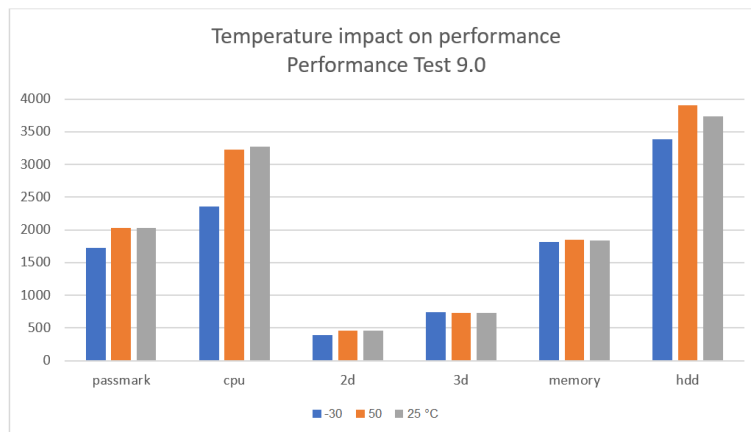


Fig. 2. Performance comparison in various climatic conditions
Source: own calculations

The above picture clearly shows that the device performance descends (*goes down*) after its cooling. Moreover, after cooling and storing the tablet for 24 hours in temperature -50°C then heating up it to temperature -30°C and then keeping it in this temperature 4 hours, tablet hung after first log in. After restarting tablet in negative temperature, the case did not repeat but in the repetition of entire test there was the same result. In the course of running in negative temperature there was shown warning regarding disc heating (*it lasted about 2 min.*).

Some solutions currently available on the market do not run the system directly from an embedded battery after decreasing ambient temperature. The system starts after supplying from external power source.

During the tests there were five devices from the market compared:

- Tablet 1 described in the document;
- Tablet 2: 12 inches screen, equipped with the Intel Core i7 CPU, 16GB RAM ECC, SSD 480GB RAID 0/1;
- Tablet 3: 8 inches screen, equipped with the Intel Core i7 CPU, 16GB RAM DDR3L, SSD 240GB;
- Notebook 1 equipped with the Intel Core i3-4000M 2.4GHz CPU, 4GB RAM DDR3, HDD Hitachi Travelstar Z7K500 500GB;
- Notebook 2 equipped with the Intel Core i5-5200U 2.2GHz/2.7GHz CPU, 8GB RAM DDR3L, SSD 256GB.

The results are shown on the Fig. 3.

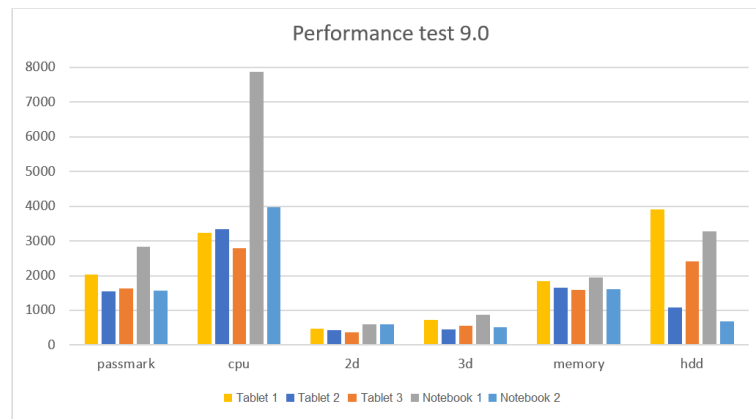


Fig. 3. The performance comparison of various devices
Source: own calculations

However, there are still no devices that, without exception, would meet all strength requirements and have full resistance to changing operational conditions and climate changes.

Mobile devices with increased environmental resistance

In order to create a solution that would meet all the previously discussed requirements, TELDAT conducts the project: „*Creating a family of innovative tablet devices with the increased resistance to mechanical and climatic conditions, allowing effective use of the latest data transmission technologies*” which is financed by National Centre for Research and Development. The assumption of the project is to create tablet devices, which will be featured by high mobility and ability to be used in very harsh terrain conditions. The result of the project is to fill the gaps in the current demand for devices with increased resistance as currently there are no solutions of this type on the Polish market, created by Polish enterprises that meet all the stringent criteria of the Defense Standards.

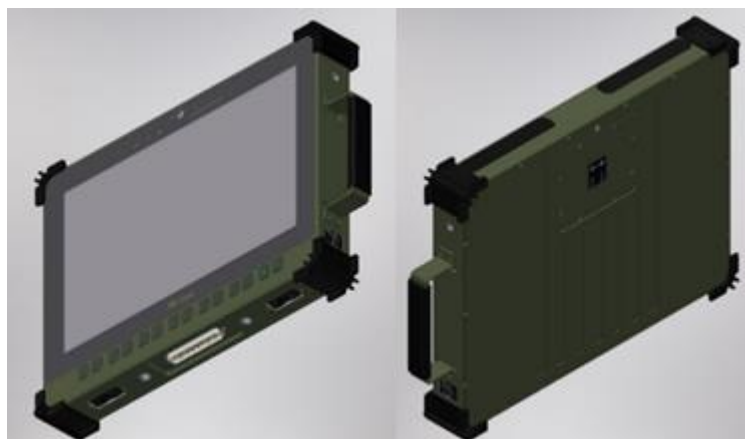


Fig. 4. 3D model of Tablet 2
Source: own project

Designed devices supposed to be resistant to dust, shocks, vibrations and effects of falling from a height of 0.75m for each plane and corners. The designed tablets will be tested during

normal work operation, although defining defensive standard resistance will be while the device is turned off. However, during the mission, or the tasks completion by the relevant services, no user will turn off the device before it falls out of his hand. An important aspect is the fact that these devices will be able to stay and work up to 1 m under water, up to two hours. The designed solution will be specified by the possibility of working in a wide temperature range, from -40°C to $+60^{\circ}\text{C}$.



Fig. 5. Testing of the Tablet 3 model on the impact of high humidity in a climatic chamber
Source: own photo

The devices will be characterized by the following parameters:

- LCD sunlight readable, Multi-touch capacitive touchscreen for use with military gloves, coated filter screen;
- Intel's CPU and GPU;
- SSD SATAIII;
- Bluetooth, Wi-Fi 2.4 and 5GHz, LTE and GPS;
- SD card reader and encrypted cards reader;
- ANR (*Active Noise Reduction*);
- 2 x camera 5Mpx;
- additional equipment: doc station „plug and play” (*connectors: Gigabit Ethernet, USB 3.0, XGA, RS-232 and audio*), cable adapter, power bank.

In order to effective use of the latest data transmission technologies, the architecture of the solution is designed so that it is possible to simultaneously use all data transmission interfaces increasing the rate and security of the transmitted information. Moreover, bearing in mind the fast and continuous development of new technologies, including processors (*subsequent generations/series*), the design of the device will enable the exchange of the computer module, with no need to change other components and parameters such as the key in this case, ensure it is complianced with the Defense Standards requirements.

This type of architecture is an innovation in polish design of mobile devices. Meeting the above rigorous requirements and assumptions will be tantamount to device classification in defense

standards: NO-06-A101 and NO-06-A103 and enrolling to the N.11-O-II-A / B, N.12-O-II-A / B and N.14-O-II-A / B groups devices [5, 6].

Conclusions

First stage of this project allowed to conduct the tests of tablet model. Based on the tests performance, it can be concluded that there is a possibility to build devices that will not only be able to work in compliance with the required defense standards, but will provide better performance than currently available solutions. In addition to that and as a result of the conducted research, it was found that the current processors on the market are specified with large decreases in efficiency along with temperature changes.

This publication was created as a result of the project implementation „*Creating a family of innovative tablet devices with the increased resistance to mechanical and climatic conditions, allowing effective use of the latest data transmission technologies*” co-financed by National Centre for Research and Development.

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FOLDING SCISSOR FOOTBRIDGE - IDEA AND THE CONSTRUCTION

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Abstract:

The paper describes a prototype of folding footbridge, starting from structural analysis through design documentation ending on prototype realization. Footbridge superstructure consists of four pairs of articulated arms. The first pair of the construction works as a rod and the others as beams. Movement of the footbridge is possible owing that whole construction has one kinematic degree of freedom controlled by actuator. The structural analysis was executed in the program ANSYS 19.2 ACADEMIC FEM system. The kinematical analysis are based on mechanical engineering literature.

Keywords:

footbridge, motion, FEM analysis, moveable construction, scissor - type bridge, folding bridge

Introduction

Moveable bridges are getting more popular, because of it's innovative and practicality. The main advantage of moveable bridge construction is the possibility of creating a temporary communication line in places, where it is impossible to create a permanent line. It allows for creating new lines, which are alternately passable.

Moveable constructions are more expensive to build and design than classical constuctions. They require cooperation between different fields of engineering knowledge. Those constructions need to be necessarily taken under periodical inspection, due to the high risk of failures and damages. Moveable bridges have been well described by Zobel and Al-Khafaji in [1] which contains lots of technical information and classification.

Folding scissor – the type of mobile bridge is well known since 1994. General information about folding bridges, which are being used by the army was given has been described in [2]. Tactical type of military scissor – type folding bridge (Fig. 1) is the basic id ea of our scissor type construction, due to the movement of articulated arms.

The first world's scissor – type stationary bridge has been built in 2016 in Geneva [3]. It is a part of the walkway directly related to the operation of Jet d'Eau. Mobile walkway (Fig. 2) invites

pedestrians to stroll around the most emblematic monument in Geneva: „the Jet d’Eau“. This folding footbridge has been called a unique masterpiece of engineering.



Fig. 1. Tactical type of military scissor – type folding bridge [7]



Fig. 2. Mobile walkway „Mobile Fussgängerbrücke“, Geneva [8]

Idea and structure

AGH University of Science and Technology has been carried out the research on the prototype of folding footbridge for one year. The structure is inspired by everyday life. The arms of the footbridge are built in the position which can be met in daily use objects such as table lamp, bathroom mirror, scissor jack, barriers and many others. This simplicity has led to the creation of an innovative structure.

The model synthesizes two fields of science: civil engineering and mechanics. The structure can be folded and unfolded, so the conception process required the work of both construction engineers and mechanics. This object is more demanding in terms of the builder’s skills. Moreover,

it's more expensive during design, manufacturing, and exploitation than fixed bridge. However, the structure can do double duty as a military bridge or live-saving bridge. Generally, the model is attractive towards architecture and can be an icon or a representative form of someplace for which it was designed.

General footbridge's structure

Designed model (Fig. 3) presented using the Autodesk Inventor consist of four pairs of combination articulated arms. One set of combination articulated arms has three arms which are unjumbled each other in three areas. This combination causes that arms are connected rectilinear along three lines. The footbridge is divided into two parts: the first part is created by the first pair of arms over support, and the second part by the other pairs which are working as a folding cantilever. The lower row of pins is connected with the deck. It can fold and unfold in the same way as all footbridge. It is designed that the deck can fold to a minimal form. This design solution allows not to interfere with the motion of footbridge. The structure can fold due to two hydraulic actuators. The first pair of arms which are working as rod, is causing that horizontal forces which run of actuators are eliminated. At the end of the construction, there are vertical braces that give the footbridge assistance to stay fixed. On the last pin, there are two wheels that provide a resilient connection with opposite abutment. The entire structure is supplied with 400 kilograms counterweight.



Fig. 3. General view of footbridge's structure

The whole scissor - type structure is built of four types of arms (Fig. 4). The differences between each type of arms are web thickness and shape of the flange, depending on the arm co-works with actuator or not.

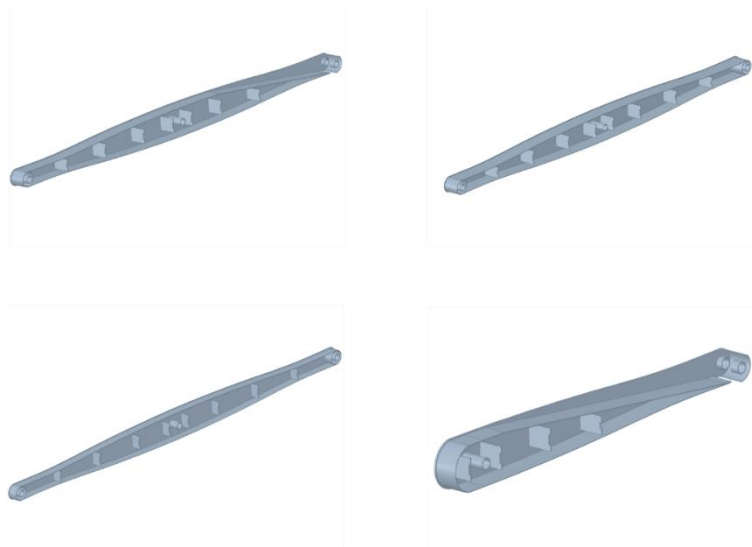


Fig. 4. Four types of arms used in scissor – type structure, longitudinal open - section view

Designed deck (Fig. 5 and Fig. 6) is inclined at an angle of 5° to the horizontal. As a result of this detail, the possibility of folding in the wrong way is removed. This configuration enforces proper direction of folding.

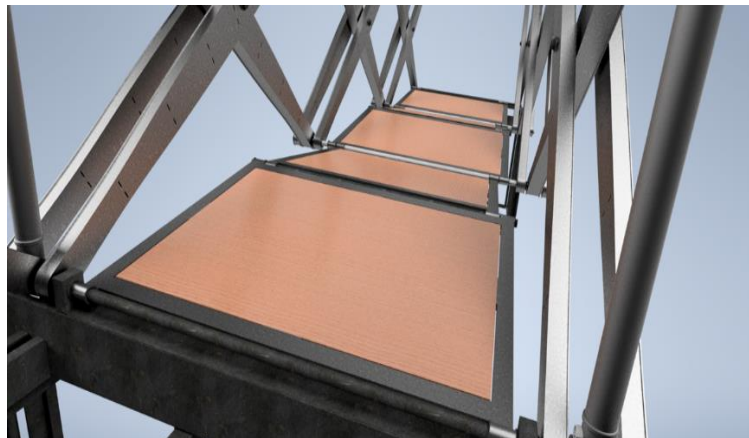


Fig. 5. View of the folded deck, inclining at an angle

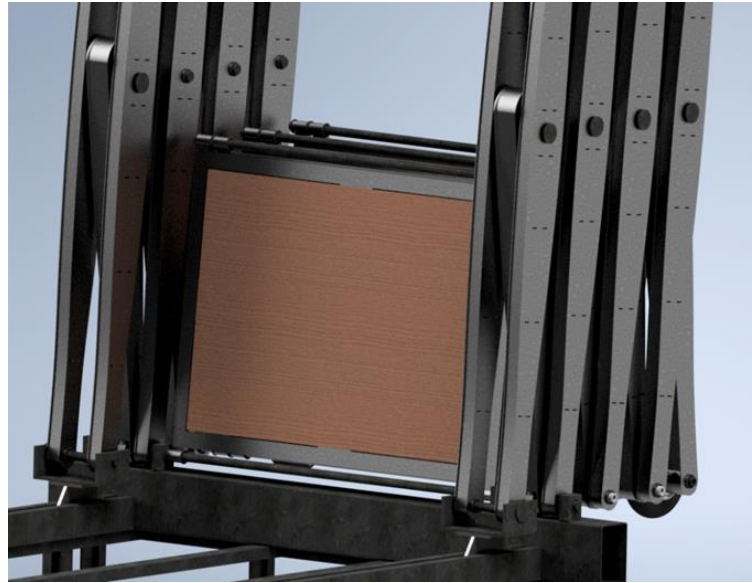


Fig. 6. View of the unfolded deck and footbridge structure

The structure has to provide rectilinearity along with three line swivel. Thereupon displacement should be as small as possible. Due to resistance of movement, it will not disturb the folding and unfolding of constructions.

During folding out the structure of footbridge works as a cantilever. After folding out the structure and basing wheels are supported on the abutment, and as a result of it the system is like a free-ends beam.

Rotational movement of the rods is provided by usage of the slide sleeves with flanges, which are a substitute for bearings.

Numerical analysis of the footbridge construction

The purpose of the calculations was to check the kinematical relationships between individual parts of the analyzed construction and preliminary strength calculations. Therefore, numerical models of the footbridge were built with the ANSYS 19.2 ACADEMIC FEM system (Fig. 7).

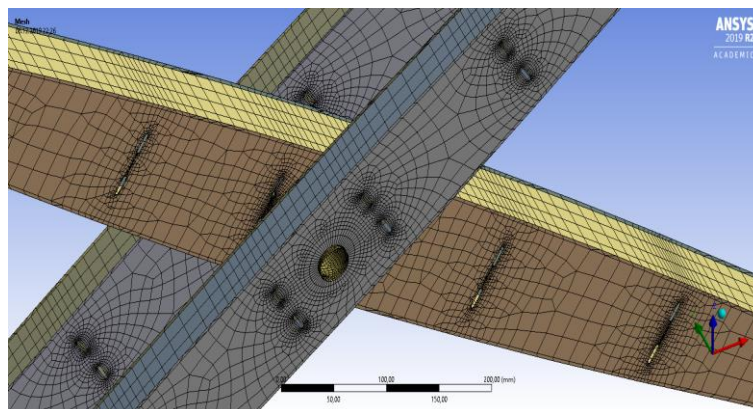


Fig. 7. Mesh on diagonal elements used in Finite Element Method analysis

With the kinematical analysis while the structure is folding it works as a cantilever and has only one degree of kinematic freedom. [4] Particular arms which are kinematic pairs [5] keep mutual displacements. As a result of making those pairs, the number of freedom degrees is deprived because one kinematic member holds the other one. The kinematic member does relative spin towards each other. [6] They also define between them some kinetic restrictions, which creates geometric constraints. Each part of construction does a determinate trajectory of motion, connected with displacements of footbridge segments. Immovable footbridge abutment is the first cell of the kinematic chain (Fig. 8), it makes a connection between construction and the environment. This is the base of our structure, which is the beginning and the end of the footbridge crossing. System of scissor - type bay does a motion in a parallel plane to each other and in parallel plane to plane of motion, which is a definition of the plane kinematic chain. When the footbridge is folded out, the end of construction leans on footbridge abutment located on the other side of the obstacle. This state makes construction works as a free-ends beam, which results of a closed kinematic chain.

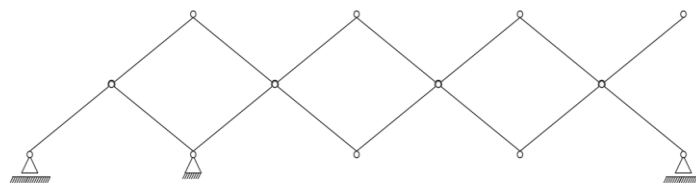


Fig. 8. Kinematic chain of footbridge structure

There have been several construction problems to cope with, connected with dimensions of each part of our folding footbridge. Each element had to be redesigned and checked several times, to avoid any unwanted contact between other elements during folding out. The main difficulties of designing geometry were:

- a) hiding actuator into arm element,
 - b) designing floor mechanism, that allows folding the floor as thin as it's possible,
 - c) designing one extra pair of diagonals, that can slide through the special rails on the abutment
- as the resulting actuator works only in the intended direction (axially).

Structural FEM analyzes were performed for each stage of folding to make sure that actuators, which we wanted to use are strong enough to provide folding of structure, so it was necessary to get known the minimum force to fold and fold out the structure of footbridge. It was extremely important to avoid perpendicular forces during folding out - that could cause curvature of this element, so it would be easily damaged.

For the static structural and optimization analysis it was necessary to optimize all parts of the structure several times, to obtain the final best results. This operation let us finally make the structure much lighter, without increasing stress in arm elements. Deformations of elements were also extremely important for us because large displacements occur non-alignment welding, which may result as construction damage or may involve much more necessary force on actuators. That would also occur higher stresses on elements and could make damages on neck bushes, which provide sliding friction.

The results of simulations and conclusion

The preliminary simulations results are very promising. They showed, that there is not any unwanted collision between elements of footbridge construction during each phase of folding and all geometry is designed properly. We have made the structural analysis for each step of folding, in order to get to know what range of stress is present during those steps. The most important analysis is when the structure works as a cantilever. This state generates the highest amount of elements deformations and stresses. The vertical deformation during the cantilever state of the footbridge is less than 20.50 mm (Fig. 9). Equivalent stress in diagonals is usually less than 85 MPa, except from holes for bracing in arms, where the maximum stress on the edge of the hole is 124.73 MPa high. (Fig. 10).

All the results obtained during analysis have shown us, that the construction is well designed and it is ready for realization. We are looking forward to assembly our footbridge and compare results from analysis with the real state.

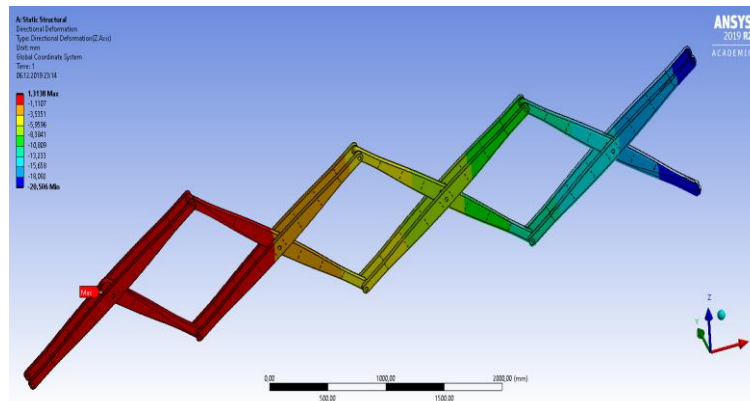


Fig. 9. Vertical deformation of diagonals, cantilever state of the folded out structure

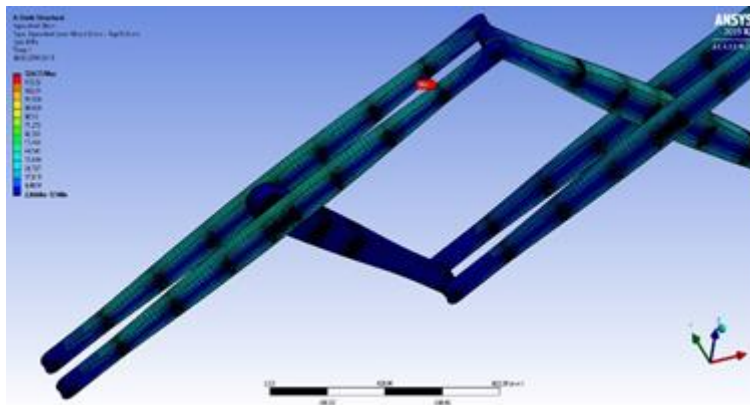


Fig. 10. Equivalent stress in diagonals, cantilever state of the folded out structure

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TOURIST POTENTIAL AND OPPORTUNITIES FOR THE DEVELOPMENT OF DUKLA MUNICIPALITY IN THE OPINION OF RESIDENTS

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Abstract:

The purpose of the research was to know and analyse the opinions of the inhabitants of Dukla municipality on the current tourist potential and the possibility of further development of the municipality. The work was put in place and analysed by the statements of the inhabitants of the municipality about the attractions that are most famous to them, as well as those that can significantly affect the tourism of the region. On the basis of the answers obtained, it was possible to respond positively to the questions raised earlier and draw some conclusions. After analysing the surveys, it can be concluded that the municipality of Dukla is an area interesting for the tourist and undoubtedly worth visiting, in addition, having considerable potential for further development. However, as the respondents noted, this requires further action by the municipality authorities (promotion) as well as the tourists themselves.

Keywords:

tourist potential, development, Dukla, tourism

Introduction

Tourism covers all activities of people who travel and stay for leisure, business or other purposes no longer than one year without interruption outside their daily environment, excluding trips where the main purpose is gainful activity [1].

However, there are combinations of this definition that it is also all phenomena related to nature and residence in a given place and the effects of interaction between organizers and tourist service providers or between the local population and the local population themselves travellers [2].

Tourist potential - in dictionary terms means "a set of elements understood as means that can be used to achieve a purpose" [3], but also: "a resource of possibilities, power, stuck in something" [4].

Development is: "the process of moving to more complex states or forms or in some ways better" or "how events develop over time". It can also mean "the process of changes occurring in organisms during the life of an individual or in subsequent generations" [3].

Agritourism - it is a tourist activity, carried out in rural areas run by agricultural families eg. renting rooms of your own rooms and providing tourists with attractions related to the region [5].

Tourist - "this is every person travelling at least 24 hours in a country that is not a country of residence, but a destination" [1]. Such a trip should not exceed one year, and the purpose of such a trip may be leisure, business matters and other tourist destinations.

Tourism can be divided according to a number of different criteria, for example: stay time, type of accommodation, means of transport, number of participants, method of organization or season, but the most important criterion is determined by the dominant objective (recital) [6]. According to this division, we can distinguish tourism:

- Exploratory i.a.: nature, sightseeing, cultural or polar or culinary tourism;
- A seating area that includes i.a.: entertainment, military tourism and agritourism;
- Health, which focuses on medical, spa and spa&wellnes;
- Qualified – its practice involves having special skills and suitable equipment e.g. canoeing, skiing;
- Business – it focuses primarily on business, corporate or congressional trips;
- Religious, which mostly includes pilgrimage tourism.

Gmina Dukla is located in the south-eastern part of Krośnieńskiego County (Subcarpathian Voivodeship). From the south side border with Slovakia. From the other three parties it is surrounded by seven other municipalities: Komańcza, Rymanów, Iwonicz – Zdrój, Miejsce Piastowe, Chorkówka, Nowy Żmigród and Krempna. This area is 235,14 km², which represents about 2% of the entire province [7].

In tourist terms, the municipality lies in the middle of the area of the Beskid Niski[8], and geographically J. Kondracki [9] defines its location in two mesoregions: Beskid Niski (which is part of the macroregion of the Beskid Środkowy), as well as Pogórze Jasielskie(macroregion of Pogórze Środkowo-Beskidzkie). They are part of Zewnętrzne Karpaty Zachodnie sub province, and this is part of the province of Karpaty Zachodnie z Podkarpaciem. [7].

In the area of the municipality we can distinguish the following bands and hills:

- Cergowej Acclivity (683 m above sea level);
- Magury Chyrowej Mountine Range(694 m above sea level);
- Iwelskie Mountines (z Franków Wierchem – 534 m above sea level)
- Piotruś Mountine (728 m above sea level)
- And a section of the Border Band:
- Baranie (754 m above sea level) with legs in the west;
- Kiczery, Dział Tylawski (610 m above sea level) i Ostra (687 m above sea level) in the east.

In addition, the municipality has the Przełęcz Dukielska (500 m above sea level) and one large river – Jasiołka, as well as many smaller ones (eg. Iwielka, Jasionka, Panna, Mszanka, or Biały Potok).

In the offer of accommodation of the municipality prevails accommodation in agritourist facilities. We can also find campsites (in the villages: Tylawa and Stasiane), four mountain student huts and one youth hostel.

In addition, there are other superior accommodation facilities in the area, such as: "Zajazd Galicia" in Dukla, Gościniec Chyrowianka in Chyrowa and Domek z Bali Szyjówka.

In the municipality, catering facilities mainly focus in Dukla and the area along the national road number 19. Here we can find restaurants, cafes, confectionery and fast-food points. Very often, hotel services are offered a meal or the opportunity to prepare a meal on their own.

The road infrastructure of the municipality is mainly based on the city of Dukla, because there is a station here – besides, in each village we will find bus stops. The main and most frequently frequented road is National Road No. 19 running from Miejsce Piastowe via Dukla to Barwinka and further to Slovakia and provincial road No. 993, and it is about these roads mainly based traffic in the municipality.

In the municipality we will also find many attractions:

- Observation tower on Cergowej
- Panorama of Franków Wierch
- Museum chamber in Olchowcu
- Slot caves.

There are also several hiking trails through the municipality, which are worth following. These are:

- Główny Szlak Beskidzki (red trail)
- Szlak niebieski (So-called. "border line")
- Szlak zielony
- Szlaki żółte.

In addition, there is a large network of cycling routes and municipal paths throughout the municipality.

Places and places in Dukla municipality, which are worth visiting:

- Miejsca kultu św. Jana z Dukli
- Dolina śmierci (dolina Iwielki)
- The open-air museum of Lemko culture in Zyndranowa
- Ski lift in Chyrowa
- Palace and park complex and museum in Dukla
- Zabudowa Dukielskiego rynku
- Cmentarz wojenny z I i II Wojny Światowej w Dukli
- Muzeum Przemysłu Naftowego i Gazowego im. Łukasiewicza w Bóbrce
- Kościół i Klasztor OO. Bernardynów pw. Św. Jana z Dukli
- Waterfall in Iwla
- Observation tower on the Polish-Slovak border
- Kościół parafialny pw. Św. Marii Magdaleny w Dukli.

The natural qualities of Dukla municipality: Magurski PN, Jaśliński PK, Rezerwat Przyrody „Modrzyna”, Rezerwat Przyrody „Cisy”, Rezerwat „Tysiąclecia”, Rezerwat „Przełom Jasiołki”, Rezerwat „Igiełki”, Rezerwat „Wadernik”.

Research assumptions and objectives

The aim of this study was to know and analyze the opinions of the inhabitants of Dukla municipality on the current tourist potential and the possibility of development of the municipality. The main research question is: is the municipality of Dukla attractive tourist and has a chance of further development?

Secondary questions have also been raised:

1. Which of the attractions of the municipality has the greatest influence on the development of tourism.
2. How to increase the tourist attractiveness of the municipality based on existing facilities.

These questions helped to answer the research hypotheses previously put forward:

- The municipality is attractive tourist and has a chance to further develop.
- Selected tourist facilities can significantly affect the development of the municipality.

The research group was the inhabitants of Dukla municipality between the ages of 18 and 65, of which 51% of those surveyed were women and 49% of men. The study was carried out from November 2018 to April 2019 on a research group of 100 people. For information about completing the survey, see the worksheet. All persons were also informed on the condition of anonymity of the responses and the purpose of the investigation.

