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FUTURE OF PACKAGING INTENDED FOR FOOD PRODUCTS

PRZYSZŁOŚĆ OPAKOWAŃ NA ARTYKUŁY SPOŻYWCZE

Summary: *Packaging of food products must meet many requirements. In the present paper, the trends of development of packaging destined for food and drinks in Poland have been discussed. Besides, on the ground of the conducted studies, the most significant properties of packaging of food products were highlighted, with the consideration of the knowledge of terms; "active packaging" and "intelligent packaging" and their role. The summing up of the mentioned studies would give the answer to the question concerning the most approved types of food products from viewpoint of the consumers.*

Keywords: *packaging of food products, survey questionnaires, significant properties of the packaging, active packaging, intelligent packagingr*

Streszczenie: *Opakowania na artykuły spożywcze muszą spełniać liczne wymagania. W artykule przedstawiono trendy rozwoju opakowań do żywności i napojów. Ponadto – na podstawie przeprowadzonych badań ankietowych – wyeksponowano najbardziej istotne cechy opakowań na artykuły spożywcze, z uwzględnieniem znajomości terminów: „opakowanie aktywne" i „opakowanie inteligentne" oraz ich wadze. Niejako podsumowaniem tych badań jest uzyskanie odpowiedzi na pytanie dotyczące najbardziej odpowiadających respondentom rodzajów opakowań do spożywczych artykułów.*

Słowa kluczowe: *opakowania na artykuły spożywcze, badania ankietowe, istotne cechy tych opakowań, opakowania aktywne, opakowania inteligentne*

Introduction

The contemporary packaging plays not only the protective or transport function but also represent the producer and supply information about the packaged product. Due to these reasons, to survive in the specific market race, the contemporary packaging becomes more and more innovative. The task of the producers is to pay attention – via the mentioned packaging – to the product, according to the principle what the first impression is most important and it is done "only" once. When staying before the shop shelf, the consumer – before he makes a choice – fist of all, pays nowadays attention to the appearance of the product and then, to its friendliness and convenience of use. In a few years, we will focus on the possibility of repeated use of the packaging and on its ecological aspects [1, 2, 4]. There are many factors affecting the directions of development of the packaging; many studies were conducted and many papers were developed. We should mention here the study of C. Olsmats and Jari Kaivo-oja (2014) where the following 5 main trends, shaping life all over the world in the coming years have been distinguished:

- world of limited resources;
- personalization of services;
- urbanization and increased mobility;
- demographic changes and
- popularization of digital world [3].

The first factor is focused on the decrease of the amount of food waste via the application of packaging which may be completely emptied and closed again, on prolongation of shelf life of the packed food and on recycling of packaging materials. The authors of classification indicate a very quick consumption of non-renewable resources which are utilized in food production and the intended packaging. It results from the increase of population, and development of economy. There is more and more ecological and biodegradable packaging. Also, its friendliness to environment is stressed. The second direction is concentrated on presentation and innovations, employed in a given packaging. During the successive several years, the next dominating trend will include designing of the packaging which allows communication with the user, with the simultaneous rise of its value. The fourth factor, shaping the packaging sector stresses the role of migration of human population, its lifestyle, labour market and housing needs. The last mentioned above factor is a passage from the analogue world to digital one due to the addition of electronic markers or intelligent labels. Owing to it, the user may also save time. There is no need to wait for computer game, wrapped in the packaging as it may be ordered and in the case of possessing the appropriate platform, it may be normally installed, using the appropriate code or link, being on-line enclosed.

Directions of development of packaging for foods and drinks

Packaging intended for food and drinks is the vastest sector in the packaging branch. Due to a quick life rate of the Poles, the change in the structure of family at the space of several recent years, producers of food packaging place the emphasis on the following:

- functionality of packaging;
- friendliness in utilization, via assistance in everyday operations such as easier dosing of the product or rationing of loose products;
- decrease of portions;
- designing of packaging for ready-to-use products for the users who do not have time to cook due to their active lifestyle and
- prolongation of the shelf-life of the product.

In respect of the convenience of use, the greatest development in the field of designing the packaging has been observed for the dairy products. The way of evolution led from the milk, packed in glass bottles, via film bags and cardboard packaging to interesting plastic packaging with a handle, facilitating dosage of the milk, or plastic biodegradable packaging in a form of jug. Earlier, we shopped the milk with own vessels. We should also mention innovative small cartons or bottles for milk and other drinks. Such packaging may be quickly emptied and dispose later. Their undoubted advantage lies in the fact that they are small and can be taken for excursion, to school or to work place. Unfortunately, the contents of such packaging should be consumed at once as they when once opened, cannot be closed again.

Also, yoghurts are packed in convenient, functional and interesting packaging. The packaging with the *corner* have not lost their popularity for many years; it is the additional baffle in the packing where any food additives may be placed, for example, candies, fruit mousses, pulps etc. The discussed element may be separated from the whole packaging what is especially attractive for the youngest users as when torn, it yields a characteristic funny click. Yoghurts are sold in the bottles of 330 ml volume; they are also functional and convenient; their advantage includes also the possibility of close the bottle cap. Owing to this fact, the user does not have to consume the whole product at once, he may close it and place in the bag or backpack and may be sure that yoghurt does not flow out from the bottle.

We may also record development in respect of packaging for cheeses, butcher's products and meat. Their producers concentrate mainly their attention on prolongation of the stability of the packed product. The problem connected with the discussed products includes their quick deterioration, desiccation, being connected with the contact with oxygen and with