The first part of the questionnaire allowed for the collection of basic information about the research group. It contained questions about age, gender, residence and residence in the municipality, as well as education. The data collected showed that a research group of 100 people was 51 women and 49 men. The largest age group was people between 26 and 39 years (50%), the second largest group were people aged 18 - 25 (27%). Those surveyed aged 40 - 49 and 50 - 65 were 12% and 11% respectively. The study did not involve a person over the age of 65, even though the questionnaire assumed such an option.

Of the 100 people surveyed, half (50%) 49% had a tertiary education and 1% were middle school. Among those surveyed there were no people with basic education. Due to their place of residence, the largest group were people residing in Dukla (44%) and Cergowa (11%). Among those surveyed were also people living in smaller municipalities, such as Nadole (7%), Wietrzno (6%), Jasionka (5%), Teodorówka (5%), Iwla (4%), as well as individuals from other towns. Among those surveyed there were people living in Kraków and Krosno, but they were former long-time residents of Dukla municipality.

Due to the specificity of the research, the surveyed also asked the question: "How long do you live in Dukla municipality?" to examine the correlation of your time of residence with knowledge of the area under investigation. The vast majority of respondents (91%) "11 years and longer". Only 4% of those surveyed declared themselves 6 to 10 years old and 2% 1-5 years old. Only 3% of those surveyed live in the municipality below the year (Fig. 1).

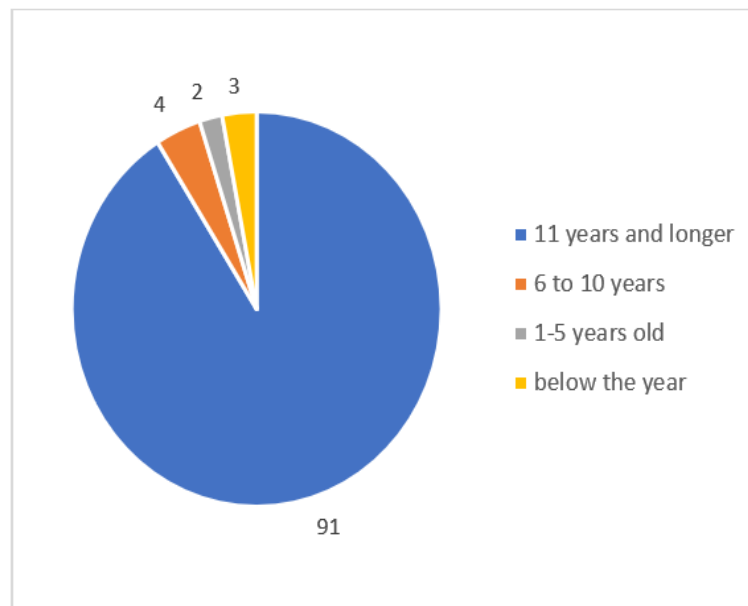


Fig. 1. Period of residence of persons in the municipality
 Source: own calculations

The first question of the main research part was the question: "Do you think that Dukla municipality is attractive to tourism?". This question was intended to examine the general opinion of the inhabitants on the attractiveness of the municipality. A firm majority, as many as 81% of those surveyed responded positively. Only 19% commented negatively about attractiveness.

The second related question was to identify the opinion of the inhabitants on the potential development of the municipality in terms of tourism. 96% of those surveyed believe that the municipality has a chance of further development, with 4% of respondents responding negatively. It is also worth noting that among these 4% of those people negating the chances of the development of the municipality, 3% also felt that the municipality is not currently attractive to tourism.

Another question referred to the evaluation of the promotion of the tourist offer of the municipality of Dukla. The respondents were to determine whether the municipality was properly promoted for a tourist offer, according to them. Only 9% of those surveyed answered this question in the affirmative (Yes, it is well promoted). 6% said that there was no opinion on this issue, while the vast majority (85%) considers that the offer deserves a better promotion (Fig. 2).

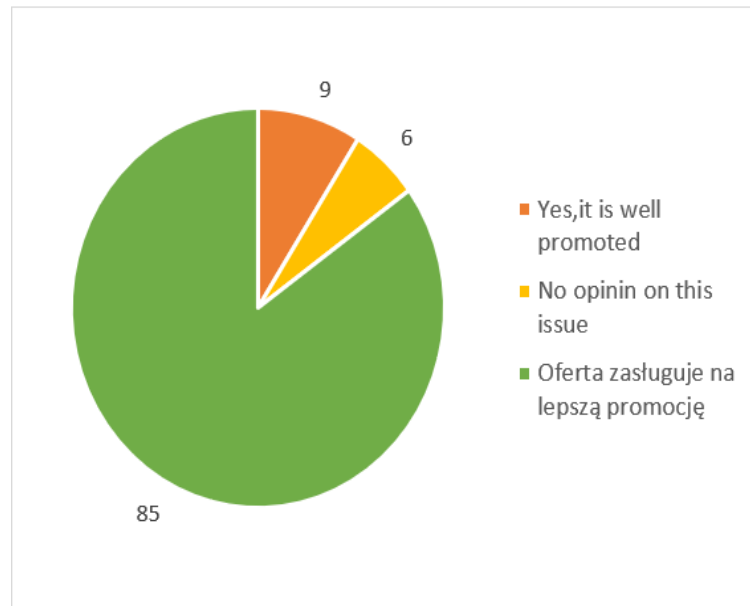


Fig. 2. Evaluation of the promotion of the tourist offer of the municipality
 Source: own calculations

The assessment of tourist traffic was similar in the opinion of the locals: 66% of those surveyed think it could be larger, 19% describe it as good, 12% have a negative opinion, and 3% have no opinion (Fig. 3).

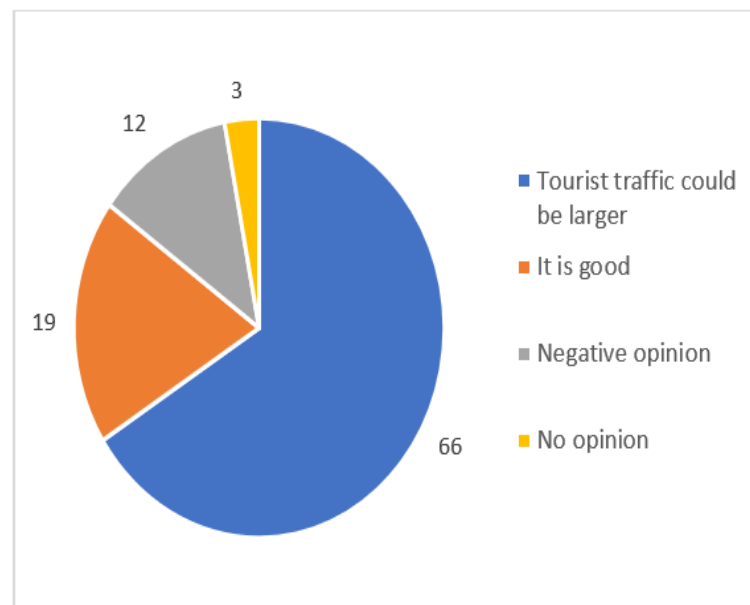


Fig. 3. Assessment of the tourist traffic of the municipality
 Source: own calculations

Another question allowed those surveyed to select three answers and aimed to establish an opinion on the most developed type of tourism in the municipality. According to those surveyed, cycling (19%) is the most popular, and historical (19%). In second place were natural tourism (17%), hereinafter national (15%) and pedestrian (13%). Only 7% of the population considered

cultural tourism to be developed. Narciarska, entertainment and military indicated 3%, and only 1% of those surveyed mentioned sacred tourism.

The next question referred directly to the previous issue and required those surveyed to enter one type of tourism from the previous question mentioned in the previous question, which has a chance of development in the municipality. The most frequently mentioned option by respondents was historical tourism (26%). Cycling (17%), sightseeing (16%) ranked in similar positions. and pedestrian (15%). A little less frequently in responses appeared natural tourism (10%) and cultural (8%). Among the rarest answers we can meet entertainment tourism (4%), ski (2%) and religious (1%) and military (1%).

Another question concerned factors directly affecting the increasing attractiveness of the municipality. According to 22% of those surveyed, the biggest impact would be to highlight tourist-attractive places. Another group (16%) people who believe that improving promotion and tourist information is crucial to increasing attractiveness. The same number of people – 15% each in favour of expanding the accommodation base and increasing the number of cultural/thematic events was supported. 14% of those surveyed suggest the need to expand the catering base, while 12% of people are expanding their range of trails. Least people (6%) in favour of the development of road infrastructure.

In the next question, the respondents were to list up to three objects that they think are the most attractive today. Most people pointed to Cergowa Mountain together with the newly built observation tower (74 votes). After 40 votes they got: Pustelnia św. Jana from Dukla and the palace and park complex in Dukla. In further places, with more than twice the number of votes, are sequentially: Zespół klasztorny oo. Bernardynów, Kościół pw. Św. Marii Magdaleny, The town hall and the Lemkowska Cultural Museum in Zyndranów. For a complete overview of the objects, see Tab. 1.

Tab. 1. The most attractive properties in Dukla Municipality

Object	Number of votes
Góra Cergowa wraz z wieżą widokową	74
Pustelnia św. Jana z Dukli	40
Muzeum i Zespół Pałacowo – Parkowy w Dukli	40
Zespół klasztorny oo. Bernardynów	18
Kościół pw. Św. Marii Magdaleny	17
Miasto Dukla wraz z rynkiem i ratuszem	16
Muzeum kultury Łemkowskiej w Zyndranowej	12
Wyciąg narciarski w Chyrowej	10
Chyrowa wraz z cerkwią	7
Cmentarz wojenny w Dukli	6
Muzeum Przemysłu Naftowego w Bóbrce	5
Wodospad w miejscowości Iwla	5
Obiekty sakralne	4
Szlaki turystyczne	3
Izba muzealna w Olchowcu	2
Farfurnia gosp. Agroturystyczne	1
Góra Baranie	1
Góry Iwelskie	1
MOSIR	1
Panorama z Franków Wierchu	1
Rezerwat „Przełom Jasiołki”	1
Ruiny synagogi w Dukli	1

Source: Own Calculations

In the next question, the respondents were tasked with assessing whether the selected objects could be an attraction for the tourist. In addition to the yes and No responses, there was also the possibility to select the option "I do not know the object", which allowed to show that residents may not know the objects that are the attraction of their municipality. As many as 99% of those surveyed with one negative voice identified the observation tower on Cergowa as an object attractive to a potential tourist. A similar situation is the case with Pustelnia Św. Jana 97% of respondents were positively assessed. Equally highly rated properties such as: Dolina Śmierci and ski lift in Chyrowa (84% of the vote for "Yes") and Główny Szlak Beskidzki and Skansen Kultury Łemkowskiej in Zyndranowa (81%).

It is worth noting that many of those surveyed do not know some of the objects listed in the questionnaire, e.g. in the case of a questionnaire. Caves on Kielowska mountain (51%) or the Museum Chamber in Olchowiec (49%). The subjects very rarely responded negatively. Only the Museum Chamber in Olchowiec received 11% of the votes, proving that it could not provide an attraction for a potential tourist.

The next question was to get the opinion of the inhabitants, which the village would recommend to a potential tourist. The most recommended village was Dukla (46%), followed by Cergowa (12%) and Chyrowa (11%). The most common argument for Dukla was the fact of the rich history of the city. The arguments in favour of Chyrowa were the good location of the village and the possibilities for development in terms of sport and recreation.

Among the arguments made by respondents were also other towns, which they believed were unusual landscapes, unique sacral objects, a rich yet diverse network of hiking trails, as well as interesting objects located in the area of the village (Tab. 2).

Tab. 2. The villages have extraordinary landscapes and objects

Bóbrka	4	Teodorówka	2
Cergowa	12	Trzciana	4
Chyrowa	11	Tylawa	1
Dukla	46	Wietrzno	3
Iwla	4	Zawadka Rymanowska	2
Jasionka	1	Zydranowa	3
Olchowiec	5	Nie polecam	2

Source: Own Calculations

Another question asked in the survey concerned the link between past events and the current attractiveness of the municipality. 53% of respondents said that religious events had the greatest impact on today's attractiveness of the region. 19% thought that the past armed conflicts were responsible for this. 13% of respondents, on the other hand, considered cultural events to be a key factor in development. The last major group was those claiming that it was the development of the oil industry that was of greatest importance (21%). The other few people opted for the period of the reign of the Męciński family (2%) and the period of the reign of the Mniszchów (2%) (Fig. 4).

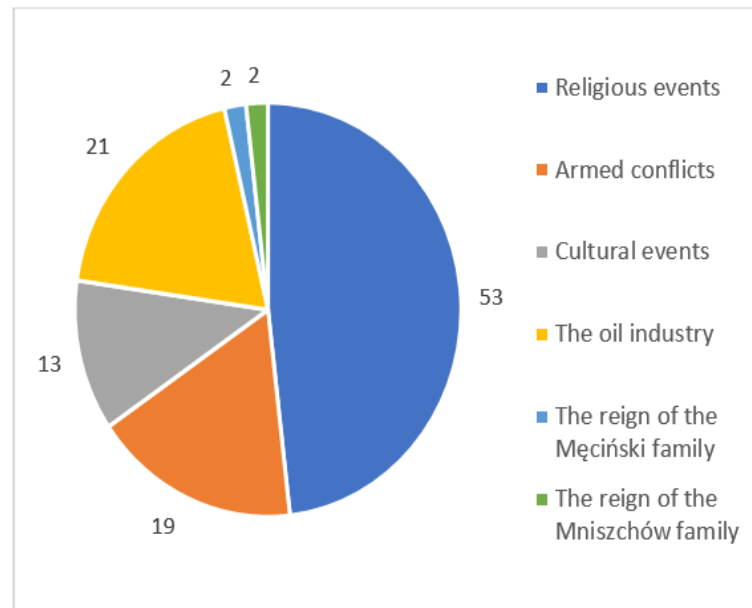


Fig. 4. Events and historical periods affecting the current tourist attractiveness in the opinion of the inhabitants

Source: own calculations

Based on the responses of the participants of the study, it can be clearly stated that the municipality of Dukla is attractive tourist, and existing facilities can be an attraction for a potential tourist. 96% of the inhabitants surveyed also felt that the municipality had a chance to further develop in terms of tourism, so this is not a permanent thing – further development is possible. The respondents believed that the municipality, although attractive, is not properly promoted (85% doubt the effectiveness of the current promotion) – which suggests that this could be the cause of reduced tourist traffic (66% of people think that tourist traffic could be greater).

An interesting finding is that quite a few residents do not know some objects, for example, Jaskinie on Kilanowska Góra which are a very interesting natural attraction of the region, as well as the Museum Chamber in Olchowiec or the panoramas of Franków Wierch. Probably the designation of a trail or municipal path would increase the availability of caves as well as Franków Wierch. However, improving the promotion and advertising of the Museum Chamber in Olchowiec will increase the number of visitors.

With regard to previous hypotheses: "The municipality is attractive tourist and has a chance to further develop" and "Selected tourist facilities can significantly affect the development of the municipality", as well as based on the results of the studies, can certainly be the municipality is already a very attractive region at this moment with a variety of forms of tourism and an abundance of interesting objects. Both the authors and the inhabitants of the municipality see that the area has great potential for development, although this requires some effort from both residents and the municipality itself.

Answering one of the questions raised in the introduction about which of the attractions seem to have the greatest impact on the development of tourism and the number of tourists visiting the property, it is undoubtedly necessary to mention the newly created observation tower at the top Cergowa, as well as the element of history, tradition and worship in the municipality – about St. Jan

of Dukla and his Hermit, which this place has enjoyed uninterrupted success for many years and this is the target of many walking tours.

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THE IMAGE OF ROMANTIC LOVE IN THE CORRESPONDENCE BETWEEN ZYGMUNT KRASIŃSKI AND DELFINA POTOCKA

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Abstract:

Delfina Potocka was undoubtedly the greatest love of Zygmunt Krasiński, as evidenced by their rich correspondence from that time. The emotional bond between Krasiński and Potocka, though doomed to failure from the outset, continues to fascinate to this day. Their letters and the love story they tell – written in the style of their epoch with its typical exaggerations that might even seem comical to modern readers – are nevertheless a beautiful testimony of their mutual feelings. Noteworthy is the structure of the letters itself – their form and the expressions and phrases used in them provide a lot of information about the relationship between the sender and the addressee. Moreover, one must emphasize the enormous literary value of the correspondence between Krasiński and Potocka. Its form brings to mind a novel describing the fate of Romantic lovers – Dąbrowski and Siołczyński. Perhaps first and foremost, it is also a valuable and, importantly, accessible and interesting source of knowledge about the morals and customs of the Romantic period.

Keywords:

romanticism, love, letters, creation

Meeting Delfina Potocka was the beginning of a new stage in Krasiński's life. For the next dozen years, she remained the only woman he loved, or at least he claimed so himself. His feelings for her remained unaffected even by his marriage to Eliza Branicka. Paradoxically, this marriage even strengthened the bond between Zygmunt and Delfina, making it a famous love affair, exemplifying the popular belief of that time that Romantic love was supposed to be marked with suffering. Krasiński repeatedly mentioned his existential pain due to his separation with his beloved. In Krasiński's entire correspondence, happiness was constantly interwoven with misery, which was typical of the poet's drama, as pointed out by Anna Kubale [1].

The love affair between Krasiński and Potocka was doomed to failure from the outset, though there was no indication of it at first. Everything began in the winter of 1838. General Wincenty Krasiński and his son Zygmunt were invited by Mrs. Komar, the widow of Stanisław Komar,

a major of the Russian army and the governor marshal of Podolia. The idea of the visit particularly appealed to the father who believed it was an ideal opportunity for Zygmunt to recover his mental balance after he had split up with Joanna Bobrowa. He also hoped that he would be able to convince his son to marry Branicka. However, he did not foresee that Zygmunt would fall in love with Mrs. Komar's daughter Delfina, all the more so as at first, after making her acquaintance, the poet did not show any interest in her, or at least he did not seem to be attracted to her. He was so engrossed in his memories of Joanna Bobrowa that a new love affair seemed out of the question. He thought Potocka was "... a strange creature who is already standing beyond a precipice [...], whose lively and strong soul, full of all the gifts that God bestowed on Polish women, was utterly spoilt by Paris and London, Duke of Orléans and Flahaut, the basest man of all, and by the vanity of fashion, the lowest of all vanities. However, some sparks have remained in that soul that resemble the eruptions of a volcano fuelled by a memory or too powerful grief. A desire has remained – as long and passionate as an Italian note sung by an accomplished singer – a desire for a higher state of being, a more beautiful sphere for the spirit, some radiant peace after so much madness and true sorrow alike. When those sparks are extinguished or when they slumber, she becomes insufferably fussy and cannot say two words in earnest, but has to keep laughing and joking to escape the terrible boredom that plagues her [...]. She often reminds me of Mrs. B[obrowa], not when she acts like a clown, but when she is truly sad. At such moments, I can see the same inconsolable despair in her, the same inability to feel any happiness at all [2]”.

From the letter to Sołtan it follows that Joanna was still much on Krasiński's mind. He even noticed a certain similarity between her and Potocka. He thought that Delfina, just like Joanna, required care and support. The sight of her sad face touched the poet and aroused pity in him. The only thing that intrigued Krasiński about Delfina were her eyes, full of sparks resembling the eruptions of a volcano. Those sparks were evidence of their owner's remarkable soul. Such soul, according to Krasiński, could only belong to a person who had experienced a lot of emotions and passions, leading more than once to the brink of madness. Apart from that, he did not find Potocka very attractive. She made on him the impression of a capricious woman, spoilt by high life, and as such unworthy of his attention.

Krasiński expressed his negative opinion about Potocka on several more occasions. His attitude to her changed only after a longer stay in Naples. It was not love at first sight then, as was the case with Bobrowa. On this occasion, Krasiński needed more time to realize that he had encountered an ideal lover, both in terms of appearance and character: "Delfina Potocka had the type of looks and elegance that was particularly admired and attractive in the Romantic period. She was a tall, slender blond with a perfect figure, blue eyes and snow white complexion, high and sullen forehead and a beautiful mouth. Besides, she had a charming voice that had a strong effect on her admirers [3]”. In addition, Delfina had "the most characteristic features of the women of her time: she could be an unfathomable soul – l'âme inconnue, despising life and seeking consolation in art and poetry; femme abandonnée, seeking distraction and new sensations; finally, she had the spark of an inspired woman – femme inspiratrice, which made her in turn a source of inspiration for artists and let her hold sway over them [4]”.

Owing to such personality, her good looks and natural grace, Delfina easily endeared herself to all men. She attracted them to her like a magnet. Little wonder that already as a twelve-year-old girl she captured the affection of Mieczysław Potocki, son of Stanisław Szczęśny Potocki – the initiator of the Targowica Confederation, and at the age of fifteen, she became his wife. The marriage was not a happy one, however, mainly due to the spouses' completely different characters. Another problem was the fact that they could not have any children. Each infant of the Potockis died soon after birth. In order to get over her grief, Delfina used to escape to Tulczyn – her family seat, and in 1830 she decided to take a trip around Europe. She did not travel with her husband, though, but with the Komars. The breakdown of the marriage was already inevitable. Delfina and Mieczysław hardly saw each other any more. At last, they agreed to a separation, after which Potocka settled permanently in Paris, enjoying the allure of its high society. Only occasionally, she would go to Naples to rest, put things into perspective and – as it turned out in 1838 – to fall in love with Zygmunt Krasiński.

Krasiński was one of Potocka's many admirers, among whom were Ferdinand Philippe, Duke of Orléans, the oldest son of the French king Louis Philippe, and August Charles de Flahaut, a famous seducer, general and French diplomat. Evidently, Krasiński had a very strong competition, but Delfina chose him of all the others. Most likely, she quickly realized that Krasiński, just like her, was a eulogist of Romantic love.

Krasiński and Potocka started their correspondence right after the poet left for Rome. Less than two days after his arrival in the eternal city, i.e. on 18 February 1839, he wrote his first letter to his Beatrice. The lovers wrote to each other regularly ever since, and their correspondence amounted to approximately 5,000 letters. Only one seventh of that number has been preserved to this day. They vary in content, but they are mainly love letters. Each letter to Delfina was meant as a homage to her, an apotheosis of her. Krasiński was trying to make a favorable impression on his chosen one. Along with his poems, he sent her various gifts – from romantic trinkets to very stylish and often expensive presents: "I have imagined a mystical bracelet for you with «Rome, Freiburg, Naples» (set in a triangle) and many more things. [...] I also ordered a few poems to be engraved on black marble for you. This marble stone will rest on the bosom of your table. Sometimes, when crossing your room, you will turn it and read it. [...] On the other side of the gem for your bracelet, I will have the following words engraved: «You – Heaven – Me » (in the three corners of the triangle). A most mystical inscription. [...] The unity of love – the truth of two hearts and the truth of the entire world! Each living in the other one, and together forming a whole. Such whole is our God and our Spirit [5]. This present sent by Krasiński was meant to remind Potocka of her faithful and devoted lover. The inscription was very significant. It was a peculiar declaration of love testifying to the importance of words in Romantic rituals. Krasiński was known to observe the rituals of Romantic love that played a vital role in the customs of the 19th century.

Equally significant was the form of the letters itself. Many of them start and end with the poet's assurances of love, which form a compositional frame [6]. Sometimes, the reader might have the impression that the contents were overshadowed by the form. The meticulous attention to detail imparted new qualities to the letters. Frequent use of figures of speech, such as metaphors or similes, was supposed to embellish them and stir the addressee's imagination. The letters resemble pictures

painted with words. "Kraśiński called Delfina «Dialy» or «Didysza». He signed his name «Zyg.» or «Siżyś», as she called him in private. When writing about himself or repeating the words of third persons, he often used his surname «Kraśiński». In his letters in French, he addressed her directly «Delphine» [7].

However, Kraśiński wrote very rarely in French, contrary to Delfina who – due to her long stay abroad and the dominant fashion of the time – hardly ever used Polish. If she wrote in her mother tongue, she did so only to please Zygmunt. It did not happen very often, though, despite his repeated requests: "[...] You know, Dialy, your Polish is wonderful. Your last letter was written in a splendid and most natural Polish, its verses seemed to spread the fragrance of lily of the valley around me – charming simplicity with a deep feeling underneath. With a little effort on your part, I am sure you would write a delightful and lucid Polish in no time [5]".

In the end, Kraśiński did not manage to convince her. He was happy to receive all her letters, no matter in what language. More important to him were their contents. He waited for each message from his beloved with longing, especially as sometimes, during the long months when they could not see each other, letters were only form of contact available to them. During such periods, the correspondence remained the only way to stay in touch, and the only link between them were words. Delfina and Zygmunt wrote to each other as often as possible. Delfina turned out to be a perfect pen pal. Compared to Bobrowa, she had much broader intellectual and emotional horizons. She was well versed in the social and political situation and the philosophical works of the first half of the 19th century.

It was from Delfina's letters that he found out about Andrzej Towiański's lectures in Paris in 1840. This renewed the poet's interest in philosophy, which was reflected in his letters to Potocka from 1841 and 1842. Many of them resembled philosophical and didactic treatises. Kraśiński frequently appeared in them as a mentor, e.g. in his letter of 6 December 1841, he tried to explain Hegel's system to his lover: "Whatever mankind touches must unwittingly refer to its journey from God and its return to God. Mankind originated from God without any self-knowledge and is now progressing towards that self-knowledge. And when it returns to God, it will know both itself and God [...] Therefore, man opposes and negates God, but then he must negate himself and return to God. At that point, he will be both man and God, even though in the beginning, there was only God. Never take the word "negation" as hostile denial, but think about it this way: There is a chest of drawers, you open a drawer and it becomes a negation of the chest of drawers. And when you negate it again, that is when you close it, by this double negation you get the same chest of drawers as in the beginning. But now you know that the chest contains drawers and what is inside them, you know the whole truth about the chest of drawers [5].

After reading the above passage, one might doubt whether the poet managed to achieve his goal. Comparing Hegel's philosophy to a chest of drawers was probably not the best idea. His argument is rather chaotic and unclear and might have been counterproductive. However, one cannot doubt his good intentions and, above all, his wish to impress Potocka at any price. He engaged in all matters related to his beloved. He offered her advice, suggestions and assistance in various practical matters. Among other things, he got involved in Delfina's divorce case and managed her financial affairs.

This was possible as – due to his marriage to Eliza Branicka in 1843 – Krasiński spent much more time in Poland than Potocka.

It would seem that marriage should result in either breaking off or limiting his contacts with Delfina, but it turned out to be otherwise. Although the lovers no longer met, they continued to write to each other regularly. Krasiński knew that letter writing was a powerful instrument of shaping reality, at least between the sender and the addressee. The poet believed in the power of words and by his letters, he strived to overcome the distance between himself and Delfina. For that purpose, he used various writing techniques, e.g. retrospection, hence the frequent references to the past. They were the poet's means to create a space that would be familiar both to himself and to Potocka, a space governed by the idea of love.

Zygmunt always chose events that were firmly imprinted both in his own and Delfina's memory. One of such events he often recalled was the moment they first met. There would have been nothing extraordinary about it if it had not happened to be Christmas Eve, which was a special day for Krasiński, "the birthday of God who was also a man and who, ages ago, incorporated in the most perfect way the principle of unity that was so important to Krasiński. Moreover, that day reminded the poet of the fate of mankind, expelled from paradise due to its first parents' sin, and of its way back to paradise that began with Christ's birth and suffering. [...] Meeting Delfina on that very day, in a quite ordinary villa in Nice, among uninteresting hosts, amounted in the poet's interpretation to a kind of magnetic summoning of a sacred space, to which every human being and all mankind was heading, owing to Christ's birth and suffering that erased Adam's sin" [8].

Christmas Eve became a pretext for idealizing his relationship with Delfina, a reminder of the extraordinary nature of their affair. The poet viewed each meeting with Potocka as a return to paradise. Krasiński associated their stay in Varenna on Lake Como in Italy or in Freiburg in Germany with everything that was perfect. And it was not magnificent architectural monuments or the beauty of nature that made the places appear so miraculous to him, but the presence of his beloved: "Never had he been happier and experienced more beauty than during our days in Varenna, separated by the Alps from the world, from the past and the future, imbued by the azure and silver of your figure! An ideal, truly, an Ideal!" [5]. Krasiński attributed to Delfina features of character that she actually did not possess. Interestingly, he did so with full premeditation. It was a part of his Romantic stylization: "By placing her in the sublimated sphere of memories and creating her ideal image in them, he wanted to stop the passage of time that changed people and destroyed feelings" [8].

Potocka had no other choice but to submit to her lover's vision, at least as far as it was possible. It required much patience and humility to live up to the fantasies of the exalted Romantic poet – not only on Delfina's, but also on Eliza's part. One might even claim that the situation of Krasiński's wife was far worse than his lover's. From the very beginning of their marriage, she had to suffer her husband's excesses. She must have realized that Zygmunt was still seeing Delfina, but she never mentioned it. She did not complain or reproach him. Instead, she did her best to make her husband happy. Sometimes, Eliza's behavior was even quite irrational and pointless. How can one explain her consent to the trip to the villa in Nice together with Zygmunt and Delfina? What did Eliza expect from a stay in the place where her husband and his lover had spent the most beautiful

moments of their lives? However, another question seems more important: What did Krasiński, who was the initiator of the trip, expect? His intentions must have gone beyond denying the gossips that were circulating about his infidelity. Surely, he did not want to bring both ladies to a nervous breakdown, either. The hypothesis of improving his relations with Delfina seems just as unlikely. If that had been his aim, Krasiński would not have taken his wife with him. According to Anna Kubale "[...] it was meant to be a fulfillment of an ideal he had envisioned, a final realization of a utopia. Hence his need to include Eliza in the drama of his life" [8]. Eliza's acceptance of the poet's relationship with Delfina was meant to be the coping stone of Krasiński's utopian project. How could he expect the two women, who were both in love with him, to become friends? Neither Zygmunt's wife, nor even less Delfina was inclined to accept their complicated situation. This time, Krasiński's plans were shattered, which made him realize that some ideals could not be fulfilled, and that achieving full harmony was not always possible.

The events in Nice changed the nature of his correspondence with Potocka. His letters from that time took a tone of resignation and were full of omissions and innuendoes. Krasiński became extremely pessimistic and perceived the whole world as a bleak and miserable place: "So many wounds in my bleeding heart! My blood – once the deepest and bravest red – has now turned sour. The slightest sun ray, the lowest birdsong from the trees, the smallest star in the evening sky tears the thin cover off and opens those wounds like a dagger! The whole nature, the whole world and the circle of heaven are turning knives, needles and razors at me..." [9].

It was not the first time that the poet realized that his affair with Potocka was far from ideal. There had been misunderstandings between the lovers before, in particular concerning Delfina's divorce case. Despite Zygmunt's efforts, Potocka lost, which had a major impact on her property. She blamed Krasiński for the financial losses she had suffered. The poet had to defend himself on many occasions against Delfina's accusations: "You call my conduct weakness combined with incredible endurance, whereas I am convinced that it demonstrates a certain strength and faithfulness in every minute, in every trifle and in every occurrence – the very strength and faithfulness that you demand [...]. Do not believe in my foolishness or prudence or egoism where you are concerned, but, verily, believe in my love!" [9]. One must admit that Potocka was very accurate in her assessment of Krasiński's attitude. Her words addressed to the poet were quite adequate to his behavior. Zygmunt, however, considered Delfina's accusations to be unfair and unjustified, though in fact he was to blame, which he did not or did not want to see.

He also did not see that his relationship with Potocka was slowly breaking down. The conflict over Delfina's divorce was only one of many symptoms indicating the end of the affair. The feeling that once united the lovers was gradually draining away. However, their correspondence continued. Interestingly, Krasiński's declarations of love can still be found in many of his letters from that later period, but they were different than at the beginning of their acquaintance. They testified more to the strong bond between them than to passionate, fiery love. Krasiński started treating Potocka as a friend. He no longer sought her favors as he used to do before. He must have realized that Delfina already had a new lover, and that he had no other choice but to withdraw and focus on his family life, which he had been neglecting for a long time.

The time he spent with his wife and children made him reflect on and change his views on love and marriage. He finally appreciated his wife Eliza, as evidenced by his last letter to Lubomirski: "I was a fool to waste the better half of my life, my strength, my soul and my health only to find insincerity, vanity and pride where I saw an angel. And all this time, I had an angel standing right at my side! But finally, I had to recognize and discover her!!! Yes, Jerzy, Eliza is such angel" [10].

It is hard to say whether this declaration was true or only a part of his creation, especially considering the poet's extremely lively imagination and his attempts to live up to the ideal of Romantic love. His epistolography provides an interesting material for psychological analyses, and Mateusz Dąbrowski found that his correspondence with Delfina Potocka was nothing else but "a laboratory of the poet's thoughts" [11] where he conducted constant experiments. The correspondence with Delfina Potocka resulted in a substantial body of letters that was described by Jan Kott as "the greatest novel of the Polish Romantic period" [12]. One must agree to this proposition, especially since Krasiński's correspondence is a very rich source of knowledge about the morals and customs of the Romantic period.

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INFLUENCE OF THE INHIBITOR ON THE PROPERTIES OF DENTAL ACRYLIC RESIN

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Abstract:

The existence of an inhibitor could influence the useful molar ratios of the individual reagents, and this would translate into molecular weights, which could lead to change in the properties of the acrylic material. The purpose of the study was to check if the inhibitor affects the selected properties of the dental acrylic resin. Commercially available liquid to create dentures was recreated by the combination of methyl methacrylate, stabilized by hydroquinone, and ethylene glycol dimethacrylate as cross-linking agent. Two groups of specimens were made. The first one was with pure MMA (without inhibitor) and the second one- with MMA and inhibitor. Time of polymerization process, glass transition temperature by DSC method, 3-points bending test, and LapShear test were conducted. Unfortunately- LapShear test was not correctly conducted to measure adhesion between two polymerized PMMA. The presence of an inhibitor does not affect the properties of acrylic resin. Furthermore, enabling longer working time with the material allows obtaining samples with the correct shapes and dimensions.

Keywords:

PMMA, hydroquinone, inhibitor, dentistry, acrylic resin

Introduction

To create prosthetic reconstruction or orthodontic appliance dental technicians use many kinds of chemical reagents. However, this is not necessarily single reagents, but mixtures of them. Examples of known ingredients of dental acrylic resins are shown in Tab. 1. Not all chemical reagents are shown, because exact formulas of acrylic resins sometimes are protected by their manufacturers.

Tab. 1. Selected chemical reagents included in popular dental acrylic resins.
All compositions are based on manufacturer leaflets.

PRODUCENT	NAME OF ACRYLIC RESIN	MONOMER / POLYMER	BASIC REAGENT	CAS / EC
Nobilium USA	Impak PF	liquid (monomer)	ethyl methacrylate	97-63-2
			hydroquinone	123-31-9
			p-methoxyphenol	150-76-5
		powder (polymer)	poly(methyl methacrylate)	9003-42-3
Vertex Dental	Vertex Rapid Simplified	liquid (monomer)	methyl methacrylate	201-297-1
			ethylene glycol dimethacrylate	202-617-2
		powder (polymer)	dibenzoyl peroxide	202-327-6
			barbituric acid	276-940-2
	Vertex Castavaria	liquid (monomer)	methyl methacrylate	201-297-1
			ethylene glycol dimethacrylate	202-617-2
		powder (polymer)	dibenzoyl peroxide	202-327-6
			barbituric acid	276-940-2
			methyl methacrylate	201-297-1
Zhermapol	Villacryl H Plus	liquid (monomer)	methyl methacrylate	80-62-6
			ethyl methacrylate	97-63-2
			1,4-butanediol dimethacrylate	2082-81-7
		powder (polymer)	benzoyl peroxide	94-36-0

In order to help with storage and transport- inhibitors could be added to the mixtures. The inhibitors are specific chemicals that reduce the speed and intensity of chemical reactions [1-3]. Studies on the effects of the inhibitor in case of powder were confusing or irrelevant because powder mostly consists of polymerized PMMA- so the addition of an inhibitor to the polymerized material is not required. It is entirely different in the case of liquids. The main ingredient is methyl methacrylate. Furthermore, this reagent during storage has tendency of spontaneous polymerization. Additionally, a presence of cross-linking agent in the same bottle (which is mostly ethylene glycol dimethacrylate) could start polymerization process even faster. That is why the addition of inhibitor to the liquid of acrylic resin is important.

Most common inhibitors of MMA are [4]:

- hydroquinone HQ (benzene-1,4-diol);
- hydroquinone monomethyl ether MEHQ (4-methoxyphenol).

However, the existence of hydroquinone usually used as an MMA inhibitor could influence the useful molar ratios of the individual reagents, and this would translate into molecular weights, which could lead to change in the properties of the acrylic material. So the purpose of the study was to check if the inhibitor affects selected properties of the dental acrylic resin, like flexural strength or glass transition temperature.

Materials

Commercially available acrylic was recreated with the use of basic chemical reagents. The powder was left in the original state (Vertex Rapid Simplified by Vertex Dental company) and the liquid was recreated by the combination of methyl methacrylate (99%), stabilized by hydroquinone (CAS number: 80-62-6, from Alfa Aesar) and ethylene glycol dimethacrylate (98%) (EGDMA) as cross-linking agent (CAS number: 97-90-5, from Sigma-Aldrich). The ratio was as follows: 95% MMA and 5% EGDMA. It was based on the datasheet of monomer of acrylic resin Vertex Rapid Simplified (Vertex Dental company) [5]. This specific kind of acrylic resin was chosen to recreate, because hot-cured acrylic resin is more durable and connects better to artificial teeth made of polymerized PMMA [2, 6-11].

Preparation of specimens

Two groups of specimens were made. The first one was with pure MMA (without inhibitor) and the second one- with MMA and inhibitor. To purify MMA, aluminium oxide was used, also known as basic alumina (CAS number: 1344-28-1, from Sigma-Aldrich) by column method. Because inhibitor change the time of initial polymerization- more specimens differing in time packing acrylic resin to molds were created. This action was caused by an attempt to find the best time after which it was possible to work with acrylic resin.

Initial polymerization proceeds are as follows [1, 2]:

1. Wet sand phase (phase immediately after the liquid was poured on the powder),
2. Swelling phase,
3. Thread phase (acrylic resin starts to pull behind the tool used to mixing),
4. Soft rubber phase (the phase in which the material can be formed),
5. Hard rubber phase (material is so hard that forming is impossible).

Results and discussion

Time of polymerization

For research purpose, five sets of specimens with pure MMA and three of MMA with inhibitor were made. The time after which the initial polymerization took place and the acrylic resin reached the phase where manual forming was possible are shown in Tab. 2.

Tab. 2. Results of measure working time of acrylic resin

MMA WITHOUT INHIBITOR		MMA WITH INHIBITOR	
Time	Action	Time	Action
0 min	rejected	0 min	rejected
2.5 min	rejected	2.5 min	rejected
5 min	used for research	5 min	rejected
7 min	rejected	7 min	used for research
10 min	rejected	10 min	rejected

The same phase specimens without inhibitor were achieved two minutes later, which was a phase where manual forming was possible. Longer working time with the material is a positive effect from the dental technician's point of view, because longer operation time allows to prepare the specimens in proper, desired shape, without any imperfections. This translates into the preparation of dentures and dental appliances- longer work with material allows achieve perfect products for the patients. An example of rejected specimens is shown on Fig. 1.

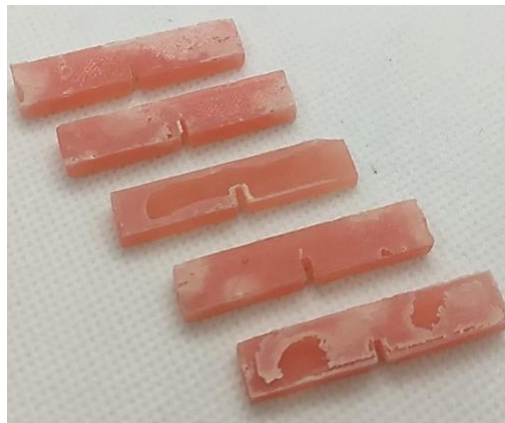


Fig. 1. Specimens made after 10 min pre-polymerization
Source: own picture

Glass transition temperature

To measure the glass transition temperature, Differential Scanning Calorimetry (DSC) was used. The results are shown in Fig. 2 and Fig. 3.

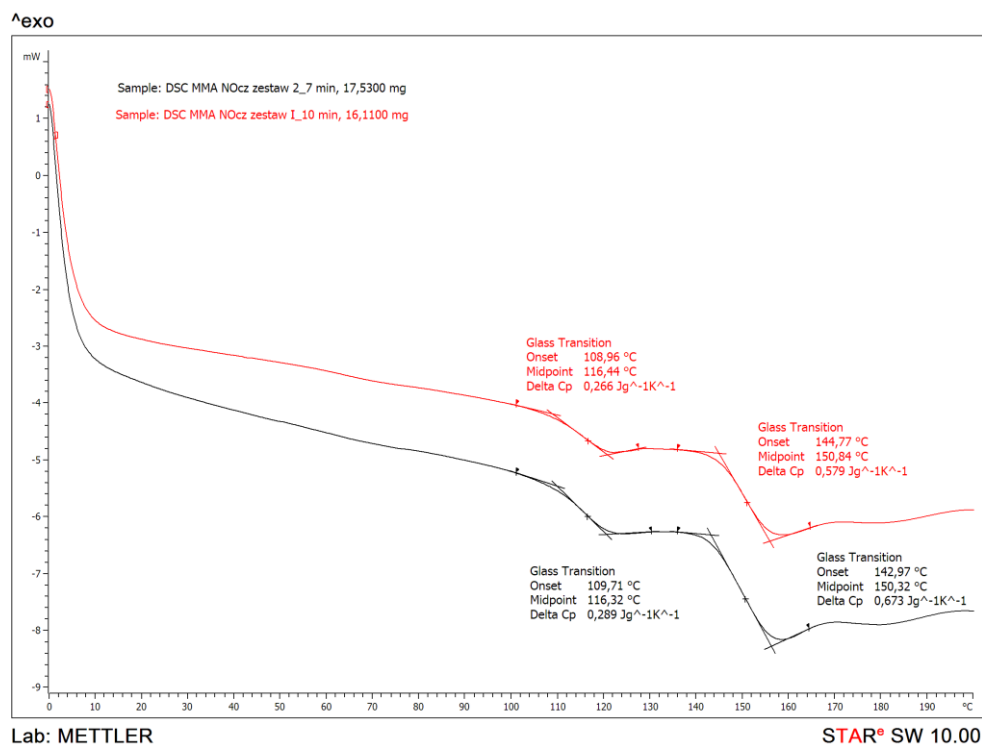


Fig. 2. Diagram of measurement results of specimens made of MMA with an inhibitor

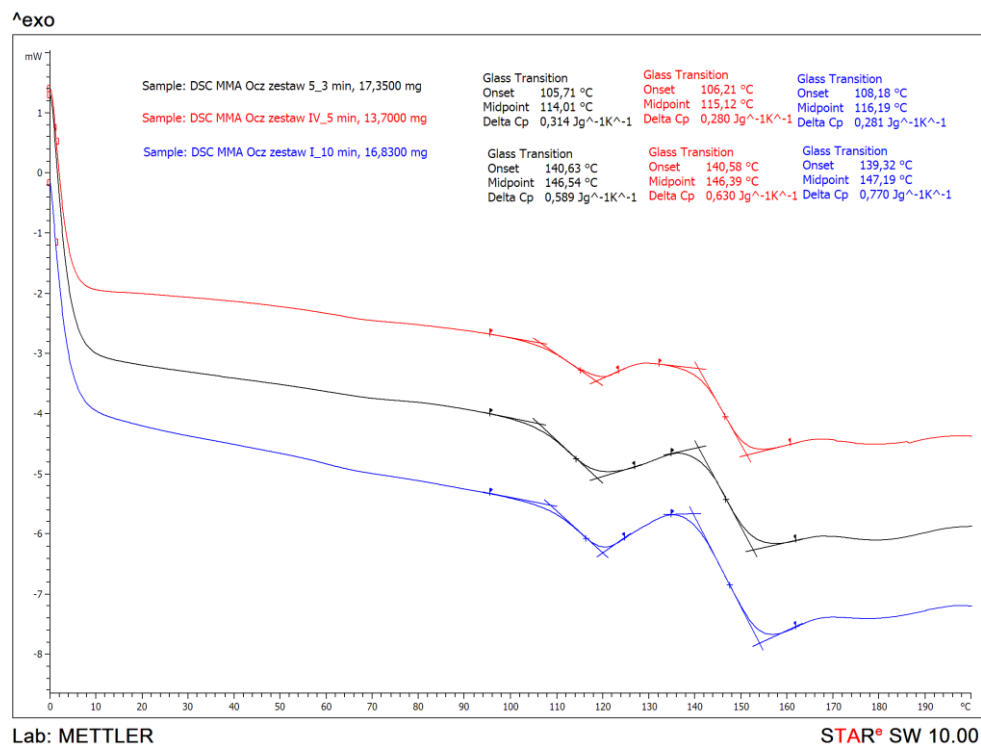


Fig. 3. Diagram of measurement results of specimens made of MMA without inhibitor

This measurement shows that there is no considerable difference between specimens made of clear MMA and MMA with inhibitor.

3-points bending test

This test was based on PN ISO 20795-1. The diagram of the force action is shown in Fig. 4. This test was chosen to measure flexural strength of created specimens.

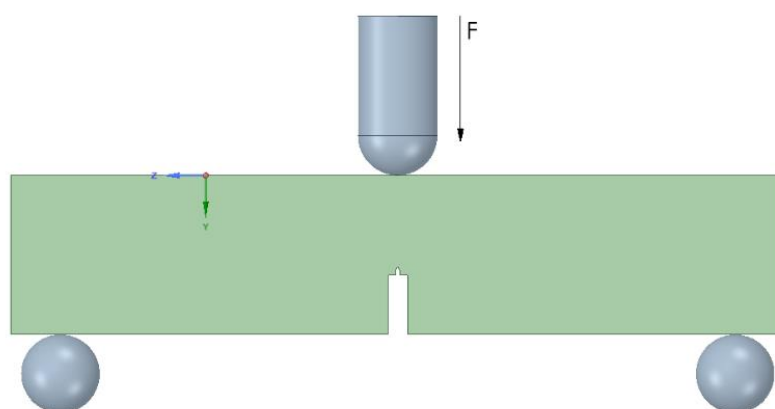


Fig. 4. 3-points bending static test
Source: own picture

The results of the 3-points bending test are shown in Fig. 5. On manufacturer's website [5] flexural strength for Vertex Rapid Simplified is given as 85.2 MPa. Calculated average flexural strengths (also taking into account the standard deviation) were similar. The difference between these two

materials was not considerable. So it can, therefore, be considered that the inhibitor does not affect flexural strength.

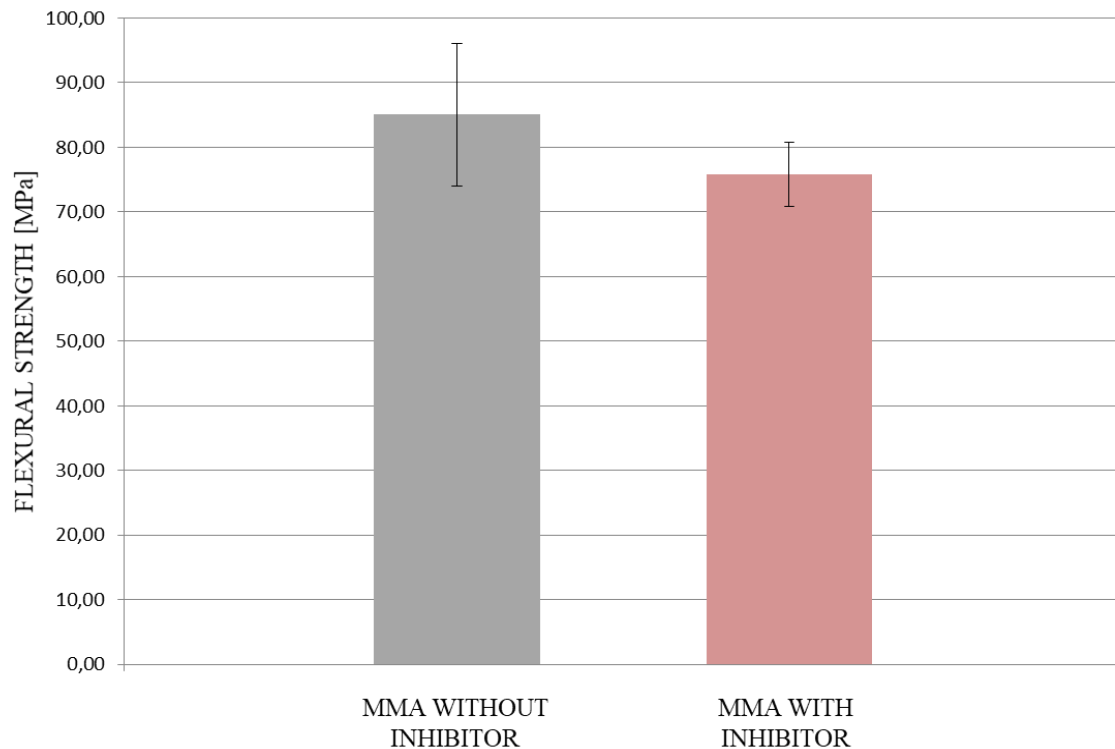


Fig. 5. Chart of average flexural strength in both group

LapShear test

This attempting to carry out the test was to check the adhesion. Sample dimensions and the procedure was based on articles [12-14]. The shape and dimensions of specimens are shown in Fig. 6. The diagram of the force and sample connection is shown in Fig. 7.

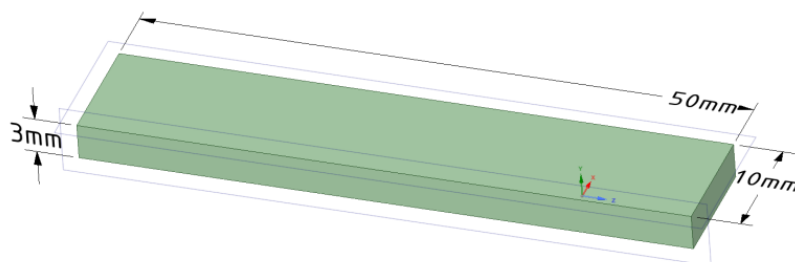


Fig. 6. Dimensions of one part of the sample used in lap shear test
 Source: own picture

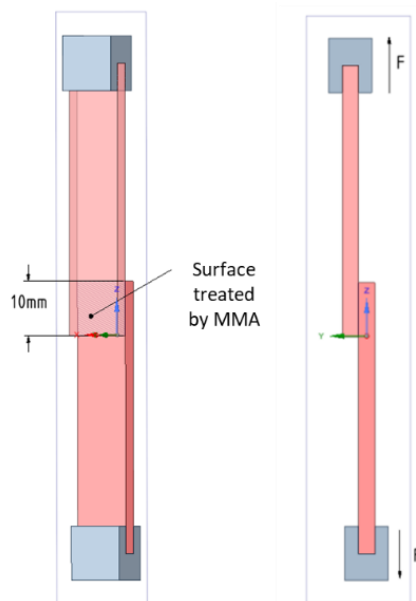


Fig. 7. Lap shear test
 Source: own picture

Unfortunately, adhesion measurement was not possible because the strength of the connection between specimens was stronger than material (Fig. 8). However, this is an excellent presentation of the problem which exists in case of removable denture metal framework. When the denture plate thickness is reduced (such a case occurs when the reconstruction of single incisal tooth appears). It leads to the quick breaking of the tooth from the prosthesis [15-18].



Fig. 8. Result of lap shear test
 Source: own picture

Conclusion

Inhibitor does not influence glass transition temperature. There was no considerable difference between specimens made of MMA with and without the inhibitor. Unfortunately, LapShear test was not properly conducted to measure adhesion between two polymerized PMMA, as it is better for elastic kinds of material. However, results show the research problem in case of removable denture metal framework. The connection between two polymerized, same kind of acrylic resin is right when the area of connection is big enough, as it is similar to the case of removable denture metal framework. In the area of molars and premolars, the connection is wide enough to keep the tooth in the base plate. When the acrylic layer is thinner- base plate breaks.

In summary - the presence of an inhibitor does not affect the properties of acrylic resin. Furthermore, enabling longer working time with the material allows obtaining samples with the correct shapes and dimensions. Moreover, this translates to the final product made of acrylic resin, like dentures or dental appliances.

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ETHYLENE – PROPYLENE ELASTOMERIC MATERIALS CONTAINING RECYCLED RUBBER SHREDS

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Abstract:

Ethylene 1-octene thermoplastic elastomers are materials that due to the architecture of their macromolecules can be processed as thermoplastic materials. At the same time, these types of materials exhibit elastic properties like typical elastomers. Unlike elastomers these materials do not need to be crosslinked. In the work, as an additive to the EPM and EPDM rubbers and thermoplastic elastomers type Engage 8452 the rubber foam waste was incorporated. The foam shreds were obtained by grinding of waste elastomeric foams. The grounded material was introduced into the elastic matrix at a different weight ratio. The density of the obtained materials was tested. The mixtures were crosslinked with dicumyl peroxide. The effect of shreds addition on melt viscosity, mechanical properties during stretching and viscoelastic properties during shearing was investigated. Using the optical microscope, the structure and morphology of the obtained blends were characterized.

Keywords:

viscoelastic properties, foam shred, recycling, ethylene-propylene rubber, thermoplastic elastomers

Introduction

Insulation materials

Insulation materials are sealing building materials that form a building's thermal barrier or otherwise reduce heat transfer. They can also be used to stop the flow of electricity or sound from one area to another.

Insulation materials include a range of massive fibrous materials, such as glass fibers, mineral wool and slag, cellulose and natural fibers, as well as foam boards and smooth foils or polystyrene. Massive materials are resistant to conductive and - to a lesser extent - to convective heat flow in the building cavity. Insulation can be categorized according to its composition, form, structural input, heat resistance mode, environmental impact and other factors. Sometimes a heat-reflecting surface, called a radiating barrier, is added to the material to reduce heat transfer by radiation and conduction [1]. The choice of material or combination of materials depends on many different

factors. Some insulation materials, such as asbestos fibers, are hazardous to health that they can no longer be used but are still in use in some older buildings.

Recycling of flexible EPDM materials used as isolators.

EPDM is used as an extremely durable roofing membrane made of synthetic rubber (ethylene propylene diene terpolymer) in low-sloping buildings in the United States and around the world. Its two main components, ethylene and propylene, come from crude oil and natural gas. EPDM can be installed entirely as an adhering element, mechanically fixed or loaded, with a roof seam sealed with liquid glues or specially developed tape [2].

In just a few years, EPDM roofing recycling has been transformed from the emerging concept into cost-effective, environmentally friendly technology that has been developed by roofing specialists in detached and worn roof designs in the United States and parts of Canada. One of the factors affecting the success of roof rubber recycling is a greater emphasis on roofing again due to stagnation in the new commercial construction market, higher expectations for ecological building practices in all aspects of construction, and proven infrastructure that simplifies the process and makes recycling economically viable for roof contractors and building owners. Study found that black and white EPDM works better than many other single-layer and bituminous membrane materials in key categories such as global warming, acidification and smog generation [3].

No special equipment is required for EPDM recycling. On the roof, the crews begin the process of removing ballast, cleaning the roof, and then cutting the EPDM panels into large sections. After cutting, the EPDM sections are assembled into bundles, stacked on pallets and set aside until the truck arrives at its destination for transport to the grinding plant. A suitable place is needed to store the material on site, awaiting the arrival of the truck that will transport the material to the recycling center. Thanks to this, loading material onto a truck is a quick and easy process [4]. Recovered material from both Firestone and Carlisle was used to make washers for passageways to new or existing roofs [5].

Materials and methods

Materials

Waste material from the production of insulation materials was used in this study. The material was delivered in the form of waste foam by K-FLEX POLSKA.

The foam was cleaned and then ground. The waste was characterized by high porosity. Popular elastomers, ethylene propylene diene rubber EPDM (KELTAN 4450)- propylene content 48%, viscosity acc. to Mooney 46, ethylene propylene rubber EPM (DUTRAL C0 054) - propylene content 41%, viscosity acc. to Mooney 44 and commercial ENGAGE: 8452 thermoplastic material were used. The main properties of ENGAGE™ POE Ethylene Octene Grades: 8452: density = 875 kg/m³, melt index 3g/10min, Mooney viscosity 11, total crystallinity 20%, durometer hardness (Shore A) = 74, T_g = -51°C.

Shred preparation

Firstly, before the mixing the reduction of waste size was done. The foam was cut into thin strips and then ground on a Brabender micromixer. The device parameters were: $T = 25^{\circ}\text{C}$, time = 15 minutes, speed 50 rpm.

Blends

Mixtures were prepared using a Brabender micromixer. The composition of the mixtures is given in Tab. 1. Mixing ingredients took place gradually, after thoroughly mixing a given portion of the mixture. Device parameters for recycled foam and rubber: temperature 25°C , time 15 min., speed 50 rpm, 50 Nm. The device parameters for mixtures containing TPE: temperature 100°C , time 10 min., speed 50 rpm, 50 Nm.

In the second stage, the crosslinking additive such as dicumyl peroxide (bis (α , α -dimethylbenzyl peroxide) by Merck KGaA) was introduced into the rubber mixtures. The introduction of the cross-linking substance in a proportion of 2 g DCP per 100 g of fine-polymer mixture took place on a laboratory rolling mill. The main parameters of the device: roll length = 450 mm, roll diameter = 200 mm, rotational speed of the front roll = 16 rpm, average roll temperature about = 40°C , preparation time for one mix about 10 min.

Crosslinking substance was added to improve the mechanical properties of the finished product. Composition of prepared mixtures

All amounts of ingredients are based on 100 parts by weight of recycled foam waste. Composition were prepared with the formulation as follows: EPDM 1_1shred - shred 100 phr: EPDM 100 phr; EPDM 1_2shred – shred 100 phr: EPDM 50 phr; (shred1,4_1EPM)_1 8452 – shred 100phr : EPM 71phr : TPE 8452 171 phr; 8452 1_1shred – shred 100 phr: TPE 8452 100 phr. 2 phr of DCP was added to cure the rubber mixtures.

Vulcanization of mixtures

Vulcanization of mixtures was carried out on the ZUP "Nysa" hydraulic press PH-ZPW90. A steel mold was placed between the two shelves of ironing. The mix from the mold was separated using Teflon film so that the mix did not stick to the press. Device parameters: $T = 160^{\circ}\text{C}$, vulcanization time according to the determined optimal vulcanization time $t = 15$ min, pressure = 200 bar.

Methods

Determination of density

The density measurement using the pycnometric method was carried out in accordance with the PN-ISO 2781:1996 standard. Three measurements were carried out for each mix and vulcanizate. All mixtures and vulcanizates were examined using this procedure. The density was calculated from the formula 1:

$$\rho = \frac{m}{m - m_1 + m_2} * \rho_c \left[\frac{\text{g}}{\text{cm}^3} \right] \quad (1)$$

where: m is sample mass (difference between the mass of the pycnometer with the sample and the mass of the pycnometer without the sample), $[g]$, m_1 is mass of the pycnometer with sample and

water, [g], m_2 is mass of the pycnometer with water, [g], ρ_c - density of water used for testing at the measurement temperature, i.e. 23 °C, $\rho_c = 1000 \text{ kg/m}^3$.

Determination of rheometric properties

The study was carried out using the MDR RPA 3000 MonTech rheometer in accordance with ASTM D6204 Part B (high strain) at 80°C, 100°C, 120°C and 140°C for mixtures blends. The device required inserting about 4 g of the mixture into the measuring chamber. Measurement of crosslinking kinetics was carried out using 7% (0.5°) strain at a frequency of 1.667 Hz. Dynamic viscosity measurements were performed at various temperatures at 100% deformation using a variable frequency range (0.1 - 20 Hz). The properties such as: change of dynamic viscosity as a function of frequency (shear rate) for each temperature; viscoelastic properties for DCP mixtures and vulcanizates, parameters such as: storage G' and loss G'' modulus, $\tan \delta$; kinetics and vulcanization time for DCP mixtures and vulcanizates, additionally minimum and maximum torque, increment of torque during curing; Payne effect were determined.

Determination of mechanical properties

The tests were carried out on a ZwickRoell 1435 tensile machine in accordance with PN-ISO 37:2007. The measurement was done during stretching. Each sample was placed in two holders and stretched. Five samples from each mix were prepared for testing. The test was carried out without an extensometer. Device parameters: temperature 23 °C, deformation rate 500 mm/ min. the following parameters were determined: tensile stress 100%, - SE100; tensile strength – TS; elongation at break – Eb; area under the graph -W at F_{\max} .

Determination of dynamic properties

The study was performed on TA Instruments advanced rotational rheometer Ares G2. The rheometer was connected to an external computer with a program installed to operate the device and analyze the results. For the test, samples were prepared in the form of discs with a diameter of 25 mm and cut with a special punch. Parameters of tests: temperature -5 °C, + 25 °C. The following measurements were carried out: determination of G' , G'' moduli with variable amplitude of dynamic deformations at various temperatures, room and -5 °C; relaxation under shear; determination of G' , G'' moduli at a variable frequency of dynamic deformations at different temperatures, room and -5°C; viscoelastic linear range and intersection of G' and G'' moduli have been determined.

Hardness test

The hardness was tested on a Type A Shore hardness tester (for foam and EPM mixes) in accordance with PN-EN 2430. About 10 measurements were taken at different sample locations for each mix. The average of 10 measurements was used as the final result.

The morphology of the mixtures was examined by means of an optical microscope at 150- and 300-times magnification. Observations were carried out for all mixtures.

Results and discussion

Analysis of plastograms obtained during milling and mixing waste material with other polymeric material was done. Tab. 1 shows the parameters determined during the mixing process in the Brabender micromixer.

Tab. 1. Calculated rheological parameters based on the plastograms obtained during mixing.

Sample	shred	EPDM 1_1 shred	EPDM 1_2 shred	(shred 1,4_1 EPM)_1 8452	8452 1_1 shred
Maximum of torque [Nm]	28.1	24.6	23.3	3.7	17.3
Minimum of torque [Nm]	9.3	17.5	15.7	0.6	12.2
Decrease of torque during mixing [Nm]	18.8	7.1	7.6	3.1	5.1
Energy of mixing [kJNm]	40.7	47.3	44.6	2.5	34.9

The maximum torsional moment was observed during grinding of the neat foam. The introduction of EPM and EPDM rubbers and thermoplastic elastomer reduced this value. The introduction of higher content of grinded foam into EPDM rubber did not significantly affected the values of the torsional moment during mixing. Due to the high flow index, the 8452 was easily plasticized in a micromixer, which is reflected by the lower maximum and minimum torque as compared to elastomer mixtures. The highest mixing energy values were observed for the mix 1_1 EPDM. The lowest maximum torque value was observed for the mixture (shred 1.4_1 EPM)_1_8452, both elastomer and thermoplastic were introduced into the formulation leading to the reduction of the viscosity of the mixture.

Mechanical properties and density of mixtures

In Tab. 2 are compiled mechanical tensile parameters and calculated density of mixtures. The TS value decreased with increasing amount of foam shred in the EPDM mixtures. Moreover, higher content of shred in the EPDM rubber formulation resulted in a significant decrease in the value of elongation at break, stress at 100% elongation, and the work needed to destroy the sample, indicating worse homogeneity of the material. Mixture (shred 1.4_1 EPM)_1_8452, which contained both rubber and thermoplastic showed the highest value of tensile strength among tested mixtures and vulcanizates. The incorporation of thermoplastic elastomer together with EPM rubber caused lower melt viscosity leading to better processability during mixing (lower energy of mixing). Better homogeneity of the blend at the same processing conditions was achieved resulting in better mechanical properties.

TPE vulcanizate has comparable hardness with elastomeric ones. The Shore hardness value for a vulcanized TPE material is about 26% lower than the value provided by the manufacturer, therefore the addition of shred had a significant effect on the properties reducing the hardness of the thermoplastic elastomer.

Tab. 2. Mechanical properties, hardness and density with standard deviation

	EPDM 1_1 shred	EPDM 1_2 shred	(shred 1,4_1 EPM)_1 8452	8452 1_1 shred
Eb [%]	758 ± 84	253 ± 54	420 ± 17	424 ± 63
SE 100 [MPa]	1.0 ± 0.2	1.4 ± 0.1	1.5 ± 0.1	1.3 ± 0.2
TS [MPa]	3.1 ± 0,6	2.2 ± 0.2	5.4 ± 0.2	2.0 ± 0.4
W at F _{max} [Nmm]	1595 ± 291	356 ± 62	1452 ± 150	1031 ± 248
Hardness [ShA]	42 ± 1	47 ± 0	54 ± 0	53 ± 5
Density [g/cm ³]	0.92 ± 0.01	0.9 ± 0.1	1.3 ± 0.1	1.0 ± 0.2

Comparing the densities of obtained materials to density values for rubbers and thermoplastics it was observed that the addition of shred to the mixture slightly reduced density. The introduction of higher loading of shred into the EPDM rubber did not significantly affect the density of mixture. Blends of shred with EPDM rubber had a lower density than those with thermoplastic elastomers.

Evaluation of the dispersion degree in mixtures

Tab. 3. Distribution of pores in mixtures with a standard deviation

Sample	Average size of foam shreds in mixtures [mm]
EPDM 1_1 shred	0.2 ± 0.1
EPDM 1_2 shred	0.3 ± 0.1
(shred 1,4_1 EPM)_1 8452	0.2 ± 0.1
8452 1_1 shred	0.4 ± 0.3

Tab. 3 contains measured base on the optical microscopy the average size of foam shreds in mixtures. Shred had a high porosity (average pore size diameter 0.5 ± 0.1). The pores were round in shape. In EPDM mixes pores still were observed in incorporated shred phase, although in shred 1_1 EPDM mix the porosity dropped due to the lower recycled foam content. The mix (shred 1,4_1 EPM) _ 1 8452 had the smallest size of recycled foam domains. The mixtures clearly differed in the morphology of the systems. In the TPE formulation better homogeneity was observed, when shred was mixed with rubber and thermoplastic. The formed domains of recycled foam shred were dispersed more evenly.

Determination of rheometric properties

Analysis of dynamic viscosity value as a function of temperature

Figs 1-4 show the relationship between dynamic viscosity and variable frequency. The measurement was made with a Montech apparatus at various temperatures using 100% stress.

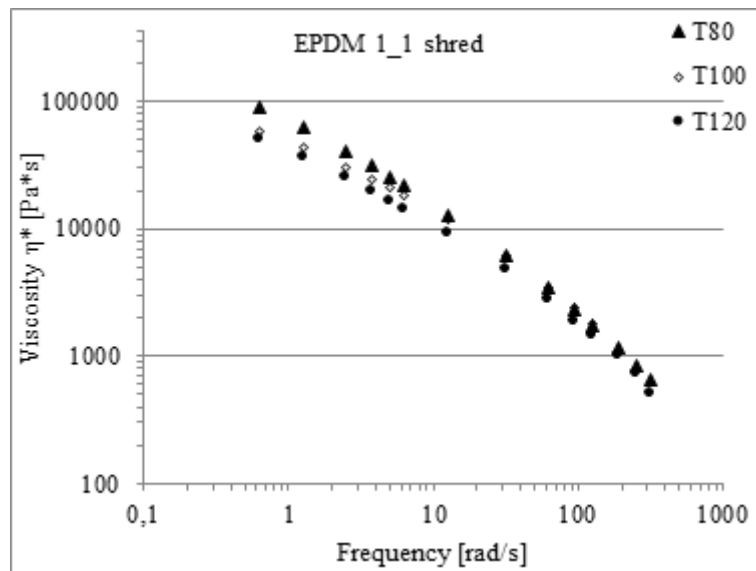


Fig. 1. The dependence of viscosity on the variable frequency for the mixture 1_1 EPDM for all temperatures on a logarithmic scale

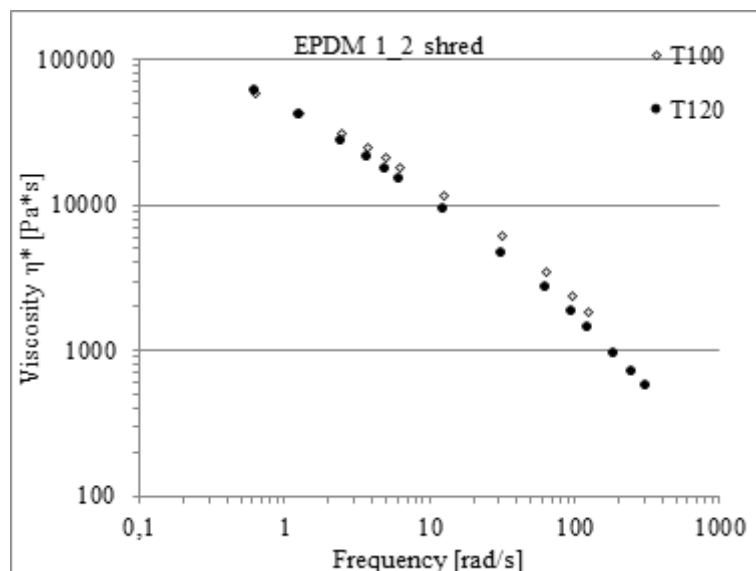


Fig. 2. The dependence of viscosity on the variable frequency for the mixture had 2_1 EPDM for all temperatures on a logarithmic scale

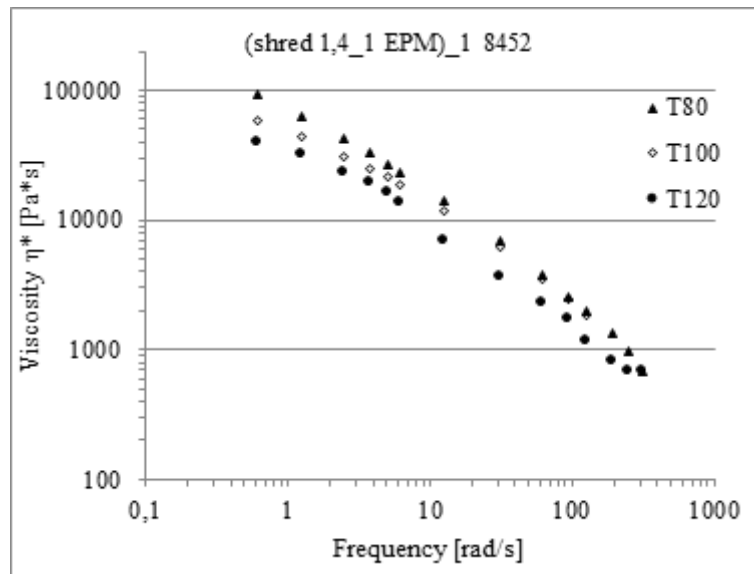


Fig. 3. The dependence of viscosity on variable frequency for the mixture (shred 1.4_1 EPM) _1 8452 for all temperatures, on a logarithmic scale

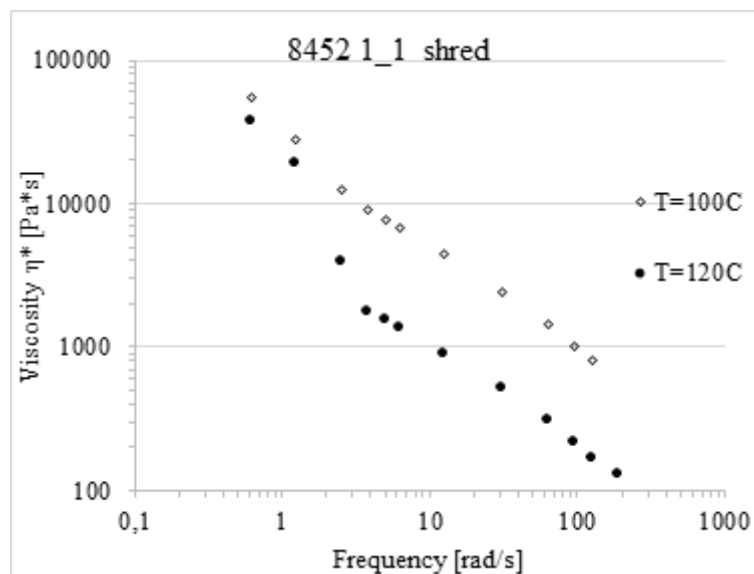


Fig. 4. The dependence of viscosity on the variable frequency for the mixture shred 1_1 8452 for all temperatures on a logarithmic scale

For all mixtures viscosity decreased with increasing frequency, according to the power law. The tested mixtures were shear thinned fluids. Increase of the temperature caused a further decrease in melt viscosity. Different technological processes are associated with the occurrence of shear forces, for individual technological operations (pressing, ejection, extrusion) the shear forces may differ. Viscosity change curves for different temperatures as a function of frequency illustrate, what decrease in viscosity will be achieved during technological processes. These types of measurements are used to select the processing temperature for the desired level of melt viscosity. It can be clearly seen that the introduction of higher content of shred into the EPDM rubber led to an increase in melt viscosity at low frequency values. The mixture of shred with EPDM rubber and TPE elastomer was

characterized by a lower viscosity in the studied frequency range than these containing EPDM rubber.

In summary, the viscosity of polymers decreases with increasing temperature. The mobility of macromolecules increases, and the viscosity also depends on the free volume between them [6]. The higher loading of shred restricted the mobility of the rubber, thus the higher level of melt viscosity was observed for the mixtures of EPDM with weight ratio shred:rubber 2:1.

Oscillatory measurements with variable strain amplitude

The Ares G2 apparatus was applied to determine viscoelastic properties at variable strain oscillation at constant temperatures of + 25 °C and -5 °C and a constant frequency of 10 rad/s. Based on this measurement, it is possible to determine the linear viscoelastic ranges of the material that affect the behavior of the material during deformation. Fig. 5 shows the changes in elastic-elastic interactions for the variable oscillatory stress for the temperature +25 °C, and the graphs for the temperature -5 °C.

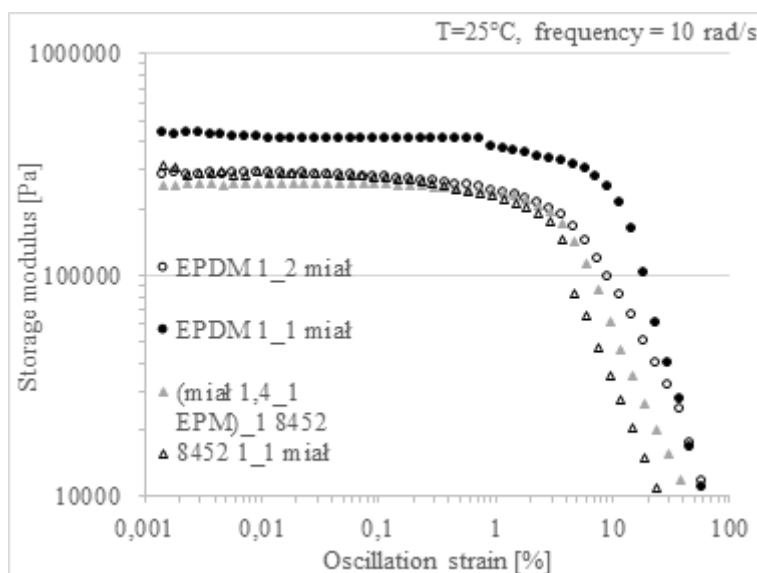


Fig. 5. The storage modulus as a function of the oscillation strain at 25 °C

The linear viscoelastic range of mixtures was comparable. The storage modulus is a measure of the elastic response of a material and it describes the material's ability to store energy. The introduction of a larger amount of shred into EPDM caused a decrease in the value of the storage module. The deterioration in properties resulted from the changes of blend morphology. As we previously described the blend characterized droplet like morphology, the size of recycled material domains differed and was larger for the blend containing higher content of shred. Worse homogeneity had influence on the dynamic mechanical properties. At -5 °C (Fig. 6), the values of the G' storage modulus for EPDM samples containing higher content of shred were comparable to thermoplastic samples. However, the EPDM samples were characterized by a larger viscoelastic range providing the increased elasticity of the tested material up to higher level of deformation.

Interactions between the polymer and the filler and between filler particles have a significant effect on the properties of the filled polymer. It should be also taken under consideration analyzing the dynamic mechanic properties that elastomeric foams used to prepare shreds contained carbon

black. The filler included in this material also influenced on the dynamic mechanical properties resulting from the tendency of carbon black to form "own-structure" in elastomer matrix via filler-filler particles interactions [7, 8].

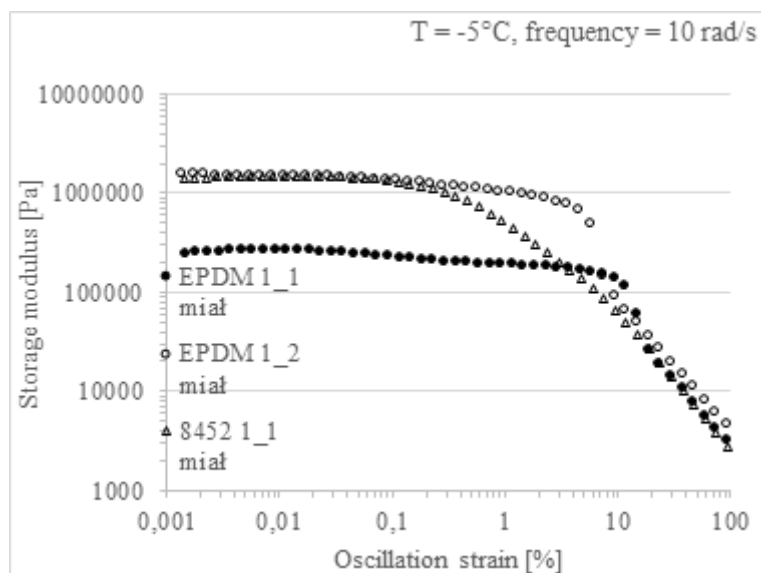


Fig. 6. The storage modulus as a function of oscillation strain at -5 °C

The values of tangent δ defined as the ratio of the loss modulus to the storage modulus were determined using the Ares G2 apparatus during oscillatory measurements using variable oscillation strain (Fig. 7). The $\tan \delta$ value is the ratio of energy lost to energy retained during deformation of the material and it indicates the damping properties of the material during the deformation. Additionally, when $\tan(\delta)$ is greater than 1 material will show dominating viscous behavior at some level of deformation. For the material with $\tan(\delta)$ less than one the elastic properties outweigh the viscous ones. A difference can be observed between the values of this parameter for rubber and thermoplastic sample. For TPE sample the cross-point $G' = G''$ of both modulus and the value of $\tan(\delta)$ equals to 1 was determined at lower oscillation strain value as compared with materials containing EPM or EPDM rubber. Increasing the shred content in EPDM based material made the mixture more elastic. It withstood larger deformations, before viscous behavior started dominating. Among the elastomer containing samples the lower value of the oscillation strain at $\tan \delta = 1$ was determined for the mixture (shred 1,4_1 EPM) _1 8452, the higher for the shred 2_1 EPDM mixture.

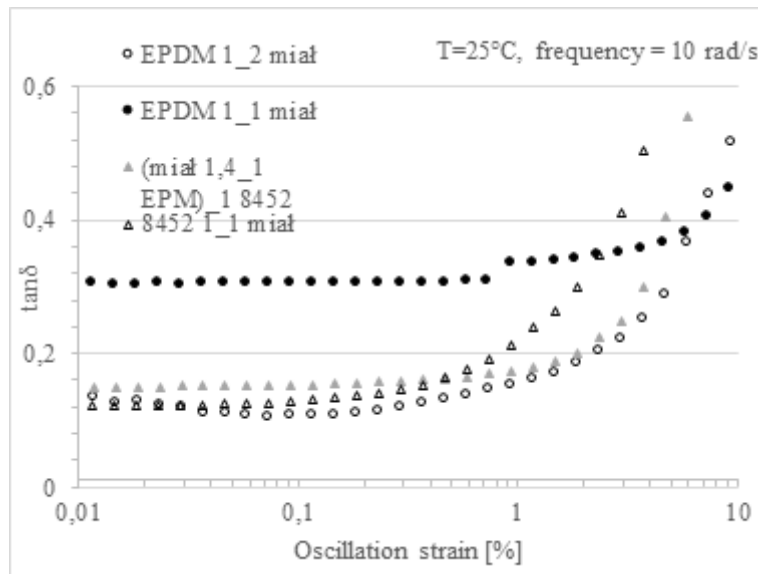


Fig. 7. $\tan(\delta)$ as a function of oscillation strain at 25 °C

Analyzing the values of $\tan(\delta)$ for the linear viscoelastic region it was found that materials characterize good damping properties at 25 °C, the values of $\tan \delta$ were larger than 0.1. It is worth noted that also at minus temperatures the obtained materials were characterized good damping properties (Fig. 8).

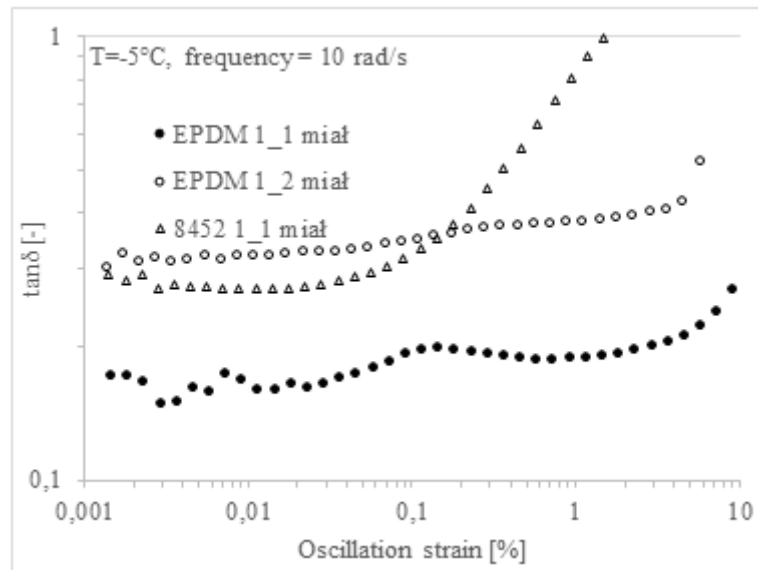


Fig. 8. $\tan(\delta)$ as a function of oscillation strain at -5 °C

Stress relaxation

Stress relaxation tests determine the material behavior under load. The measurement consists in calculating the relaxation modules (disappearance of applied stress caused by the use of deformation) depending on the time of the test. The result of the test are relaxation times characteristic of the material. Fig. 9 shows the change in relaxation module for studied mixtures

as a function of time. The measurements were carried out within 6 minutes as described in the test methodology.

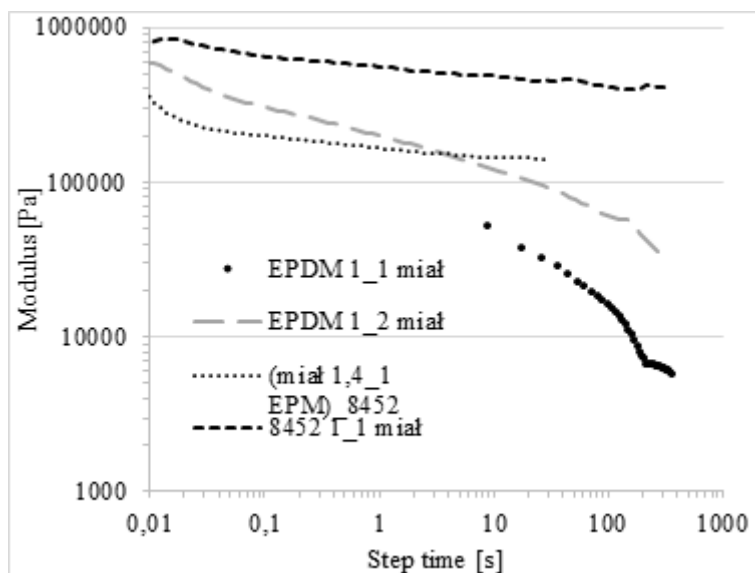


Fig 9. The relaxation module as a function of time

EPDM vulcanizate 1_1 was characterized by the occurrence of a rapid initial decrease in stress over time. The lowest values of the relaxation module were also obtained for the same sample. Mixtures differed in initial relaxation modulus. The highest value of relaxation modulus at the beginning of the test was observed for the mixture 2_1 EPDM. This means that for the same ethylene-propylene-diene rubber, the addition of higher loading of shred increased the initial value of the relaxation module. For the EPDM mixtures in the tested period it was not possible to reduce the stress level to equilibrium. The stress continued to drop. In the case of the systems based on TPE or TPE and EPM the equilibrium was reached in the tested period.

Conclusions

The highest density had the mix (shred 1.4_1 EPM) _1 8452. The application of various types of elastomers or TPE resulted in different tensile behavior of the mixtures. Melt viscosity of prepared formulations decreased with increasing frequency and temperature for both rubber and thermoplastic mixtures. The shred content had an effect on viscosity. Among the materials used, for the same frequency values (similar shear rate), vulcanizate (shred 1.4_1 EPM)_1 8452 had the highest melt viscosity at studied temperatures. The highest value of the storage modulus was observed for the blend shred 1_1 EPDM, and for thermoplastic shred 1_1 8452. The storage modulus decreased with increasing content of shred for the EPDM based formulations. All materials characterized the values of $\tan(\delta)$ higher than 0.1 at room and -5 °C. The introduction of higher amount of shred into EPDM influenced the relaxation modulus.

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MATERIALS WITH ENHANCED MECHANICAL AND VISCOELASTIC PROPERTIES BASED ON ELASTOMERS AND ELASTOMERIC FOAM WASTE

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Abstract:

Currently, elastomers are used in many areas of technology due to their unique properties. Flexible materials are applied for the production of many articles, including flexible foams used in construction as lagging providing the appropriate protective and thermal properties. After use, this type of material should be recycled and reused because of environmental reasons. Mechanically ground waste of flexible elastomeric foams were used as a component of rubber mixtures. For this purpose the elastomers such as NR, NBR, SBR rubbers were applied. Flow rates and viscosity of prepared elastomeric mixtures as a function of temperature and shear rate were determined. The reinforcing effect of added foam waste on the properties of vulcanizates, tensile strength, elongation at break, hardness was observed. The influence of additives on the relaxation and morphology of obtained new materials was investigated. Potential areas of application for this type of materials have been identified.

Keywords:

styrene-butadiene rubber, acrylonitrile-butadiene rubber, natural rubber, material recycling, foams

Introduction

The development of technology contributes to the increase in the amount of generated rubber waste. The demand for rubber is mostly dependent on the automotive industry as the largest consumer of this product. Rubber products are also widely used in construction, in many devices as cable lagging, gaskets, for upholstery of furniture as foams, in elements of clothing e.g. as footwear soles, in sports equipment or toys. Rubber waste does not decompose naturally, which generates a serious ecological problems during the rubber waste storage. Rubber recycling includes material and energy recycling.

Energy recycling means the burning of rubber combined with the recovery of heat generated in this process. The calorific value of rubber can be even higher than the calorific value of coal [1].

Rubber may contain up to 1-2% sulfur, which oxidizes mainly to SO₂ during combustion. For this reason, rubber burning ovens must be fitted with gas desulphurisation installations. Due to its calorific value, rubber is a valuable energy material, the use of car tires lying on landfills in cement or power plants allows their quick utilization [2-5]. Despite this, energy recycling is the least desirable way to manage rubber waste.

The fragmentation of used rubber products is the solution for their further processing and creating the possibility of their secondary use. This process involves mechanical cutting and grinding. Rubber waste can be crushed at room temperature or by cryogenic method using liquid nitrogen. Further waste management depends on its properties, e.g. type of rubber, size and shape of the disintegrated particles, method of disintegration and modification, crosslinking density, specific surface.

The application in road construction e.g. the construction of bituminous surfaces and sports playgrounds surfaces can be a crucial, material-consuming application of ground rubber waste materials. Modification of asphalt with rubber can be implemented relatively easily in a road enterprise. Rubber is used as an additive in asphalt surfaces mainly for technical reasons not for environmental reasons. Rubber fines introduced into asphalt increase its elasticity and durability, reduce light reflection and ensure good adhesion and cohesion. Other advantages of surface with a rubber-asphalt binder are: reduction of vehicle traffic noise, increase of surface roughness and its abrasion [4, 6-7].

There are many reports of the application of recycled rubber materials for construction products such as mortar/concrete mixtures. Rubber waste can be used as part of fine aggregate, coarse aggregate or both. [8-10].

A lot of research is currently focused on the properties of elastomeric blends prepared with recycled rubber waste [11-15]. In this work mechanically ground waste of flexible elastomeric foams were used as a component of rubber mixtures. For this purpose the elastomers such as NR, NBR, SBR rubbers were applied.

Experimental

Materials and preparation of rubber mixtures

In the experiment grounded waste insulation materials were used to prepare polymer blends containing NR (RSS1), NBR (Europrene ® N 3960: ML 1+4 (100 °C) - 60 / ASTM D1646, total ash ≤ 0.5 wt % / ASTM D5667, ACN content – 39 wt % / ASTM D3533), SBR (Ker ® 1500: ML 1+4 (100 °C) - 45-55 / ASTM D1646, total ash ≤ 0.4 wt % / ASTM D5667, bonded styrene 22-25 wt % / ASTM D5775) rubbers. The mixtures with various weight ratio (polymer/waste dust) 1:1 and 1:2 were made with each of the listed elastomer. DCP dicumyl peroxide (M = 270.37 g/mol, prod. Sigma Aldrich) was added as a crosslinker.

Preparation of recycled material included foam cutting into thin pieces, which were then mechanically comminuted using Brabender micromixer. The process was carried out at 25 °C during 15 min at the rotors speed of 50 rpm.

The weighed blends' ingredients were mixed using Brabender micromixer. The mixtures were prepared in portions for 10 min to ensure stable parameters of the device: T=100 °C,

speed = 50 rpm, force = 50 Nm. Dicumyl peroxide was added to the blends as a crosslinker in a proportion of 2 g DCP per 100 g of waste-polymer mixture using laboratory two-roll mill. The device was equipped with rolls (length of 450 mm and diameter of 200 mm), the compositions were prepared in about 10 min at 40°C using the 16 rpm rotational speed of the front roll. Rubber mixtures were vulcanized using electrically heated hydraulic press under pressure of 200 bar at 160 °C during 30 min.

Methods of investigation

Stress at 100% extension (SE100), tensile strength (TS) and elongation at break (EB) were determined using tensile machine Zwick model 1435. The experiment was performed according to ISO-37-2005 standard.

Hardness was determined using a Shore A type hardness tester Zwick / Roell according to ASTM D2240 standard.

Rubber Process Analyzer RPA 3000 Mon Tech was used to characterize viscoelastic properties of uncured rubber mixtures according to ASTM D6204 Part B (high strain) standard at temperature 80 °C, 100 °C, 120 °C, 140 °C, 160 °C. Complex viscosity measurements were performed at constant high oscillation strain 100%, in frequency range 0.1-20 Hz.

Dynamic rheological measurements were carried out using the oscillation rotational rheometer Ares G2 equipped with plate-plate geometry (25 mm diameter). The measurements of the storage G' and loss G'' shear modulus were performed at 25 °C, at constant angular frequency of 10 rad/s, as a function of oscillation strain in range of 0.001 – 100 %. The frequency sweep test were carried out at 30 °C, at linear viscoelastic region as a function of angular frequency in range 600 – 0.09 rad/s. An assessment of the damping properties included the analysis of the value of mechanical loss tangent δ defined as ratio of the loss and storage shear modulus. Stress relaxation tests were performed under shear deformation at 25 °C, a constant strain of 0.05% was applied and the changes in stress were measured during 10 s.

The optical microscope Zeiss was used to perform the morphological properties analysis. Observation and record of domain and pores sizes was carried out using connected computer program.

Results and discussion

Viscoelastic properties of recycled rubber blends at processing temperatures

To analyze the flow behavior of rubber mixtures it is crucial to understand how rapidly the viscosity is changing with increasing shear rate. The consistency index K and the exponent of the potential equation n were calculated by applying the power law equation (1) to the experimentally measured values of the complex viscosity as a function of shear rate. The calculated values are compiled in Tab. 1.

$$\eta^* = K\dot{\gamma}^{n-1} \quad (1)$$

where:

η^* - complex viscosity [Pa×s]

K – consistency index [Pa]

$\dot{\gamma}$ – shear rate [s⁻¹]

n – exponent of the potential equation [-]

Tab. 1. Flow index n, consistency index K and correlation coefficient R²

		NBR 1:1	NBR 1:2	NR 1:1	NR 1:2	SBR 1:1	SBR 1:2
	K [kPa]	23.0	20.3	8.6	8.4	15.1	15.3
80 °C	N	0.239	0.228	0.262	0.273	0.259	0.230
	R²	0.996	0.996	0.996	0.995	0.998	0.998
	K [kPa]	15.0	14.3	6.9	6.8	11.6	11.4
100 °C	n	0.309	0.291	0.310	0.314	0.290	0.242
	R²	0.995	0.997	0.995	0.997	0.999	0.999
	K [kPa]	1.,3	10.8	6.5	6.4	9.7	5.5
120 °C	N	0.296	0.275	0.264	0.238	0.265	0.212
	R²	0.996	0.997	0.995	0.998	0.997	0.999
	K [kPa]	20.4	18.9	23.6	25.8	27.6	31.0
140 °C	N	0.187	0.184	0.113	0.141	0.131	0.120
	R²	0.995	0.995	0.998	0.999	0.997	0.998
	K [kPa]	82.1	66.2	68.0	63.3	92.3	83.5
160 °C	n	0.029	0.044	0.037	0.060	0.039	0.039
	R²	0.999	0.999	0.999	0.999	0.999	0.999

Source: own calculation

The addition of higher amount of ground foams did not affect significantly the consistency factor at temperatures below 120 °C. This parameter initially decreased due to growing flow ability caused by the increase of temperature. The increase of K observed at 140 °C was associated with the start of crosslinking of the mixtures (Tab. 1). At 160 °C, the process of specific vulcanization occurred and the consistency coefficient values were several times higher than those tested at 80 °C for each sample. Based on these observations, T = 120 °C was determined as the processing temperature for uncured rubber.

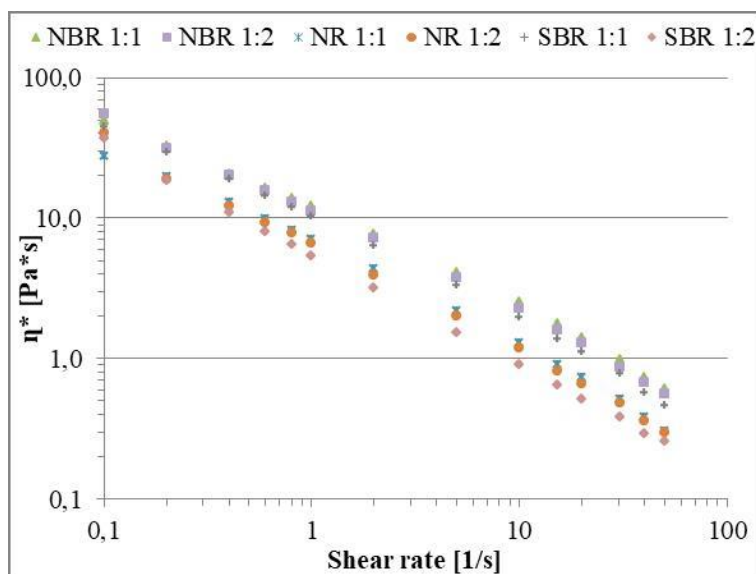


Fig. 1. Complex viscosity at 120°C in function of shear rate
Source: own calculation

At the processing temperature, the mixtures containing NBR rubber had the highest values of melt viscosity for the same shear rate, and the lowest ones were observed for these with SBR rubber (Fig. 1). Low shear rates ($<1 \text{ s}^{-1}$) reflect the conditions prevailing during the pressing process, while above 50 s^{-1} may prevail during extrusion. The viscosity of mixtures corresponding to these conditions are listed in Tab. 2.

Tab. 2. Complex viscosity at 120°C at shear rate 1 and 50 $[\text{s}^{-1}]$

	NBR 1:1	NBR 1:2	NR 1:1	NR 1:2	SBR 1:1	SBR 1:2
Shear rate [1/s]	Complex viscosity [kPa*s]					
1	12.1	11.3	7.1	6.6	10.2	5.4
50	0.6	0.6	0.3	0.3	0.5	0.3

Source: own calculation

Viscoelastic behavior of recycled rubber blends

Rubber performs both viscous and elastic properties. In the uncured state, the elasticity of this material depends mainly on the entanglement of rubber chains. Due to the fact that processes such as a shape forming of the final product are dependent on the viscoelastic properties, G' and G'' measurements were carried out in the function of angular frequency at high oscillation strain which are equivalent to real processing conditions (Figs. 2-3). These mixtures that exhibit higher elasticity (higher values of G' , lower values of $\tan \delta$) may characterize less dimensional stability and larger die swell during extrusion. Mixtures NR and SBR 1:2 showed lower values of both moduli G' and G'' . Additionally the values of $\tan \delta$ at the frequency range higher than 100 rad/s (the equivalent of shear rate generated during extrusion) also indicated better processability of these mixtures.

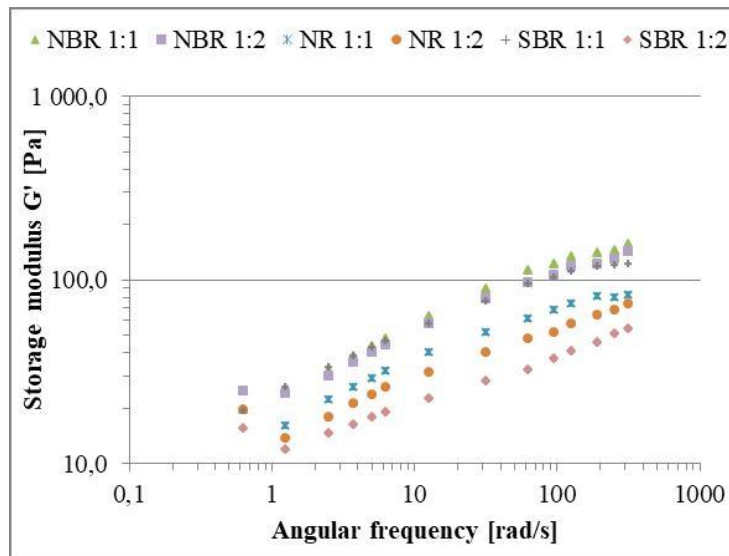


Fig. 2. Storage shear modulus G' of uncured rubber blends at 120°C in function of angular frequency
Source: own calculation

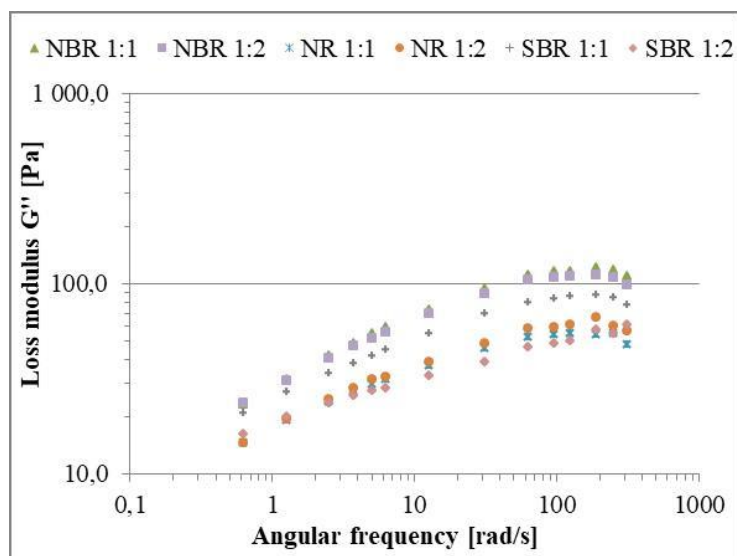


Fig. 3. Loss shear modulus G'' of uncured rubber blends at 120°C in function of angular frequency
Source: own calculation

Mechanical properties of recycled rubber at room temperature

Tab. 3. Mechanical properties of cured rubber mixtures at room temperature

	SE ₁₀₀ [MPa]	TS [MPa]	EB [%]	Hardness [°ShA]
NBR 1:1	2.36 ± 0.12	5.41 ± 0.72	246 ± 22	51 ± 0
NBR 1:2	2.18 ± 0.15	10.8 ± 0.68	512 ± 38	55 ± 0
NR 1:1	1.75 ± 0.03	13.6 ± 1.37	629 ± 33	47 ± 0
NR 1:2	2.22 ± 0.02	12.3 ± 0.81	510 ± 27	54 ± 0
SBR 1:1	2.59 ± 0.02	3.36 ± 0.27	143 ± 15	57 ± 0
SBR 1:2	2.65 ± 0.04	4.97 ± 0.41	216 ± 14	59 ± 0

Source: own calculation

Mechanical properties were measured under static conditions (Tab. 3). The hardness of the tested formulations corresponded to the range of medium-soft systems. The values of tensile strength of vulcanizates containing NR rubber was the highest. The use of a larger amount of recycled ground foam improved the mechanical properties of NBR and SBR vulcanizates. High tensile strength, together with their flexibility may allow NR and NBR mixtures to be used as mats, belts or other similar products. Systems containing SBR rubber showed both the least elasticity and tensile strength. The presence of aromatic rings in its structure made them stiff. The obtained results clearly showed that in case of SBR the composition of these mixtures should be changed by using a different cross-linking agent.

Dynamic mechanical properties of recycled rubber at room temperature

Measurement of the storage modulus as a function of the oscillation strain (Fig. 4) showed that samples containing NR rubber probably had higher crosslink density than those from NBR, higher G' values were observed. The impact of the elastomer type on the tested property was less significant in comparison to the impact of the amount of recycled elastomeric foam. The SBR 1:1 sample was a non-homogeneous system. During dynamic stresses, the material structure was destroyed at lower value of the oscillation strain. The use of higher amount of recycled foam in this case resulted in increased stability and, as a result, in an extension of the LVE region.

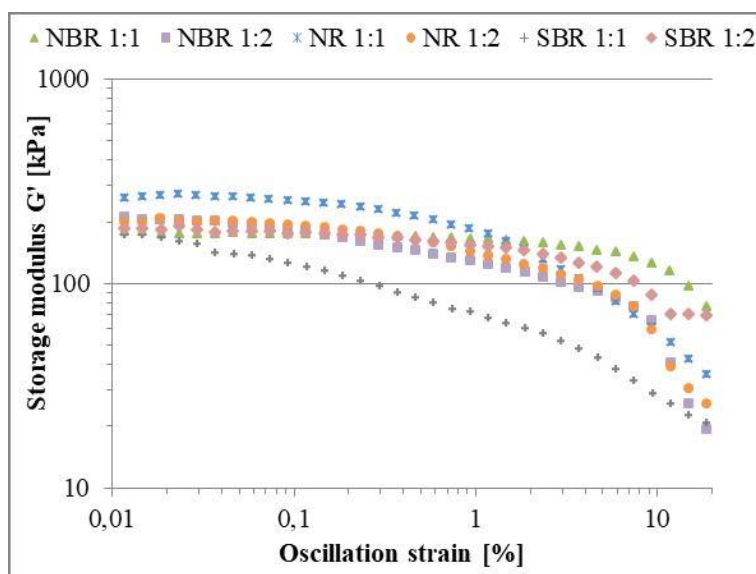


Fig. 4. The storage modulus G' in function of oscillation stress at 25 °C for cured rubber blends
(angular frequency 10 rad/s)
Source: own calculation

The calculations of mechanical loss tangent shown in Fig. 5 illustrate that increasing the amount of recycled rubber waste used in preparation of mixtures we are able to improve the damping properties of NBR blends. Weight ratio systems 1:1 (rubber / foam waste) characterized higher elasticity, the lower mechanical loss tangent values was observed. An opposite tendency occurred in case of the SBR mixtures, the use of a larger amount of ground rubber waste had

a plasticizing effect leading to better homogeneity of the blend thus increasing the resilience of the system.

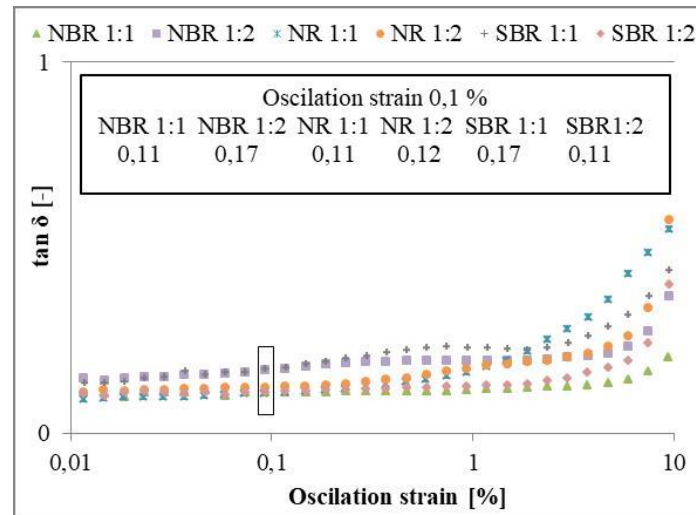


Fig. 5. The loss factor $\tan \delta$ in function of oscillation stress at 25 °C for cured rubber blends (angular frequency 10 rad/s)
Source: own calculation

The frequency sweep tests were performed in the linear viscoelastic region at very low oscillation strain (0.05%) (Fig. 6). The loss modulus G'' increased more rapidly than the storage modulus for all analyzed samples. However, the NBR 1: 1 sample had the highest stability of created structures. The use of more ground foam for this elastomer resulted in a significant decrease in the G' value. Other trends were observed in mixtures containing NR and SBR rubbers. The greater amount of used recycled material in mixtures increased their elasticity, which is particularly evident for SBR samples.

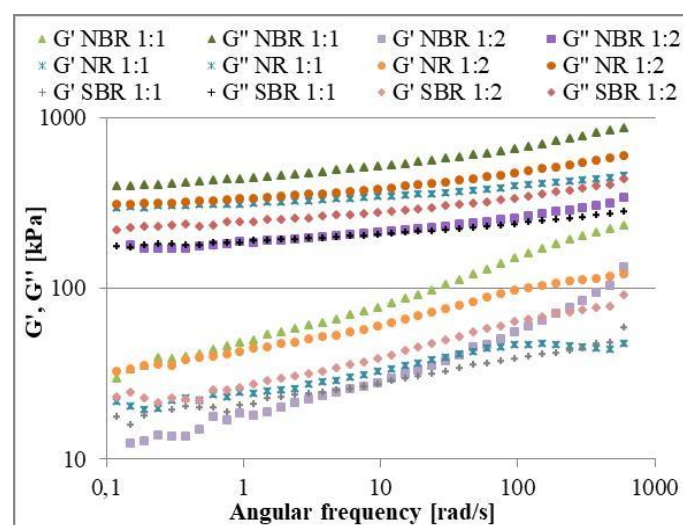


Fig. 6. The storage and loss modulus in function of angular frequency at 25 °C for cured rubber blends (oscillation stress 0.05%)
Source: own calculation

Relaxation behavior

Relaxation of polymeric materials consists in decreasing stress needed to maintain constant deformation. To estimate the differences in mobility of created network in the samples, the relaxation behavior at fixed 0.05% shear stress of cured rubber was performed. As shown in Fig. 7, using higher amount of recycled foam waste resulted in faster relaxation. The ability of the macromolecule chain movements depends on the morphology as well as the crosslinking density. Moreover, it has been shown that samples prepared from SBR rubber had the highest relaxation rate, which may just be caused by the lower degree of crosslinking. This conclusion was also confirmed by the results of mechanical tests under static conditions, where it has been shown that a different type of crosslinking agent should be used for samples of this rubber to improve its performance.

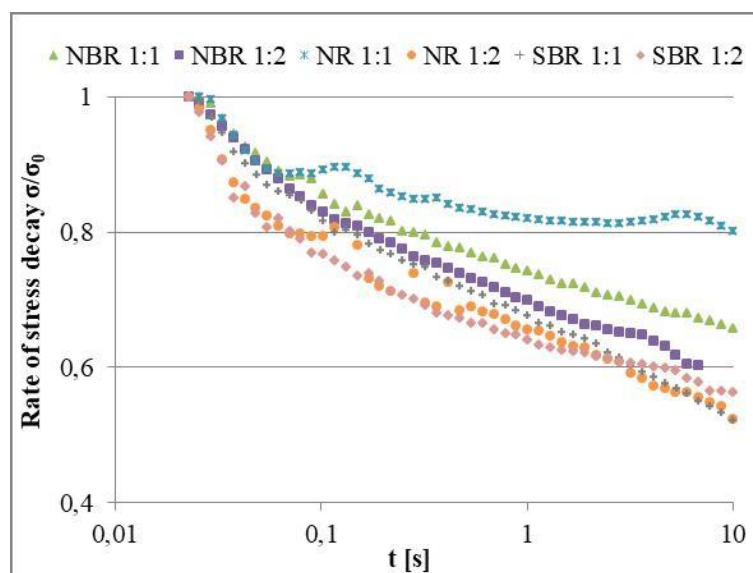


Fig. 7. Rate of stress decay σ/σ_0
Source: own calculation

Morphology of the blends

To examine the morphology of the obtained vulcanizates, observations were carried out using an optical microscope at magnification x200 (Fig. 8-10). Based on the following observations, it can be concluded that the best mixability and compatibility with the used recycled waste material characterized samples made of NBR and NR rubber. The SBR structure had large pores and discontinuities. However, the use of more ground foam material had a positive effect on the SBR and NR morphology. The fractures of these samples became more homogeneous.

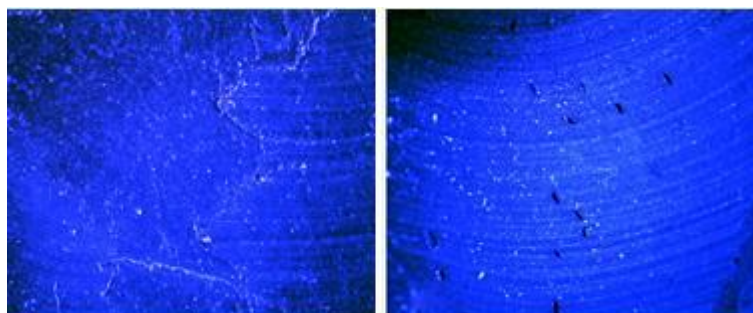


Fig. 8. Optical microscopy images of NBR vulcanizates (NBR 1:1 on the left, NBR 1:2 on the right)
Source: own observation

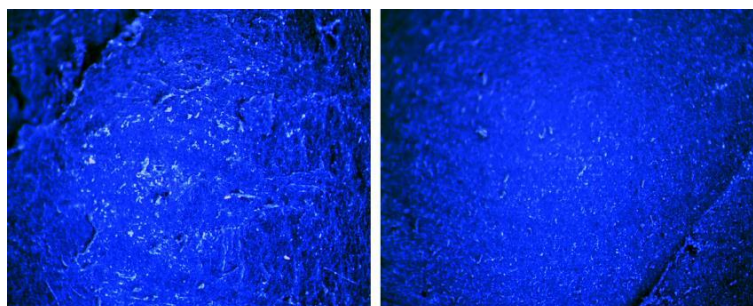


Fig. 9. Optical microscopy images of NR vulcanizates (NR 1:1 on the left, NR 1:2 on the right)
Source: own observation

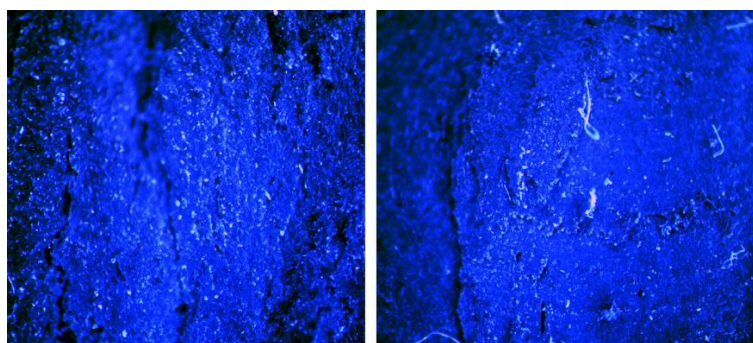


Fig. 10. Optical microscopy images of SBR vulcanizates (SBR 1:1 on the left, SBR 1:2 on the right)
Source: own observation

Conclusions

Rubber foam waste can be successfully used to obtain new elastic materials. By using rubber fines as a filling for typical elastomers NR, NBR it was possible to obtain new materials with good mechanical properties (tensile strength above 10 MPa). The mechanical performance qualifies such materials for re-use. The obtained materials due to the presence of recycled foam were characterized by good damping properties ($\tan \delta > 0.1$). The addition of foam waste influenced on the relaxation behavior of the blends. Better compatibility and homogeneity of the blend was observed when NR and NBR elastomers were used as a second component of the blend.

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FREEGANISM – ANTI-CONSUMPTION LIFESTYLE OR A FAD?

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Abstract:

Freeganism has been gaining popularity in recent years in Poland. Freegans are the alternative and anarchistic environmentalists who are fed up with participation in the conventional economy and decided instead to try to mitigate the harm to the earth by reducing their personal waste. Presented results cover an ethnographic study which involved 160 freegans of different age who carry on their activities in Polish provincial cities. All the surveyed respondents choose to acquire goods from „dumpster bins” and also use unconventional ways of exploitation conquered products. Volunteers were asked to share their expenditures on food, sources of knowledge about freeganism, motives on starting being a freegan, frequency of „dumpster diving”, places of search, products they find, problems they face and advantages to obtain. The structure of examined freegans is not homogeneous. Surveyed volunteers have very varied motivations, they come from different environments and also have different, sometimes extreme, views. Surveyed freegans’ life seems to be creative and innovative. Instead of trying to make money to spend it, they strive to make less, spend less, and make the most out of what is available. No significant differences were found between respondents from both age groups except for a few slight disparity. This study has raised many more questions than could be addressed within the article.

Keywords:

freeganism, dumpster diving, anti-consumption, food waste,

„What is an apple? In your kitchen, it’s food, nourishment.

At the market, it’s currency, a player in transactions,,

Meredith Lanoue

Introduction

Freegans are people who implement alternative lifestyles based on limited participation in conventional market economics and minimal resource consumption. They are characterized by: community, charity, prosociality, freedom, cooperation, being in opposition to a society based on materialism and moral indifference, the rat race, conformism and greed. The expression of their actions is boycotting products from unethical concerns responsible for human rights violations, environmental destruction and the use of animals. Freeganism stands opposite the economic system, where the desire for profit overshadows ethical considerations, in which very complex production systems mean that all the products consumers buy have a decisive impact on many issues that they do not even realize. Instead of avoiding buying products from one consortium, just to support the other, freegans avoid buying anything as much as possible [7].

Freeganism was initiated in the United States, and its name was created from a cluster of two words: "free" and "veganism". The roots of the movement are seen in the organization "FOOD NOT BOMBS". Its members began operating by distributing vegetarian and vegan meals on city streets. In this way, they opposed the financing of research on new forms of armaments in a situation of escalation of hunger and a constantly increasing number of homeless people. First, they acquire vegetarian products from warehouses, shops, bakeries and other places, where it is no longer possible to sell them (usually due to expiry date), and then prepare meals for people in need. Nowadays, the "FOOD NOT BOMBS" initiatives are carried out in many countries around the world, including in several cities in Poland. Importantly, they are not forced to do so by poverty or thrift. They do it in the name of ideology - in order to „not to waste” in general. They manifest against injustice, because they cannot bear the consciousness that huge useful things are decaying, while many people in the world are unable to meet their basic needs [4].

The freeganism movement quickly spread to many Western European countries, especially in Germany, Spain and Portugal, where it gained mass character. In some European cities, such as Barcelona, Berlin or Madrid, there have even been created special guides for freegans, which describe not only places where you can get food or exchange things for free, but also the hours when it is best to appear there. They are usually containers located near hotels, restaurants, fast food bars, patisseries and bakeries. In Poland, however, information about freeganism can be found mainly on the Internet. Despite this, there are many people in Poland who, through their activities, are part of this social movement and create groups especially on the Internet.

Freegans, unlike people who are driven by poverty, can afford a high standard of living, while they consciously give up excessive consumption, treating freeganism as a specific lifestyle. It should be noted that their activities also have an ecological dimension, because according to the principle: reduce, reuse, recycle, refuse, they make many products re-used. Thanks to them those products do not end up in landfills. Freeganism is a trend for an economical lifestyle, while people who consider themselves freegans are generally well educated and they live in good neighborhoods of large cities. There are five key principles that freegans follow: 1) recovery of waste; 2) minimization of the amount of waste produced; 3) ecological transport; 4) squatting; 5) self-sufficiency; 5) reduction of work in order to devote more time to family and the local community. [8].

Polish supporters of freeganism are referred to „dumpster divers". Many Polish consumers have not yet saturated themselves with the multitude of products found in supermarkets and shopping malls, which can be partly explained by the period of communism, which was characterized by a permanent market shortage. However, the prospects for the development of freeganism in Poland are large, especially in cities, among students and young people who are against capitalism [8].

This consumer trend identified with diving in the garbage and collecting food, which we throw in the trash, is and will remain an alternative, niche lifestyle, because Polish society is mostly conservative-hierarchical, and for majority of Polish people becoming a dumpster diver do not fit in their mentality [8].

Purpose and hypothesis

The aim of the study was to examine freegans among two age groups, their educational background, monthly expenditures on food, reasons for interest in freeganism, activities due to the freegan lifestyle and its frequency, personal attitudes, beliefs, experiences on dumpster diving, problems they face and benefits they obtain.

The hypotheses about the significant impact of the age group on the reasons for starting a freegan lifestyle, source of knowledge about freeganism and frequency of dumpster diving activities were formulated during the study.

Methods and setting

The study was based on the use of research techniques using an indirect survey among volunteers declaring belonging to the freegan community.

The study involved 160 randomly selected volunteers both women and men ranging in age from 18 to 50 years. Volunteers were divided according to two age groups which constituted a differentiating factor. The first group consisted of 87 respondents (54.4%) aged from 18 to 29. The second group included 73 respondents (45.6%) aged from 30 to 50.

Volunteers for the study were found on Facebook groups that associate freegans from 8 Polish provincial cities - Gdańsk (including whole Tri-City agglomeration), Poznań, Warsaw, Wrocław, Białystok, Olsztyn, Kraków and Łódź.

The questionnaire form was made up of 9 multiple and single choice closed questions. Respondents also had the opportunity to add their own answers that were not included in the survey.

Presented analysis of the results of the survey was carried out using Excel spreadsheet tool to collect, organize, classify and summarize the data.

Results

Characteristics of respondents

First part of the questionnaire was aimed at obtaining information on educational background, monthly food expenses and approach to their activities, according to dumpster diving, in terms of anonymity or openness.

Fig. 1 presents the level of education represented by respondents from both age groups. Higher education occurs as a major answer among respondents altogether (47.5%), 39.1% among volunteers aged 18-29 and 60.3% among volunteers aged 30-50. 33.3% respondents aged 18-29 and 27.5% volunteers aged 30-50 declared that they were during studies. This may suggest that freegan community create not only students but also well educated people from middle-class families even if their present lifestyles make them low-income which may be associated with people from the social margin.

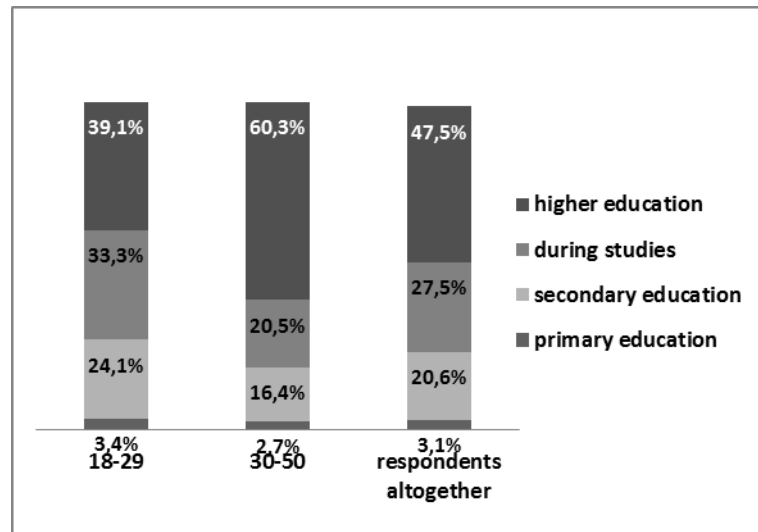


Fig. 1. Educational level
Source: own study

Forasmuch the largest part of Poles' monthly expenses is food, the respondents were asked to estimate the amount of monthly food expenses. According to the report from 2018 released by The Central Statistical Office individual person spends approximately PLN 300 on average each month for food and beverages [10].

Fig. 2 shows distribution of monthly expenditures on food based on predefined categories, ranging from "up to PLN 100" to "more than PLN 1000". On the basis of this information, the average amount of expenses in both groups ranged from PLN 300 to PLN 600 (46.9%). Only individual people in both groups declared the highest (4.4%) and lowest expenses (8.1%).

Although the philosophy of this lifestyle is trying to get things by spending the least amount of money, there are no huge differences in expenses of surveyed freegans comparing to the data obtained from The Central Statistical Office which took into account the entire Polish society (per capita) [10].

Despite this, it's worth mentioning that the share of people who spend less than a statistical Pole ranks 36.9% (sum of the answers "up to PLN 100" and "PLN 100-300").

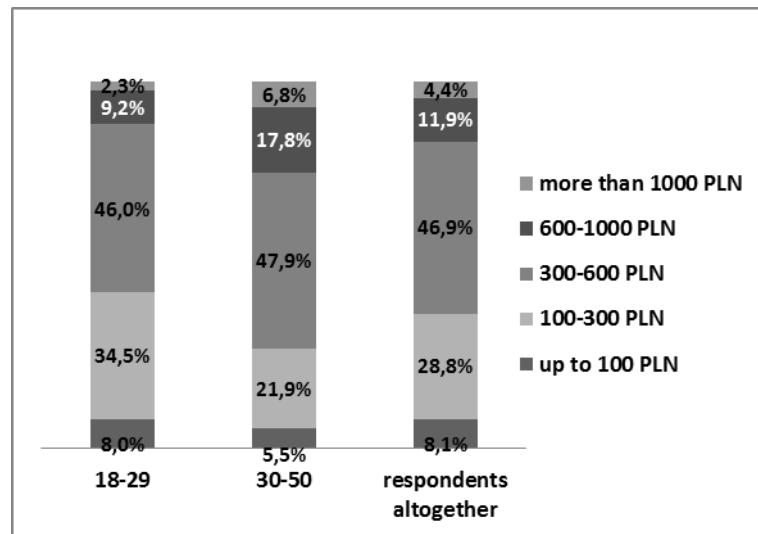


Fig. 2. Monthly expenditures on food
Source: own study

Public interest towards taboo-defying and illegal trespassing eating garbage is especially strong when these activities are performed for reasons other than dire poverty [6].

This sense of exclusion and "going against the stream" can cause difficulties in directly and openly declaring ones belonging to the freegan community.

Fig. 3 presents results on the question "Do you openly declare your affiliation to the freegan community?". In general, there are no large differences between two groups of respondents. In both groups the highest percentage of answer was that they declare it openly (46.9%), but the second largest group were freegans, who share this knowledge only with the closest people (38.1%), who probably would not judge them by activities they perform according to being a freegan.

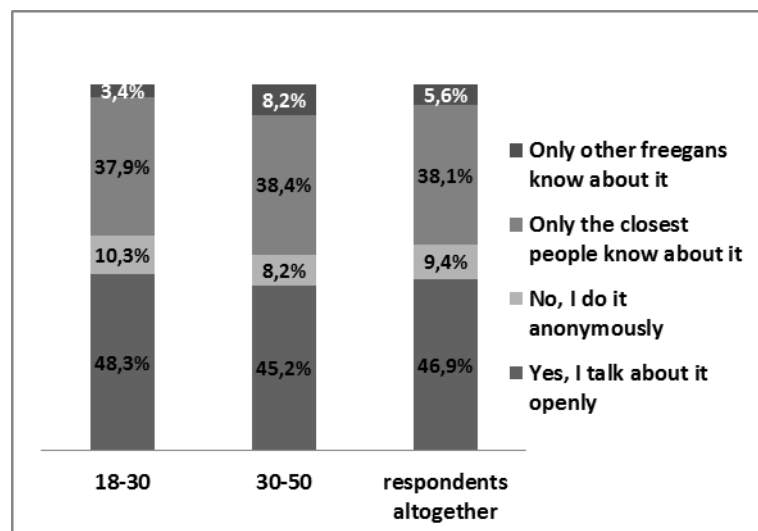


Fig. 3. Openness
Source: own study

Sources of knowledge about freeganism and reasons on starting anti-consumer lifestyle

Fig. 4 presents sources of knowledge about freeganism, from which respondents learned about the existence of this movement. Facebook is a free and very common way for folks to find each other, post event info, share advices and good places for skipping [9]. As time goes more and more Facebook groups are being created. Therefore freegans are a little more active on this website than among other means of communication, which is why a lot of volunteers derived knowledge from "Facebook" as a source (34.4% of all respondents). A larger number of people aged 30-50 declared that Facebook was their very first source of knowledge about freeganism (39.7%) comparing respondents aged 18-29 (29.9%).

"Friends" occurred another important source of information (indicated by 33.8% of respondents).

Several people also mentioned that accidentally viewed documentaries released on the TV inspired them to try this activity.

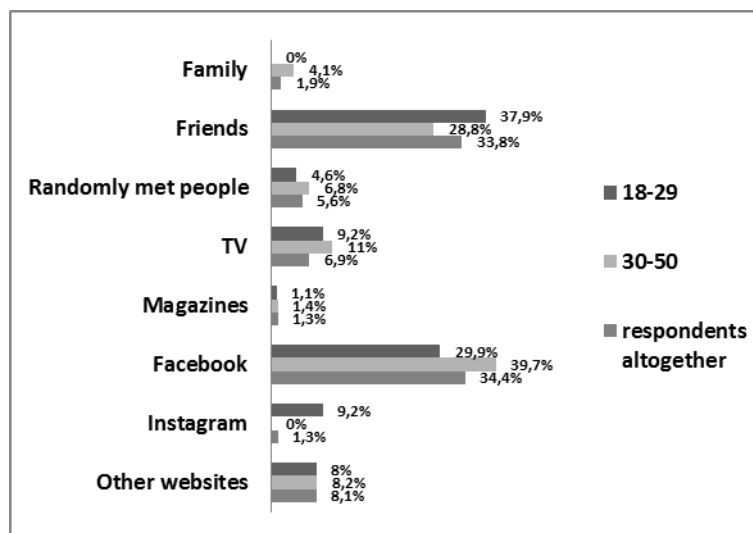


Fig. 4. Sources of knowledge about freeganism
Source: own study

Freegans give a variety of reasons for choosing to live the way they do. For the question about reasons on becoming a freegan, multiple answers were possible. With respect to the reasons why respondents have become a freegan lifestyle there are again no large differences among both groups. Main reasons are "frugality", "willingness to reduce waste", "willingness to protect the environment" and "drawing attention to the problem of food waste". However, more volunteers aged 18-29 mentioned much more frequently "curiosity" (41%) and "a sense of social responsibility" (37.9%) than others. Volunteers aged 30-50 pointed out "curiosity" (26%) and "a sense of social responsibility" (21.9%) as an less important factor of starting freegan lifestyle for them.

All other reasons were mentioned less frequently by all respondents (less than 30%), which suggests that they are of minor importance e.g. "willingness to change consumerist habits" – 22.5%; "lack of livelihood" – 10%; "trends" – 3 %; "desire to stand out" – 2.5 %.

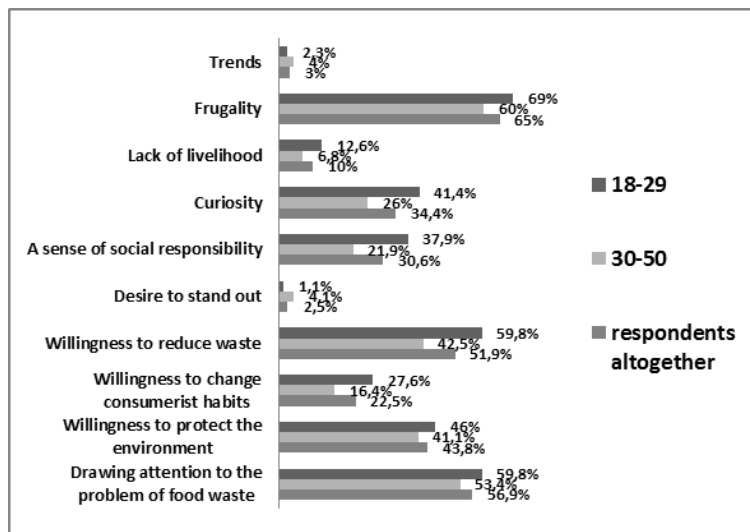


Fig. 5. Reasons on becoming a freegan
Source: own study

Frequency of dumpster diving activity

The most common way of gathering food is by 'dumpster diving', literally foraging through skips. Focus groups also covered questions concerning frequency of organizing skips. Skip is a night trip to the garbage cans due to looking for products.

Fig. 6 shows frequency of dumpster diving activity. Answers that assumed a greater frequency than „every second day” were distributed fairly proportionally among the representatives of both focus groups. However, more respondents aged 18-30 (27.4%) organise skips 2-3 times per week than respondents aged 30-50 (10.3%). It cannot be clearly stated how often the surveyed freegans organize skips. As it can be seen in Fig. 6, this is a highly individual matter. However, it usually oscillates between „once a week” (21.9% of respondents) and „few times per month” (23.1% of respondents) and „2-3 times per week” (18.1% of respondents).

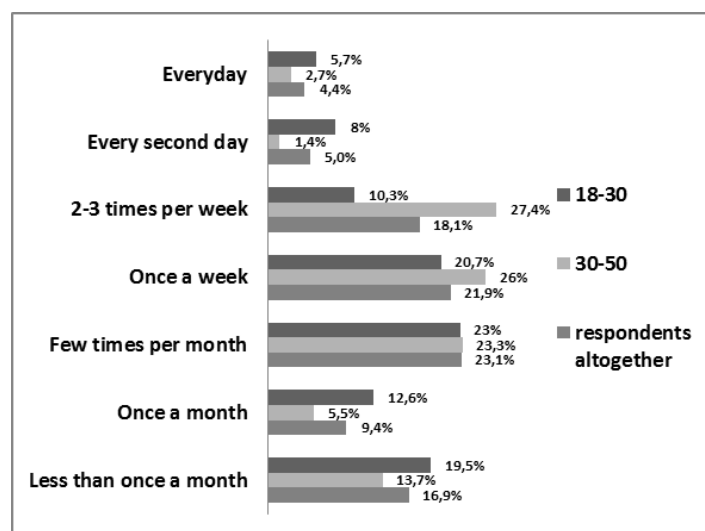


Fig. 6. Frequency of dumpster diving activity
Source: own study

Freegan products sources

Factors for choosing dumpster diving locations often take priority over other considerations such as the quality and quantity of food, proximity to food collection locations and the degree of ease [3].

Fig. 7 presents sources of skipped products. For this question multiple answers were possible. It is easy to notice that big supermarket chains are favored over other locations in each group (58.1% among all respondents). Respondents aged 30-50 scavenge more likely on the markets and super market containers than volunteers aged 18-29.

The freegans also barter with others (36.3% of all respondents). Some of the respondents also enter into unwritten agreements with sellers, e.g. at markets or grocery stores, who give them food instead of throwing away.

Bartering fits well with the freegan life since they are so focused on the use-value of items as well as community building.

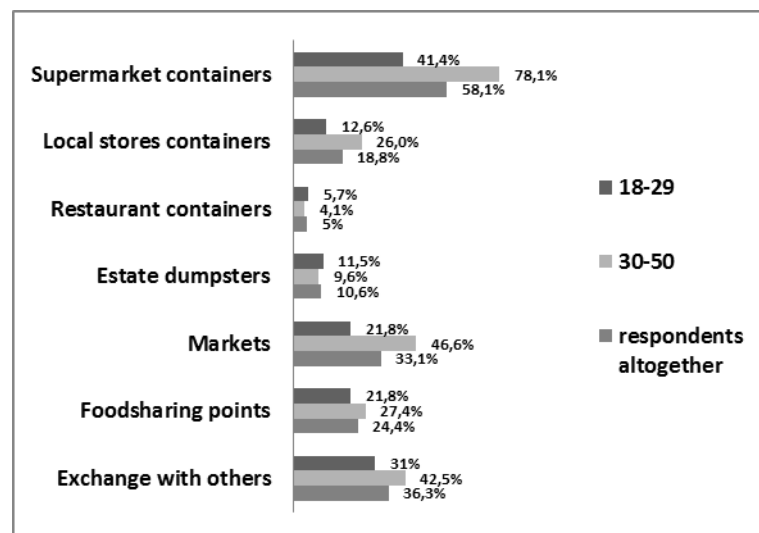


Fig. 7. Sources of skipped products
Source: own study

Types of products found

Fig. 8 shows different kind of products that volunteers usually skip. Based on the literature review, 10 product categories have been classified, which are usually thrown away and can be found in the trash. The surveyed freegans were asked to identify 4 types of products that they find most often.

Fruits and vegetables are thrown away predominantly – 91.9% of all respondents find them most frequently. Bread and confectionery is the second most frequently product group to find, indicated by 59.4% of respondents – 52.9% respondents aged 18-29 and 67.1% respondents aged 30-50. It is also common to find grain products (31.9% of respondents altogether), sweets (26.3%) and eggs and dairy (21.9%). It needs to be mentioned that skippers don't take everything. They use the "take it only if you are ensured that you can eat" principle. They give most of what they collect to those in need.

The idea of living for free is not just food. Furniture was mentioned by 23.8% volunteers. 16.9% of respondents pointed out cleaning products and cosmetics as well as clothing and footwear. The reason may be that stores are obliged to take old electronic equipment from customers. This is problematic for companies, because they have to deal with its disposal, so they are more likely to give it away for free. Also, respondents display furniture or clothes in the garbage cans throughout the city which allows them to equip flats and dress at no cost. More furniture is found by respondents aged 30-50 (30.1%) in comparison to respondents aged 18-29 (18.4%).

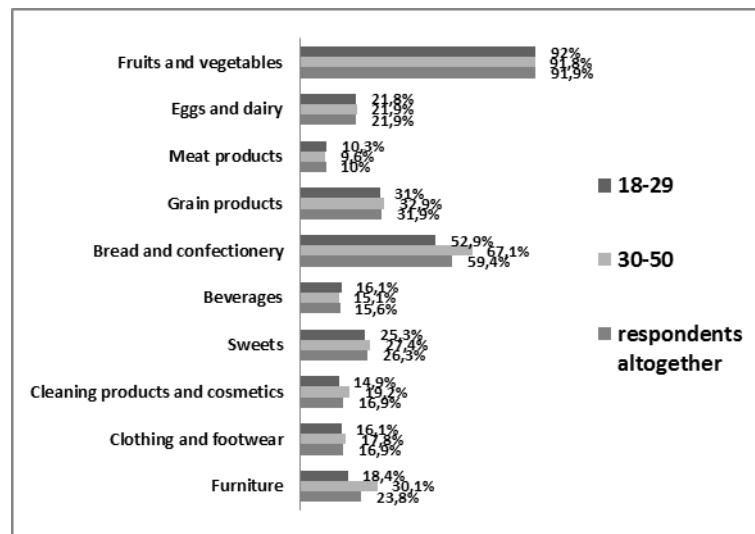


Fig. 8. Types of products
Source: own study

Problematic plight

While many freegan view their lifestyle only in a positive light – they focus on fighting waste, protecting environment, helping each other, sharing what they found and so on – this movement also has its drawbacks.

Fig. 9 presents problems that surveyed freegans have experienced since they began to lead such lifestyle.

No access to containers seems to be the biggest and the most crucial obstacle respondents face. 83.8% of them claimed that it was their major problem. It is known that for security reasons it is not possible to publicize actual locations with open access, which would lead to companies blocking or restricting it.

Freegans struggle against stigmas, disdain and revulsion within the urban environment. 13.1% of respondents feel excluded from the community, 25.6% of them claimed to be criticised and 9.4% were offended or insulted.

Two of all surveyed freegans pointed out (additionaly) that they had experienced risky situations while „diving into dumpster” with dangerous objects like broken, dirty glass and also faecal. Besides the risk of injury that comes with diving into dumpsters, there are other obvious health hazards associated with eating food found in the trash.

Along with the good stuff, there can be contaminated and spoiled food. Although freegans consume ‘garbage’, almost every participant in the study claimed that they had never fallen ill from

food either dumpstered or exchanged except 3.8% of all respondents. These health standards may be upheld while keeping within precautions, e.g. by thermal treatment and following food safety standards. 10.6% of all respondents claimed that they have never face any difficulties. This question showed no significant differences in the responses between the two groups.

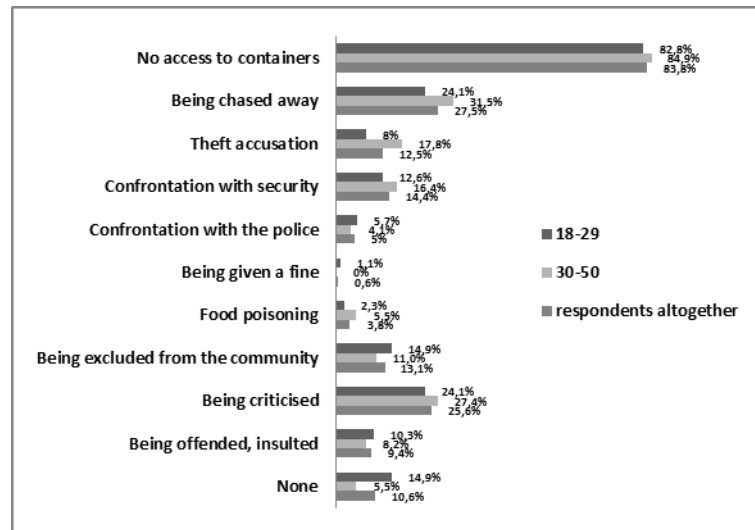


Fig. 9. Problems experienced by respondents
Source: own study

Benefits of a freegan lifestyle

The advantages of being a freegan is that, one could prevent further abuse of natural resources, reduce the expenditures of goods, and decrease the amount of waste in general. Freegans are committed to lengthening the life cycle of every product that comes into their lives.

Fig. 10 shows exemplary benefits respondents can gain thanks to their extraordinary lifestyles.

The most important advantages pointed out by respondents in both groups are: 1) intangible benefits (70.6%) such as sense of empowerment, accomplishment, satisfaction etc.; 2) increased savings (68.8%); 3) increasing own ecological awareness (59.4%); 4) drawing people's attention to the problem of waste (59.4%).

Some of the respondents pointed out that they diet started to be more varied (31.3%), because they had started being satisfied with what they had found, not what they had decided to buy themselves. It can have a positive cognitive effect manifested through this lifestyle.

32.5% of respondents indicated that thanks to dumpster diving they started to consume products (including luxury goods) that they could not have previously bought just like expensive alcohols, ripening meats, exotic fruits or exquisite cheese, which had to be thrown away for lack of interest from customers. No significant differences in the respondents' answers between the two groups were noticed.

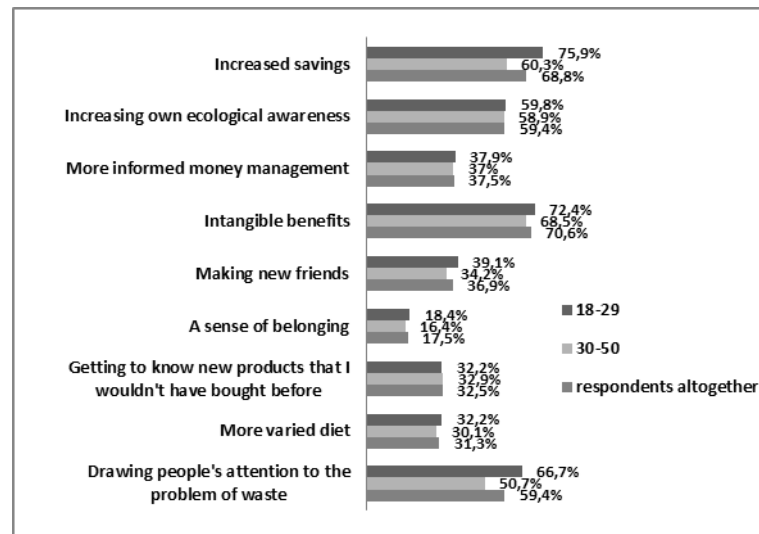


Fig. 10. Benefits freegans gain
Source: own study

Discussion

Freeganism is essentially an anti-consumeristic ethic about eating. Freegans are anti-capitalists, who protest the economy by withdrawing from it without using money [9].

However that this does seem to be a very white, middle class movement engaged in by people in developed societies. Many of them have the safety net of social welfare to fall back on [11]. Australian authors found that people drawn to dumpster diving were predominately males in their mid 20's from well-educated middle-class backgrounds. They had strong ideological beliefs on which they based their activities. Those people considered environmental and humanitarian aspects of food productions, and had a standing out awareness of the ethical food consumption [3].

There is an eternal conflict between freegan activists who desire to call attention to waste problem in order to develop the movement and those who wanted to keep it anonymous in order to ensure room for maneuver to take covert actions and to stay on the margins of the system [1].

By targeting generally large corporations, freegans may be perceived as modern day 'Robin Hoods'[3]. Redistributing goods to people in need instead of spending money and time on products and activities that support elite. People also dumpster dive from small stores but with different motives. The stores' bins often provide high quality products, extremely valued by freegans. Small scale shops can be hypothetically more resourceful with their stock than mass stores, may produce less waste overall and invest more time in details [3].

There are also legal issues. On the one hand, there are no regulations that prohibit the search of garbage cans, and on the other, the police have the right to detain people caught and accuse them of littering or invading the private area.

The authors examining the foundations of this trend agree that freeganism may be too radical lifestyle to ever have mass appeal, so it's potential for social change is limited. This is at least in part countered by the breadth of the movement allowing for small-steps approach to be applied for those who are not ready to go through with total commitment [1, 2, 5, 11].

Conclusion

The structure of examined freegans is not homogeneous. Surveyed volunteers have very varied motivations, they come from different environments and also have different, sometimes extreme, views. Freegans' life seems to be creative and innovative. Instead of trying to make money to spend it, they strive to make less, spend less, and make the most out of what is available.

No significant differences were found between respondents from both age groups except for a few slight disparity in the percentage of sources of knowledge about freeganism, reasons on becoming a freegan and sources of skipped products which may result from personal beliefs, experiences and motives rather than directly from belonging to a given age group.

This study has raised many more questions than could be addressed within the article.

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POTENTIAL ROLE AND THERAPEUTIC INTERESTS OF MYO-INOSITOL

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Abstract:

Myo-Ins is a member of inositols family, which are molecules of slightly different compounds derived by C6 sugar alcohol. It is a natural substance, which can also be synthesized in our bodies. Currently myo-Ins is recognized as a very safe substance, with only mild, mainly from gastrointestinal tract, side effects of orally supplementation. Because of the fact, that myo-Ins is involved in regulation of many physiological processes, it is currently being tested in some disorders as a possible treatment option in future. Currently, there are over 45 000 articles in pubmed.gov database, which are associated with subject of myo-Ins. However, most of them concentrates on in vitro trials or only on myo-Ins effects in one disorder. This review will focus on presenting, in a comprehensive way, currently available knowledge about the potential role and therapeutic applications of myo-Ins.

Keywords:

myo-inositol, cancer, metabolic diseases, Hashimoto's thyroiditis

Introduction

Inositols are a family of slightly different compounds derived by C6 sugar alcohol. There are nine known forms of inositol: myo-inositol (myo-Ins), scyllo-inositol, muco-inositol, epi-inositol, allo-inositol, cis-inositol, neo-inositol, L-chito-inositol and D-chiro-inositol [1]. This review is going to concentrate on myo-inositol, its potential role and therapeutic applications.

Myo-Ins can be consumed by humans in three different forms: free form, inositol-containing phospholipids and most frequently - phytic acid [2]. It is mostly found in fresh vegetables and fruits – especially in seeds and brans [3]. The biggest amount of phytic acid can be found in almonds (9.4% of dry weight), walnuts (6.7% of dry weight) and Brazil nuts (6.3% of dry weight) [4]. Among vegetables, beans and peas are considered to have the highest amount of myo-Ins. In contrast, the leafy vegetables seem to be the poorest source of myo-Ins. When it comes to fruits, cantaloupe and citrus fruits (except of lemons) have high concentration of myo-Ins [5] – a portion of grapefruit juice (120 g) provides about 470 mg of myo-Ins [3] A typical, 2500 kcal American

diet can provide about 900 mg of myo-Inositol per day. However, a well balanced diet can provide even a 1500 mg of myo-Ins per 1800 kcal in a diet [3].

It is worth to mention, that myo-Ins can also be synthesized endogenously. Biosynthesis occurs mainly in kidneys, which produce about 4 g of myo-Ins per day [1]. Myo-Ins is synthesized from glucose: Glucose-6-phosphate is isomerized to inositol-3-phosphate, which is then converted to inositol monophosphatase-1, from which myo-Ins is obtained [6]. When it comes to catabolism, kidney is also the most important organ. It is known that nephrectomy in animals impairs myo-Ins degradation and that renal failure is associated with increased plasma level of myo-Ins and with abnormalities in myo-Ins metabolism [1, 7].

The myo-Ins cell uptake is possible, due to two groups of transporters: Na⁺/inositol transporters and H⁺/inositol symporters [1]. SMIT1 and SMIT2 are Na⁺/inositol transporters, which use the energy obtained from transporting two ions of sodium with concentration gradient, to active transport of one particle of myo-Ins into the cell [8]. It is worth mentioning that hyperglycemic concentration of glucose seems to be a competitive inhibitor of sodium dependent myo-Ins uptake [9]. On the contrary, H⁺/inositol transporters – HMIT1 (proton coupled inositol transporters) seem to be insensitive for glucose concentration. It also seems that other inositol isomers are competing with myo-Ins for HMIT1 binding [1].

The concentration of myo-Ins is different in different tissues [10]. It is currently known that the organs of male reproductive tract have high concentration of free myo-Ins [11]. Also the concentration of free form of myo-Ins seems to be higher in brain, choroid plexus and cerebrospinal fluid [12]. Small intestine and kidneys also seem to be rich in free myo-Ins. On the other hand, the phospholipid-bound form is the dominant form in liver, heart and muscles [1]. It is worth mentioning, that also mammalian semen [13] and during lactation breast milk [10], have much higher concentration of myo-Ins, comparing to blood levels. But, despite the fact that myo-Ins can be synthesized endogenously, it seems that its tissue concentration is dependent from amount of inositol provided by food supplementation. The only tissue, which seems to be independent from food inositol supplementation is brain - in other ones (testis, heart, lung, kidney, intestine, liver) the reduction of myo-Ins in diet, results in lower tissue concentrations, comparing to controls [14].

Myo-Ins is involved in many physiological processes. It is known that free myo-Ins act as an osmolyte, which provides protection from environmental and metabolic stresses. It also provides protein stabilization, freezing avoidance and osmotic compensation [15]. Myo-Ins is also the main inositol which can be incorporated into phospholipids (some studies suggest, that occasionally also scyllo- and chiro-inositol can be incorporated into phospholipids [16,17]). When it comes to phospholipids, they can be phosphorylated to phosphatidylinositol-4 phosphate, phosphatidylinositol-bisphosphate and finally to phosphatidylinositol-trisphosphate (PIP3) [18]. PIP3 is being involved in process of activating downstream signaling. For example, PIP3 is used to activation of serine-threonine kinase (AKT) [19], which plays an important role in regulating cells survival, growth and proliferation [20]. Myo-Ins is also present in glycosyl-phosphatidylinositols (GPI) and inositol phosphoglycans (IPGs), which are involved in transduction of insulin action [5]. IPGs affect metabolic processes by activating enzymes, which are responsible for metabolism of glucose [21].

Myo-Ins supplementation is safe and well tolerated. The LD50 of myo-Ins orally administrated, in mouse, is 10 000 mg/kg body weight [22]. In humans, orally administrated doses were up to 30 g/day (with maximum tolerated dose 18 g/day). The side effects of myo-Ins, are mild and mainly from gastrointestinal tract [23]. The duration of treatment in humans was given for prolonged periods – from weeks, up to years [5]. It is also worth to mention that myo-Ins is currently present in some infant milk powder, with GRAS status (generally recognized as safe) [24].

The aim of this study was to summarize the currently available knowledge about myo-Ins, especially about its potential role and therapeutic interests.

Myo-Ins & cancers

In 2018, in Poland there were 185 630 new cases of cancer and over 110 000 humans died because of them. In male population, the most common cancers are: lung cancer (18.9% of the new cases), prostate cancer (16.1%), colorectal cancer (14.7%), bladder cancer (8.6%) and stomach cancer (4.4%). In females, the most common ones are: breast cancer (22.4%), lung cancer (11.7%), colorectal cancer (11.6%), corpus uteri cancer (8.7%) and ovary cancer (5.6%) . The most common cancer, in overall population is a lung cancer – with over 28 500 new cases and over 26 500 deaths per year [25]. Taking all these facts into consideration, it comes as no surprise that people are looking for a medicine, which can have chemoprevention properties.

Myo-Ins has been proven to have anti-oxidant and anti-inflammatory effects, which makes it a possible chemopreventive agent [26]. It was shown that myo-Ins decreases both the incidence and multiplicity of malignant lung tumors, which were chemically induced in mice [27]. It was also shown that supplementation of myo-Ins inhibits lung tumorigenesis in mice exposed to benzo(a)pyrene and 4-(methyl-nitrosamine)-1-(3-pyridyl)-1-butanone [27].

Clinical trials on humans have shown a possible positive effects of myo-Ins as a lung cancer chemopreventive agent. A phase I study, in which smokers with over 30 pack years were given 18 g/day of myo-Ins, showed an increased rate of regression of preexisting dysplastic lesions (91% in myo-Ins group vs 48% in placebo group, $p=0.014$) (dysplastic lesions can transform into a cancer). The treatment with myo-Ins was given for 3 months and what is very important – was well tolerated with only mild side effects [23]. However, a randomized Phase IIb trial has not confirmed such a difference in reduction of dysplastic lesions ($p=0.76$). Nevertheless, this study has shown that myo-Ins treatment, in comparison to placebo, significantly reduces the level of IL-6 in bronchoalveolar lavage fluid (BAL) ($p=0.03$). IL-6 is one of the proinflammatory cytokines, which is responsible for activating inflammatory response, which can be one of possible carcinogenesis factors. This study also showed a decrease in a gene-expression signature reflective of PI3K activation within the cytologically-normal bronchial airway epithelium ($p=0.002$). The dose of myo-Ins was 9 g/day for the first two weeks and then 18 g/day. The treatment with myo-Ins was given for 6 months. The authors of that study concluded that such a heterogeneous response to myo-Ins implicate a need of targeted therapy approach, based on molecular alterations, in future clinical trials [28].

Some anticancer properties of myo-Ins have also been shown in breast cancer. Breast cancer cells, which were treated in vitro with myo-Ins have underwent cytoskeleton remodeling. Such cells

have also lesser motility and invading capacity. It was also shown that myo-Ins treated cells, have down-regulated PI3K/Akt activity, which results in a decrease of downstream signaling effectors, like: COX-2, SNAI1, or NF- κ B. To sum up, these data suggest that myo-Ins can have anti-cancer effect, by inhibiting pathway supporting epithelial–mesenchymal transition (EMT) in cancer cells [29].

In conclusion, myo-Ins seems to have some anti-cancer properties, but these properties are not studied sufficiently to include myo-Ins in a current regular treatment or chemoprevention of any cancer. Further studies to evaluate the usefulness of myo-Ins in regular therapies are needed.

Myo-Ins & Polycystic ovary syndrome (PCOS)

PCOS is one of the most common endocrine and metabolic disorders. The occurrence of PCOS is about 5-10% of women population in their reproductive age. It is characterized by hyperandrogenism, ovulatory dysfunction and polystic ovaries. With PCOS there are frequently coexisting some metabolic dysfunctions, such as: insulin resistance, hiperinsulinemia and central obesity (this metabolic disorders are also factors in pathogenesis of PCOS) [5].

Myo-Ins supplementation was proven to be able to restore spontaneous ovarian activity and to improve fertility in most women with PCOS [30]. Also the positive hormonal changes were noticed - decreased LH, FSH, testosterone levels and increased estrogen and progesterone levels [31]. Moreover, myo-Ins had a positive effect on insulin resistance (reduced HOMA-IR index). Myo-Ins was also shown to decrease triglycerides, LDL and total cholesterol levels and to increase HDL level [32]. Also BMI index was decreased among patients with PCOS [30]. In conclusion, myo-Ins seems to have very positive effects on women with PCOS. Taking into consideration its safety and such a positive effects, myo-Ins can be a possible first line treatment for women with PCOS [30].

Myo-Ins & metabolic syndrome

The prevalence of Metabolic syndrome, due to increasing number of overweight and obese people, is still increasing (only in years 1988 – 2010, average BMI in the USA increased by about 0.37 % per year). Currently, one third of US adults have a metabolic syndrome [33].

MetS can be diagnosed when patient meets at least 3 of 5 following criteria : increased waist circumference (for Europe – women >80 cm, men >94 cm), increased level of triglycerides (>150 mg/dl) or treatment of elevated triglycerides), lower level of HDL-c (women <50 mg/dl, men <40 mg/dl) or treatment of such condition, higher systolic blood pressure (>130 mmHg) or higher diastolic pressure (>85 mmHg) or treatment of hypertension, higher glucose level (>100 mg/dl) or treatment of diabetes mellitus type II [34].

The properties of myo Ins in the treatment of MetS have been tested in some studies. The data from meta-analyze, which concentrated on effects of inositol supplementation on lipid profiles, showed that inositol supplementation may result in reduction of total cholesterol level, LDL level and triglycerides level. However, no change of HDL level has been noticed [35]. The data suggest that inositols have positive effects on lipid profile in MetS.

Myo-Ins also seems to be affecting insulin resistance, which is one of the main factors of pathophysiology of diabetes mellitus type II and impaired glucose levels. Myo-Ins have been proved to be about two-times more effective in reduction of insulin resistance than currently used insulin-sensitizing substances such as metformin, rosiglitagold and pioglitazone [5]. Myo-Ins have also been proved to have a positive effects on glucose profiles in gestation diabetes [36] and postmenopausal women with MetS [37].

Taking all these information into consideration, it seems that myo-Ins supplementation has a positive effects both on lipids profile and glucose level, which makes it one of possible future treatment options for people with MetS. Further studies, on less specific population are needed to well establish possible pluses of myo-Ins supplementation in general population.

Myo-Ins & Hashimoto's thyroiditis

Hashimoto's thyroiditis (HT) is currently considered as the most common autoimmune disorder in the world. The prevalence of HT is still increasing and currently it is estimated that HT affects about 0,8% of population [38]. Etiology of HT seems to be multifactorial. The main factors, which are implicated in pathophysiology of HT include: immunology factors (such as anti-thyroid antibodies, lymphocytes T/B, NK cells), genetic factors, gender (women are affected at least about 8 times more often than men) [39], infections agents (HHV-6 [40], EBV [41]) and environmental factors – like iodine, selenium, smoking, alcohol drinking and vitamin D. HT symptoms are mainly because of hypothyroidism, which makes them unspecified [39]. Currently, the only available treatment of HT, due to lack of rational one, is supplementation of levothyroxine [34].

Treatment with myo-Ins seems to be a potential therapeutic option for people with HT in future. A study conducted by Maurizio Nordio and Sabrina Bascani showed that in patients with HT and subclinical hypothyroidism, treatment with myo-Ins and selenium can ensure euthyroidism. Patients included in this study were receiving tablets (600 mg of myo-Ins and 83 µg of selenium) orally for 6 months. Posttreatment, TSH level dropped from 4.32 ± 0.06 mIU/L at baseline to 3.12 ± 0.09 mIU/L after treatment ($p \leq 0.001$). Also levels of TPOAb and TgAb significantly decreased ($p < 0.001$). Moreover, fT3 levels and fT4 levels of patients were significantly higher posttreatment as compared to the baseline. The patients wellbeing after treatment was also observed to be much better than before ($p < 0.001$) [42].

To sum up, myo-Ins seems to have positives effects on both laboratory parameters and wellbeing of people with HT. Further studies to investigate the efficiency of myo-Ins (and selenium) treatment of HT, on greater populations are needed.

Conclusions

Myo-Ins is a member of inositols family, which involve molecules of slightly different compounds derived from C6 sugar alcohol. It is a natural substance, which is also synthesized in our bodies. However, the endogenous production seems to be insufficient, therefore the supplementation of myo-Ins through a diet is very important. Myo-Ins is currently recognized as a very safe substance, which in addition to its many physiological properties, makes it a very good

substance to be tested in different disorders. Its supplementation seems to have positive effects on patients with PCOS, metabolic syndrome, Hashimoto’s thyroiditis and even some positive effects on chemoprevention of lung cancer. The summary of effects myo-Ins supplementation in different diseases (cancers, PCOS, metabolic syndrome and HT) is presented in Tab. 1.

Tab. 1. Effects of myo-Ins supplementation in different diseases

Disease	Myo-Ins supplementation effects
Cancers	Decrease of both incidence and multiplicity of malignant lung tumors, which were chemically induced in mice
	Decrease of IL-6 level in BAL, lesser PI3K activation in cytological normal bronchial airway epithelium - in smokers
	Possible chemoprevention effects against lung cancer in selected population – in general population randomized trials showed no such effect of myo-Ins supplementation
	Breast cells, treated in vitro with myo-Ins – cytoskeleton remodeling, lesser motility, lesser invading capacity, decrease of downstream signaling
PCOS	Restore of spontaneous ovarian activity and fertility improvement
	Decrease of LH, FSH, testosterone levels, increase of estrogen and progesterone levels
	Reduction of HOMA-IR index
	Decrease levels of : triglycerides, LDL and total cholesterol. Increase HDL level
MetS	Decrease of BMI index
	Reduction of total cholesterol level, LDL level and triglycerides level.
HT	Reduction of HOMA-IR index (more effective than currently used substances like: metformin, rosiglitazone, pioglitazone)
	Decrease of TSH level
	Decrease levels of TPOAb and TgAb
	Increase levels of fT3 and fT4
	Better patients wellbeing

Source : own edition of date, basing on different publications (see literature)

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SUSTAINABLE DEVELOPMENT IN THE OPINION OF STUDENTS OF THE MARITIME UNIVERSITY IN GDYNIA

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Abstract:

Work titled Sustainable development in the opinion of students of the Maritime University in Gdynia raises the issue of sustainable development, knowledge about it, and the values represented by modern students. The work was based on own research using a questionnaire consisting of 9 closed questions. 100 respondents took part in the survey. The respondents were diversified in terms of the year of study and the faculty in which they study. The aim of the research was to determine consumers' attitudes, behaviours and knowledge regarding the concept of sustainable development. As a result of the research it was found that, among others for respondents, sustainable development is real action for the world, taking into account economic, ecological and social goals, the Internet and mass media are the most and most often chosen sources of information, and environmental protection is a less important aspect than economic considerations

Keywords:

sustainable development, students, behaviours, knowledge, research

Introduction

In the 1960s and 1970s public awareness of the growing threats, including consumption of natural resources, high demographic growth or social inequalities has increased significantly. The ecological crisis caused by the dominance of economic aspects over socio-environmental aspects has also increased. In response to the emerging unrest, the concept of sustainable development was created, defined as a model of a civilization that saves the environment and provides access to resources for present and future generations. This concept has been defined by large international organizations, largely by the United Nations. Behaviours that fall within the framework of this idea have already appeared before, among others terrace cultivation in China or forest management in Nuremberg. The prototype of sustainable development was eco-development, which was the main issue during the UN conference on The environment and man in Stockholm in 1972, where, among

others attempts were made to resolve the inequality between the rich North and the poor South. Sustainable development was a basic element of the report of the UN Committee on the Environment and Development entitled *Our common future* from 1987 (report from Brundtland). The report calls for intergenerational equality, sustainable development and for integration of economic, ecological and social goals. Sustainable development was subsequently raised at the second UN conference in Rio de Janeiro, at which the so-called Agenda 21, containing practical solutions for implementing the concept [1]. The concept of sustainable development appears in many sources, both domestic and foreign, but it should not be legally formalized due to the width of the fields to which it belongs and many sectors to which it applies. Virtually every organization, state or company can characterize this concept differently, depending on the activities it conducts. Sustainable development is therefore interdisciplinary, impossible to close into a narrow definition framework. At the same time, sustainable development has become a compulsory concept used in the political, administrative or strategic arena. The popularity of the concept usually has a positive reception in the world of science and social relations, but it has also gained its opponents, representing a critical approach to practical solutions for sustainable development or high-profile slogans used by rich individuals to justify the not always correct economic - socio-environmental activities. Critics of sustainable development note the vague and contradictory definition. It has not been determined which social, environmental or economic variables are the most important and which should be considered key? What should be balanced? Although the concept of sustainable development occupies a high position in the scale of the whole world, it is even necessary to drastically change the thinking of society in order to implement this concept consciously and jointly. Individual cooperation is needed to create a utopian sustainable world [2].

Purpose and method of research

The aim of the research was to determine the attitudes, behaviours and knowledge of consumers towards the concept of sustainable development. The study was conducted using a questionnaire, which consisted of 9 closed questions, single and multiple choice. 100 respondents took part in it. The respondents were diversified in terms of the year of study and the faculty in which they study. In the first part of the questionnaire of the surveyed students, they were asked about worldview issues - what is sustainable development for them, what principles are guided in life, which values are most important to them. In the following, the basic knowledge of the concept of sustainable development was verified. The respondents were asked about the correct definition, basic pillars or the origin of sustainable development.

Findings

The survey covered 29% of students from the Faculty of Entrepreneurship and Commodity Science (WPiT), 24% from the Faculty of Electrical Engineering (WE), 24% from the Faculty of Mechanical Engineering (WM) and 23% from the Faculty of Navigation (WN). 25% of respondents were during the first year of study, 27% during the second year, while 24% during the third and fourth year of study.

Fig. 1 shows the opinion of the respondents in relation to sustainable development depending on the faculty in which they study.

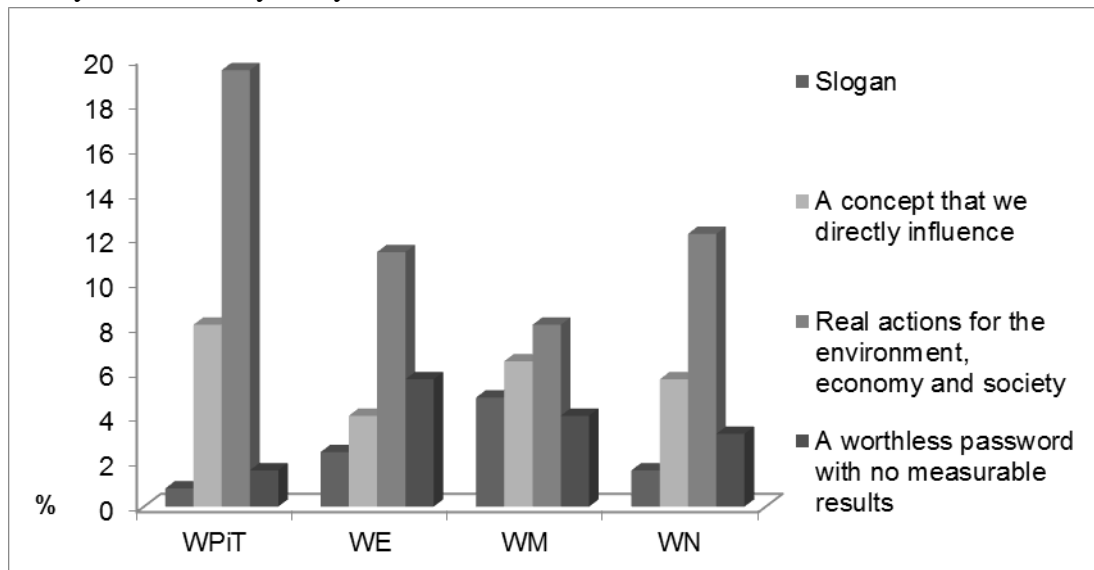


Fig. 1. Opinion of respondents regarding the concept of sustainable development depending on the faculty
Source: own study

The vast majority of students (51.2%) from all faculties declared that sustainable development is a real activity for the environment, society and the economy. 24.4% of respondents from all faculties noted that we have a direct impact on the concept of sustainable development as a society, working together at the appropriate level. Students from the Faculty of PiT constituted the smallest percentage of responses (2.4%) claiming that sustainable development is only useless activities that have no measurable effects and meaningless advertising slogans. Unlike the PiT Faculty, for a relatively large number of respondents (8.9%) from the Mechanical Faculty, sustainable development is worthless advertising slogans.

Considering the opinion of the respondents, depending on the year of study, it can also be seen that the most frequently chosen answer (50.5%) for each year was real action for the environment, society and the economy. Then the students pointed (21.8%) to the direct impact of society on the development of the concept of sustainable development. Relatively rare (1.7%) second-year students claimed that the concept of sustainable development is just an advertising slogan. However, this was the answer most often indicated (5.9%) by the respondents from the first year of study.

Fig. 2 shows the sources from which the respondents obtained knowledge about sustainable development depending on the faculty in which they study.

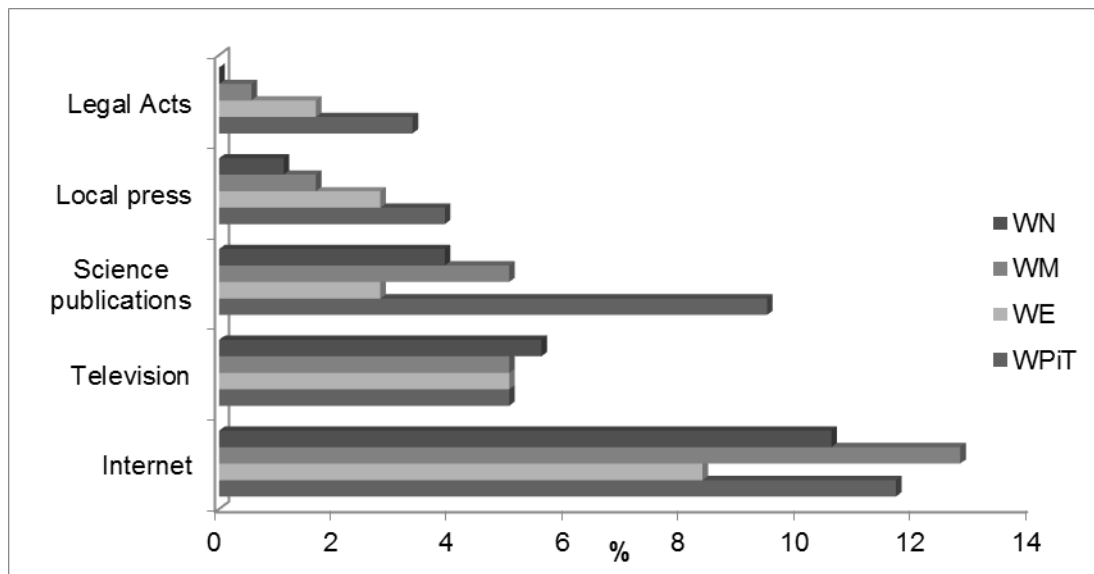


Fig. 2. Sources of knowledge about sustainable development according to respondents differentiated in terms of faculty
Source: own study

According to the vast majority (43.3%) of students, the most common source of information on sustainable development was the Internet. Subsequently, the respondents chose scientific publications (21.1%), television (20.5%) and local press (9.4%). The least chosen (5.5%) source of information was acts, acts and ordinances. For students from the Department of Entrepreneurship and Commodity Science in second place, after the Internet (11.6%), the use of scientific publications (9.4%) was an important aspect, while for the Faculty of Mechanical, Electrical and Navigational Science it was television. The obtained results inform about the superiority of mass media over more specialized sources of information.

Depending on the year of study, it was mainly (13.3%) for the respondents from the second year of study that the Internet played the largest role in obtaining information on sustainable development. Then, for students from the first, third and fourth year of study, it also came first (10%). Respondents from the fourth year of study relatively often (6.1%) chose scientific publications, the least important for them was the local press (1.7%). The least interest (0.5%) among the respondents from the third year of study was enjoyed by acts, laws and ordinances.

Fig. 3 shows the preferences and principles most relevant to the respondents, depending on the year of study.

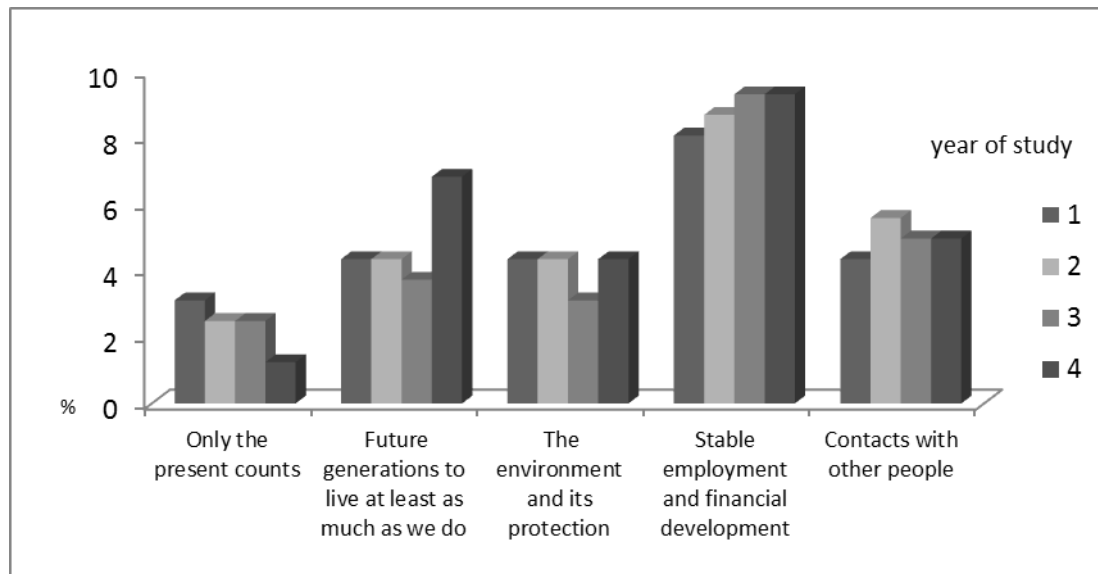


Fig. 3. The most important worldview preferences among the respondents, depending on the year of study
Source: own study

The most important aspect and the most frequently chosen answer among the respondents was stable employment and financial development (35.4%). Relatively often, the respondents also indicated contacts with other people (19.3%) and the willingness to arrange such a state of the world and goods for future generations, at least at the same level as today (19.9%). The least frequently indicated view among respondents was paying attention only to the present, without worrying about what will happen in the future (9.3%). Fourth-year students most often pointed to ensuring a sufficient standard of living for future generations (6.8%), but for the respondents from the third year this was the least indicated value (3.7%). The natural environment and its protection was a relatively rarely indicated response among respondents (16.1%).

The results of the research, depending on the faculty, were as follows. For students from the PiT faculty, the most important issue was stable employment and financial development (8.7%), then ensuring future generations the same level as today (8.1%), and least paying attention to the present (1.2%). Only students from the Faculty of Navigation most often pointed to contacts with other people as the basic principle that they follow in life (6.2%). In contrast, stable employment and financial development (25.5%) was the most important value for the respondents from the other faculties, especially for students from the Faculty of Mechanical Engineering (9.9%). The least frequently chosen answer among the respondents from the Faculty of Mechanical Engineering was environmental protection (2.5%).

From the above results one can observe the advantage of economic aspects over others. This is primarily due to the state of the modern economy - the pursuit of continuous maximization of profits and the multiplication of capital, primarily of individuals, which results in increasing social disparities. Another reason may be human nature referred to as *homo economicus*. Society with a choice of perspective changes will usually choose tangible - related to personal, economic profit [3].

Fig. 4 shows the most damaging effects associated with wasting resources among respondents, depending on the faculty and year of study.

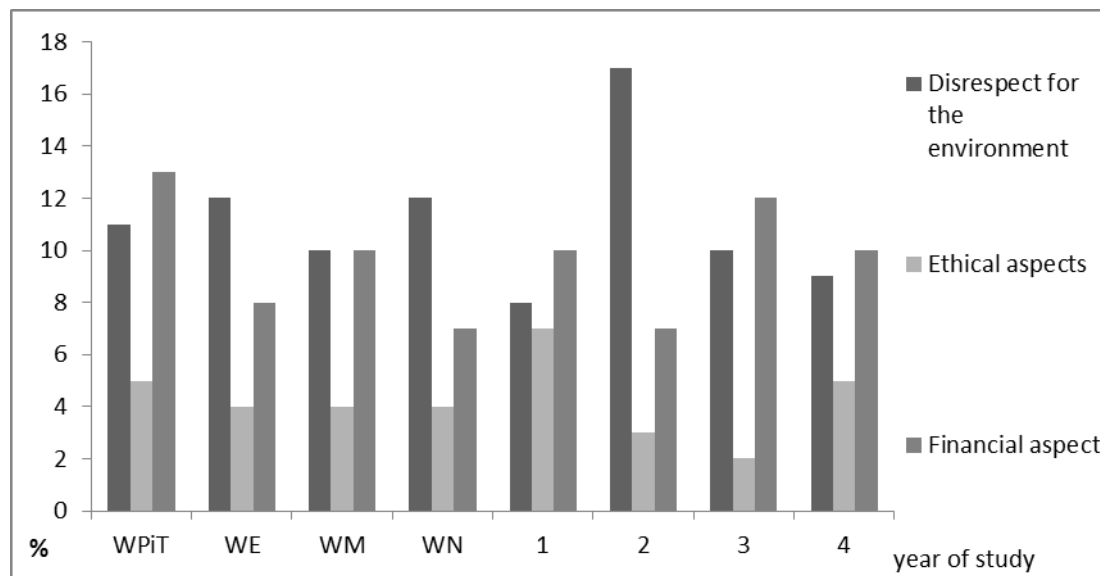


Fig. 4. The most damaging effects of wasting resources among the respondents varied in terms of faculty and year of study
Source: own study

The most frequently chosen answer among the respondents from the Faculty of Electrical and Navigation was the ecological aspect - disregarding the environment (24%). For students from the PiT Faculty and the Faculty of Mechanical Engineering the most severe effect of wasting resources was the financial aspect (23%). Ethics were the least frequently mentioned answer among all faculties. Lack of respect for the environment was most often indicated by second-year students (17%), followed by the third year (10%), fourth (9%) and first (8%), respectively. Respondents from the third year most often pointed to financial burdens (12%), and the least frequently to ethical considerations (2%). The respondents from the first year of studies relatively often indicated ethical and social considerations (7%).

One way to reduce waste is the idea of sustainable consumption and production, which is to use goods and services to meet the needs of a better quality of life. The implementation of these goals will be accompanied by a radical reduction in the consumption of natural resources and energy, reduction of waste emissions and environmental pollution, and cessation of the use of toxic materials. At the same time, achieving a better quality of life for current generations will not be an obstacle to the fulfillment of needs by future generations [4].

Fig. 5 shows the ratio of respondents to growing social disproportions around the world, depending on the year of study.

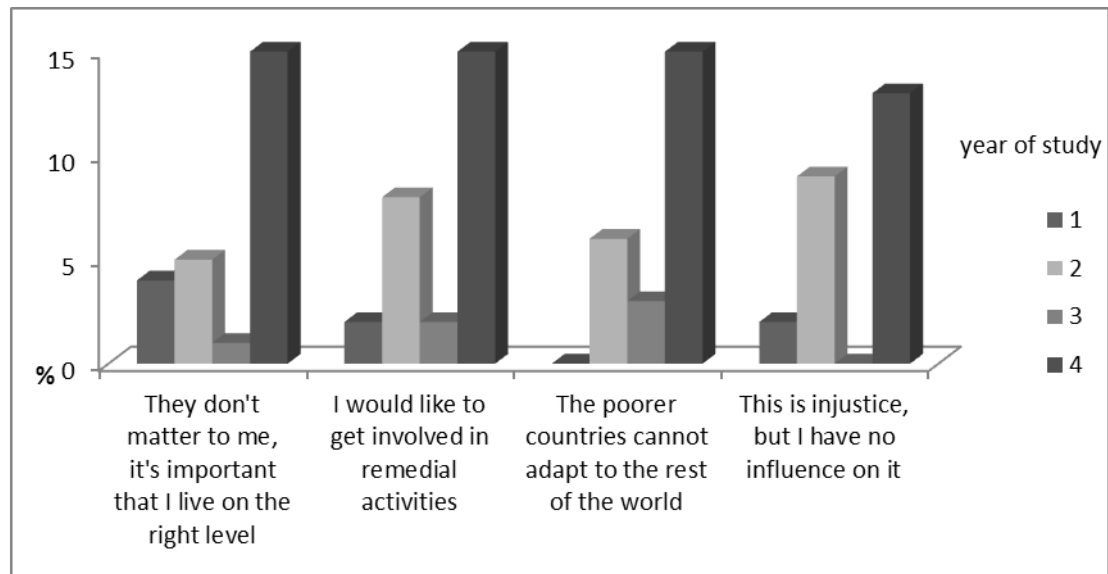


Fig. 5. The attitude of respondents in relation to growing social disparities, depending on the year of study
Source: own study

Respondents from all years of study most often pointed to the injustice associated with social aspects in the world, while claiming that they do not affect the situation (58%). They said relatively often that they would like to engage in repair activities (28%). None of the respondents from the third year of study chose an answer regarding the lack of interest in social problems. Fourth-year students did not blame the current state of the poorer countries.

As much as 87% of responses from the Navigation Department concerned social injustice, but nevertheless it was the answer most often indicated by all faculties. The respondents from the PiT Department most often compared to other faculties would like to get involved in activities for the benefit of society (10%). It was the answer most rarely indicated by respondents from the Navigation Department (2%). None of the respondents from the Faculty of Navigation pointed to the blame of the poorer countries in relation to the growing social disparities.

Fig. 6. shows the definitions of sustainable development indicated by respondents, depending on the faculty.

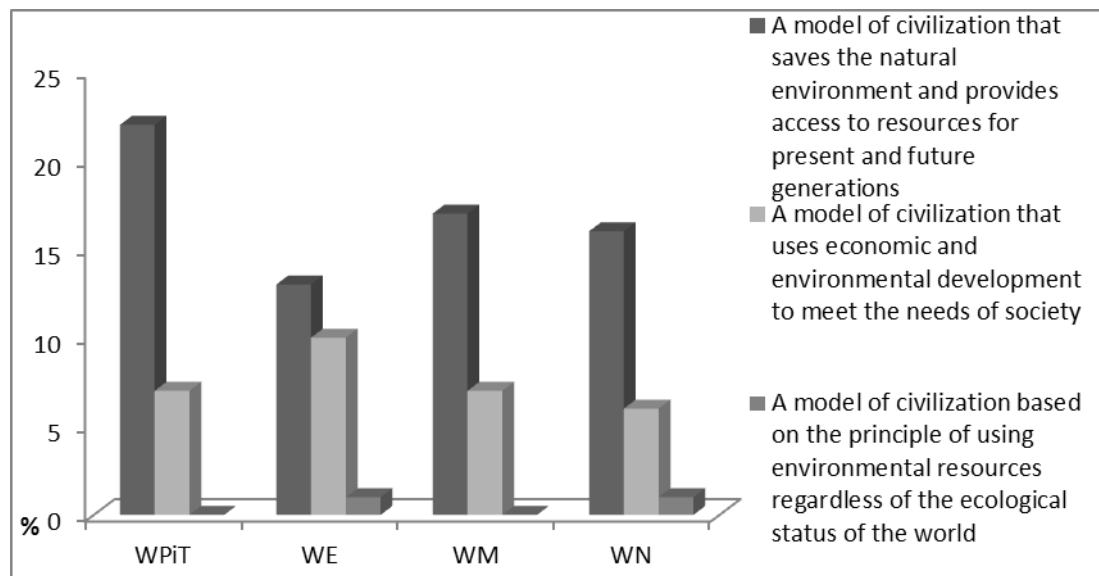


Fig. 6. Definitions of sustainable development indicated by respondents, depending on the department.
Source: own study

The most frequently cited answer among all faculties was A model of civilization that saves the natural environment and provides access to resources for present and future generations (68%). Relatively often (10%) students from the Faculty of Electrical Engineering pointed to A model of civilization that uses economic and environmental development to meet the needs of society. Only 2% of respondents from all faculties chose A model of civilization based on the principle of using environmental resources regardless of the ecological status of the world.

Students from all years of study provided relatively similar answers. The largest number of votes was in the definition of A model of civilization that saves the natural environment and provides access to resources for present and future generations (68%). Then A model of civilization that uses economic and environmental development to meet the needs of society (30%) and A model of civilization based on the principle of using environmental resources regardless of the ecological status of the world (2%).

The correct definition is A model of civilization that saves the natural environment and provides access to resources for present and future generations. However, the concept of sustainable development is not and cannot be explicitly defined, because it has many different definitions that cannot be put in a tight frame. At the 1992 Rio de Janeiro Summit, sustainable development was defined as *a strategy for ecological, social, technical, technological and organizational transformations aimed at achieving a rational and sustainable level of social well-being, enabling it to be passed on to future generations without fear of damaging the destruction of natural resources, and ecosystems* [5]. A literature review allows defining the concept of sustainable development as, inter alia, a feature of eco-development, a concept identical to sustainable development, a broader concept than self-supporting development [6]. In the Act on environmental protection, sustainable development is defined as *socio-economic development in which the process of integrating political, economic and social activities takes place, maintaining natural balance and sustainability of basic natural processes, in order to guarantee the ability to meet the basic needs of individual communities or citizens of both the modern generation and future generations* [7].

Fig. 7 shows three basic pillars of sustainable development selected by the respondents depending on the year of study and faculty.

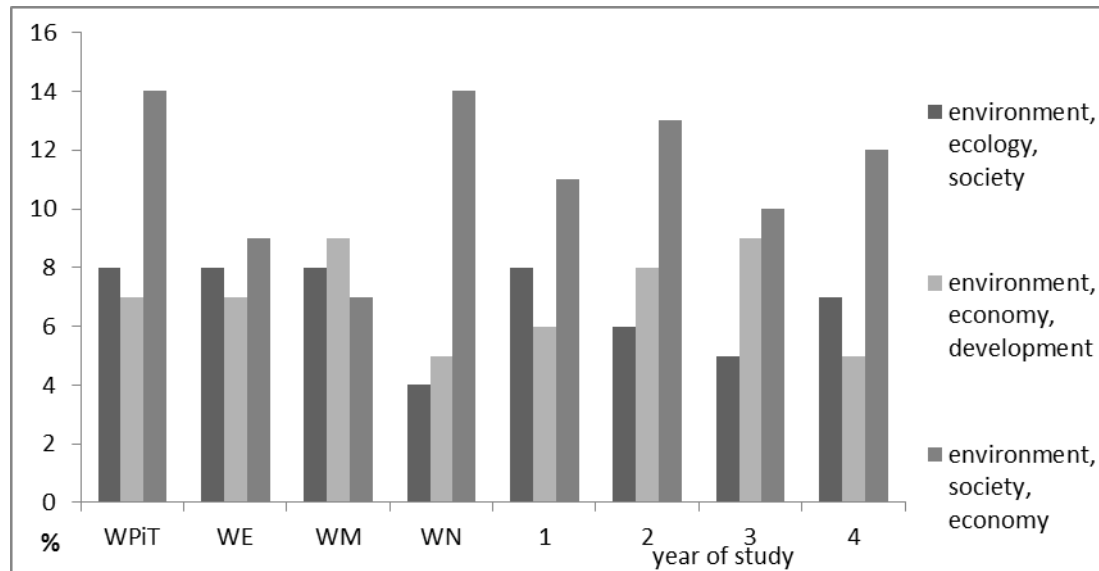


Fig. 7. Basic pillars of sustainable development in the opinion of the respondents, diversified in terms of year of study and faculty
Source: own study

Almost all the groups included in the survey gave the correct answer regarding the three basic pillars of sustainable development - environment, society, economy. The respondents from the Faculty of Mechanical Engineering most often pointed to environment, economy, development (9%).

From among all the years of study, the respondents most often pointed to environment, society, economy (46%), followed by environment, economy, development (28%) and environment, ecology, society (26%).

The environment, society and economy were first designated at the Earth Summit in Johannesburg in 2002 - sustainable development should be based on them. The essence of their applicability is interdependence, which entails solving problems on a common path towards a better future [8]. However, already during the creation of the Brundtland report postulated that the economy and nature should be treated as systemically interdependent, while economic, ecological and social goals should be deeply connected [2].

Fig. 8. shows the respondents' answers regarding the origin of the definition of sustainable development, depending on the faculty and year of study.

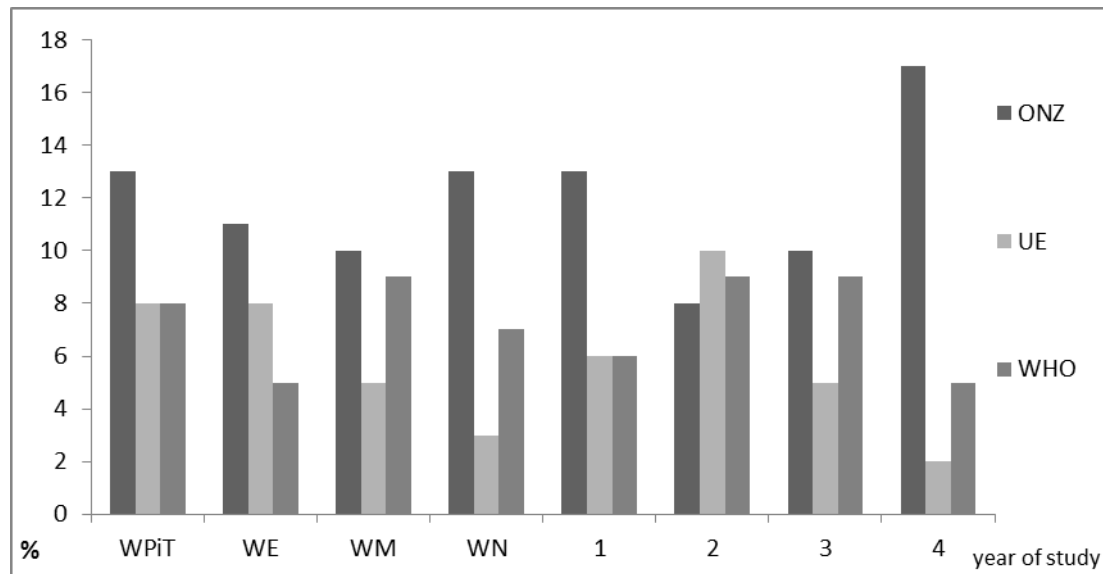


Fig. 8. The origin of sustainable development according to respondents differentiated in terms of faculty and year of study
Source: own study

Students from all faculties most often gave the correct answer regarding origin - the introduction of the concept of sustainable development by the United Nations (47%). The relatively frequently chosen answer, especially among respondents from the Faculty of Mechanical Engineering (9%) was the World Health Organization (29%). The respondents, in particular the Navigation Department (3%) pointed to the European Union (24%).

The respondents from the second year of studies most often pointed to the European Union (10%), then the World Health Organization (9%) and the United Nations (8%). Unlike them, the rest of the surveyed respondents indicated the European Union least frequently (13%). Of all the years of study, respondents from the fourth year most often gave the correct answer (17%), then from the first year (13%), the third (10%) and the second (8%).

The concept of sustainable development was introduced over 5 decades ago, in particular the United Nations. Originally, however, the concept of sustainable development was presented by H. C. von Carlowitz in the work entitled *Sylvicultura economica* from 1713. This concept referred to such forest management that it would always be able to recover. The term has been taken over by other fields, despite initial use only in forestry [9].

Fig. 9 shows the respondents' answers on how to more effectively implement the concept of sustainable development, depending on the year of study.

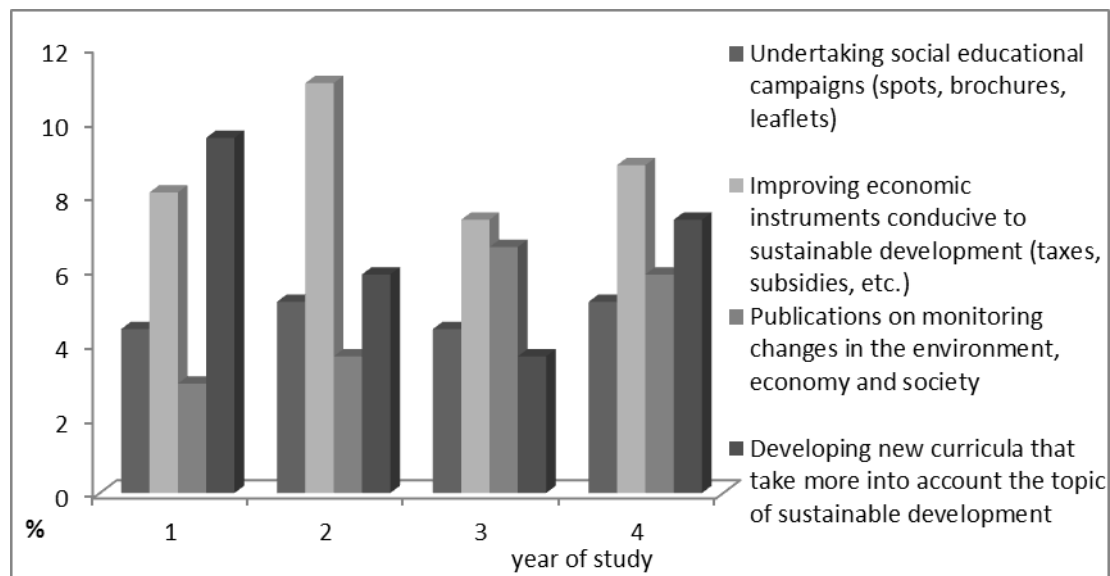


Fig. 9. Ways to more effectively implement the concept of sustainable development in the opinion of respondents, depending on the year of study
Source: own study

The most frequently given answer by respondents from all years of study was improving economic instruments conducive to sustainable development (taxes, subsidies, etc.) (35.3%), followed by developing new curricula that take more into account the topic of sustainable development (26.5%), undertaking social educational campaigns (spots, brochures, leaflets) (19.1%) and publications on monitoring changes in the environment, economy and society (19.1%).

Improved economic instruments conducive to sustainable development (8.1%) were the most frequently indicated way by respondents from the Faculty of Navigation, while the least frequently undertaken social educational campaigns (3.7%). Relatively often respondents from the Faculty of Mechanical Engineering pointed to developing new curricula that take more into account the topic of sustainable development (7.4%), as did students from the Faculty of Electrical Engineering (5.4%).

One of the basic educational activities for sustainable development was the establishment of the Decade of Education for Sustainable Development at the Johannesburg Summit. The need for education under this concept has been recognized at all levels of education. In higher education, the manifestations of the idea of sustainable development began in the 1990s, including in 1999, as part of the Quality - offer - cooperation program of the Krakow Foundation "Partnership for the Environment", it was a conference dedicated to the exchange of information and experience regarding the paradigm, which resulted in the book Education for Sustainable Development [10]. Current educational orders were determined during the 70th Session of the United Nations General Assembly, meeting September 25-27, 2015 in New York with the participation of 100 representatives of states, heads of government and leaders of civil society. A "2030 Agenda for Sustainable Development" was adopted, indicating seventeen sustainable development goals that the international community should strive to achieve in the next fifteen years. Each of the goals is accompanied by a few to several tasks, on the implementation of which depends the success in

achieving individual goals. The agenda's 4th goal is to provide high quality inclusive education for all and to promote lifelong learning [11].

Conclusions

1. For the vast majority of respondents, sustainable development is real action for the world, taking into account economic, ecological and social goals.
2. The Internet and mass media are the most and most often chosen source of information by all respondents.
3. Environmental protection and aspects related to improving the quality of resources were not particularly important for a relatively high number of respondents.
4. Despite earlier declarations and a lack of interest in environmental factors, for most of the respondents the most severe effect of wasting resources was ecological aspects.
5. Relatively many respondents seem to notice conflicts and growing disparities in the world. However, they cannot react appropriately to situations that directly affect them.
6. The knowledge of the respondents regarding setting the correct definition of sustainable development was described as relatively high - most of the respondents were able to indicate the correct one.
7. The three basic pillars of the idea of sustainable development in 44% of the obtained answers have been verified correctly.
8. Almost half of the respondents were able to correctly identify the institution that introduced the concept of sustainable development on a larger scale.
9. For most respondents, the most effective way to implement and raise public awareness about the concept of sustainable development was the development of new curricula - educational aspects.

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3D PRINTING- THE FUTURE OF THE MEDICINE?

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Abstract:

The spatial printing (3D printing) is one of the methods of additive manufacturing, which consist of the production of physical objects by adding material layer-by-layer. The essence of the process is build a real elements based on virtual geometry developed in the computer system. There are several 3D printing methods. The main division criteria are the way to applied the layer and the type of construction material. The purpose of this article is to present the procedure that allows making the physical models using the additive (incremental) printing techniques (3D printing) based on computed tomography (CT) images.

Keywords:

3D printing, implants, prostheses, preoperative planning, medical care

Introduction

The spatial printing (3D printing) is one of the methods of additive manufacturing, which consist of the production of physical objects by adding material layer-by-layer [1, 2].

In the initial stage of development, the elements were characterized by low quality (accuracy) and served for a general presentation of the shape of the product, which were made by traditional methods. However, the use of 3D printing has reduced the time and costs of the prototyping process. The technological development contributed to the improvement of the quality and increased the amount of available methods and building materials. Currently, 3D printing methods have found application in many areas of life, including industrial design, automotive, aerospace, architecture, jewelry, and even in medicine and veterinary medicine, bringing many innovative and revolutionary solutions.

There are many the additive printing techniques available on the market, which differ the way to applied the layer and the type of construction material. In most projects, the choice of technique is a compromise between costs and properties (e.g. physical, chemical or mechanical) the manufactured object.

In Tab. 1 presents the most popular 3D printing techniques together with a description, which account the type and form of the construction material.

Tab. 1. Overview of incremental printing techniques (3D printing)

Methods	Description	Type and form of the construction material
Electron Beam Melting (EBM)	A similar method to SLM allows the production of elements from fused metal powders by means of an electron beam. The whole process takes place in a vacuum chamber filled with helium.	Titanium or cobalt and chromium powders
Fused Deposition Modeling (FDM)	A method based on modeling by liquid thermoplastic material extruded by extruder. The variation of this method is FDMm, which allows modeling by liquid metal.	Thermoplastic materials or metal alloys with a melting point below 300°C in the form of a fiber wound on a spool (filament)
Laminated Object Manufacturing (LOM)	The method of producing objects from layers of laminated paper or foil. The printer cuts out each of the layers, and then glued them together.	Special heat-sealable paper, composite foil, polymer, metal
Jet Modeling (JM)	So-called contactless dosing of the material, which consists of spraying the photopolymer from a multi-nozzle head. Each layer must be cured with UV light.	Photopolymers, resins (liquid form)
Selective Laser Sintering (SLS)	The method of selective sintering the powders of various materials by laser beam.	Polyamide and metal powders
Selective Laser Melting (SLM)	The method of selective fusing (remelting) the powders of various materials by laser beam.	Polyamide and metal powders
Stereolithography (SLA)	The oldest method (patent 1986, UVP company), which consists of the polymerization of resins by UV light	Resins (liquid form)

Source: Own study based on [1, 2]

The choice of the incremental printing technique is associated with the selection of the appropriate prototyping device, i.e. 3D printers. There are many models available on the market, which can be divided into:

- *plug and play* printers with a closed design. They are easy to use- the user can start working immediately after connecting, without much intervention in the hardware configuration,
- *open hardware* printers, which are the group of printers for self-assembly. The user can use the printer schema available on the network and complete the necessary components himself or buy a complete set [1].

The main criterion for choosing a 3D printer is the cost of the device and user skills (experience). It is worth noting that the user who decided to buy the plug and play printer from a specific manufacturer, gains qualified technical support in the field of integration (assembly), operation (training, inspections), repair (service) or purchase of construction material.

Purpose of the project

The purpose of the project was to develop a procedure that allow the production of the physical models using the additive (incremental) printing techniques (3D printing) based on computed tomography (CT) images. The models were to reflect selected anatomical structures as closely as possible. All the works carried out in the project can be divided into four basic stages:

1. three-dimensional modeling and preparation of the mesh model,
2. virtual preparation of the layered model,
3. building a layered model,
4. model finish.

Materials and methods

Mesh models

The first stage of work was the development of three-dimensional models of the anatomical structures based on computed tomography (CT) images. For this purpose, the free program InVesalius was used. In the described case, a series of images made using the spiral computed tomography technique, after intravenous administration of the contrast agent was used. The study area included the abdominal cavity with pelvis. After implementing the selected series of CT images into the program (saved in the DICOM format, Fig. 1), the anatomical structures were separated (the so-called masks).

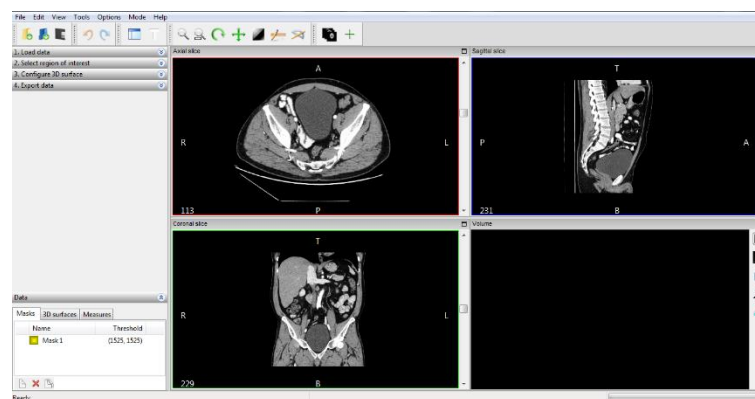


Fig. 1. View of the InVesalius window with the imported CT image series

Source: own study

The InVesalius software allows the user to:

- automatic generation of the masks by using pre-defined settings (filters) or their manual modification.

This solution is especially useful for the bones structures or the skin.

- manually drawing of the masks

This is the time-consuming solution, but allows the user to accurately draw anatomical structures, in particular the internal organs and the soft tissues.

During the modeling process, both options for specifying masks were tested. Finally, it was decided to manually draw the selected anatomical structures:

- the soft tissues: bladder, kidneys and liver (Fig. 2),
- the bones structures.

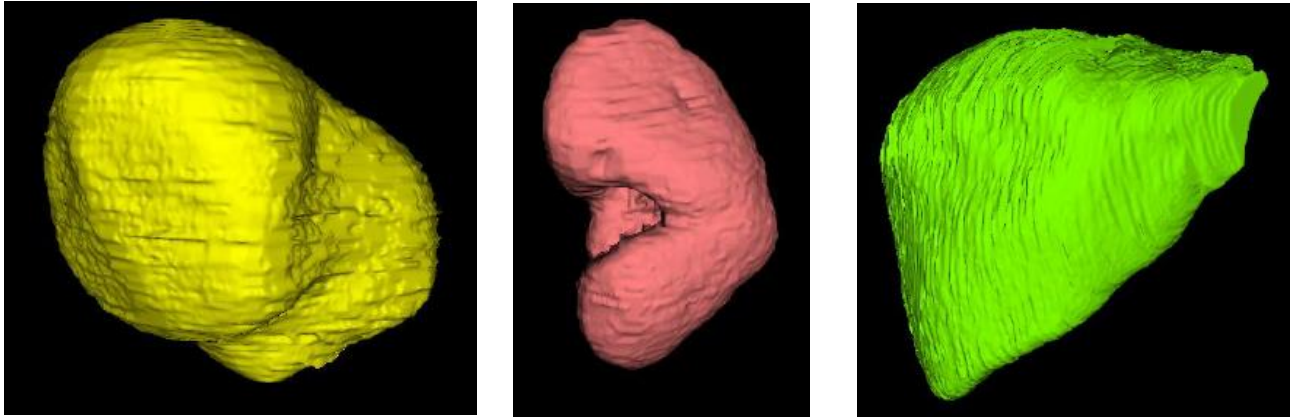


Fig. 2. The three-dimensional surface models (from the left): bladder, kidney and liver

Source: own study

Base on the masks, the three-dimensional surface models were obtained. In the next step this models were exported to STL format files. In this way, mesh models, the basis for subsequent stages of work, were obtained.

Hardware preparations

Parallel to the modeling process, the hardware preparation were began. This stage included the choice of:

- additive printing techniques
- prototyping device (3D printer)
- construction material.

The main requirement, that the models were to meet, was to represent the real anatomy of selected anatomical structures as closely as possible. Accordingly, their properties (in particular mechanical properties), have been omitted. It is worth noting that such a simplification would not be possible in a situation where the created object would attend the role of an implant, prosthesis or orthopedic supply.

In connection with the above, it was decided to use the Fused Deposition Modeling (FDM)-the method based on the modeling by the liquid thermoplastic material extruded by the extruder. The construction material was the ABS (Acrylonitrile Butadiene Styrene). The biggest disadvantage of this material is his shrinkage. The ideal print environment is a heated working platform, closed in a heated chamber, with controlled cooling after printing. These operating conditions were provided by the ATMAT Signal XXL printer device.

Layered models

The next stage of the work involved the preparation of the layered models using a slicer program. It is a software, that automatically divides mesh geometry into layers with a certain

thickness. Then, for the each of the layers, the program generates so-called working paths (travels), which control the movements of the printer head, and hence - the order of adding the material. The paths are saved in the form of G-code. This process is presented in Fig. 3.

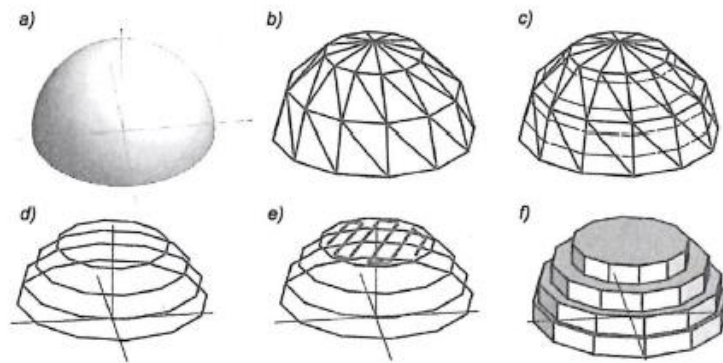


Fig. 3. Conversion of virtual geometry in the 3D printing
a) original solid object b) mesh model (file in STL format) c) division of mesh model into layers
d) layer model e) sample work paths (travels) generated for each layer f) approximate shape of the real object
Source: [2]

In the project was used the Cura (2.6.2)- one of the most popular slicer program dedicated to 3D printers of the FDM type, which is develop and made available (under an open-source license) by the Dutch company- Ultimaker. When running the program for the first time, it is necessary to perform the configuration, which involves on entering the parameters of the prototyping device. The next step, after configuration, was loading the mesh model (saved in STL format, Fig. 4) and entering the printing parameters (so-called Print Setups). The number and type of parameters, which have a significant impact on the quality of the printout, depends on the properties and applications of the physical object. The user has the option of manually setting print parameters or using ready-made profiles available in the program or on the printer manufacturer's website.

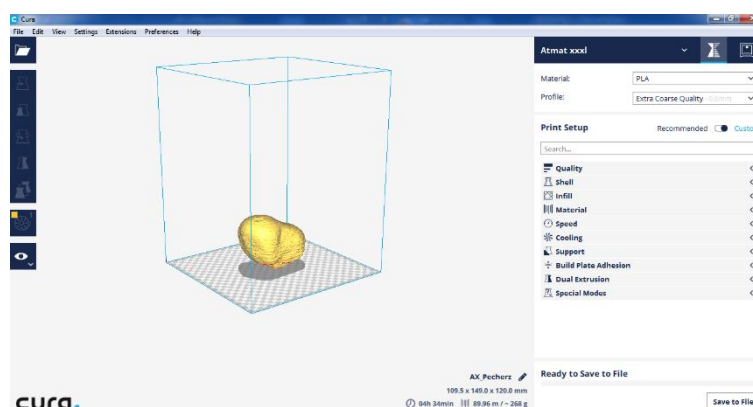


Fig. 4. View of the Cura window with the imported mesh model
Source: own study

After each change of the printing parameters, the model is automatically divided into the layers and supporting structures are generated. The Cura program allows the user to view the individual

layers of the model (Fig. 5). The preview shows such elements as: work paths (travels), supports and structures improving the adhesion of the model to the working platform, outer contour lines (shells), filling structures and internal contour lines.

Another interesting option (useful from the point of view of work planning) is the calculator, which gives the approximate time of printing the model and the amount of the filament (construction material).

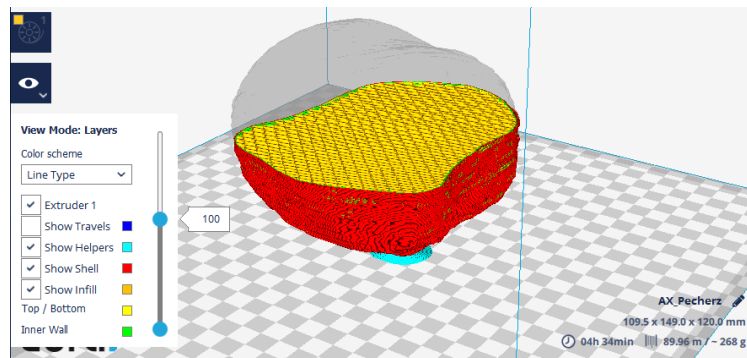


Fig. 5. View of the single layer
 Source: own study

The next step, after obtaining the layered model, is save it as a set of commands understandable for the 3D printer, i.e. G-code.

Construction of the physical model - printing process

The printing process is preceded by proper preparation of the prototyping device. In the case of the 3D printers of the FDM type this stage includes:

- checking (according to the user's manual) the correct operation of individual elements, above all the extruder, limit sensors, temperature sensors, motors or thermistor,
- table calibration and leveling,
- cleaning of the table surface and covering it with a tape, which additionally increases the model's adhesion.

The printing process starts loading the SD card with the ready G-code to the printer. The effects of the work are shown in Fig. 6.



Fig. 6. The bladder physical model made of ABS using the FDM method
Source: own study

Final results

The obtained physical models satisfactorily represent the real anatomy of the selected anatomical structures, both of internal organs (soft tissues) and bone structures. This indicates the great versatility of the proposed solution and great application potential, in particular in the field of:

- medical education and preoperative planning,
- production of individual bone implants and endoprostheses,
- design and production of prostheses and orthoses.

However, depending on the area of the application, the incremental printing technique should be modified, because the properties of the object and the working conditions should be taken into account. For example: the bone implants and the endoprostheses used in the reconstruction operations, e.g. of the hip or facial skull, are mainly made of the titanium. For their production, it is best to use Electron Beam Melting.

The valid stage in the modeling process was the selection of tools to the CT images (saved in DICOM format) processing. The goals formulated at this stage, in particular, the condition of faithful reproduction of real anatomy, was achieved using the option of manual definition of the masks, available in the InVesalius. This process, although time consuming, gave better results in compared to the automatic option. In addition, it requires some knowledge about the anatomy, and in the case of practical applications- consultation with specialist (radiologist).

Summary

One of the main applications of the additive printing technique is the medical education and the preoperative planning. Based on imaging tests (e.g. computed tomography, magnetic resonance imaging or 3D / 4D ultrasound) it is possible to make the models of the selected anatomical structures. In this way, doctors gain a new work tool that allows them to pre-plan surgery. This is very important in the case of the complicated operations, e.g. the cardiac surgery or cancers in various locations and level of advancement.

The 3D printing is also used in the production of the individual bone implants or the endoprotheses. The implants are an important element of the skeletal reconstruction surgery, among others the hip (e.g. hip implants from Lima Corporate) or the craniofacial. Tailored to the individual needs of the patient, the upper and lower limb prostheses accelerate his rehabilitation and return to satisfactory mobility.

More and more biotechnology companies are working on the develop of the 3D bioprinter that allows the production of the fully functional internal organs from the biological material - the stem cells from the patient himself. This would solve the main problem of the modern transplantology - not enough donors.

The examples described above are a small fragment of the possibilities offered by the incremental printing. Nevertheless, it confirms that it is a tool that will contribute to the significant development of medicine. It is possible that in the future, using the 3D printers and the stem cells, doctors will be able to replace any defective part of our body. The method described in this article may become a starting point for this applications.

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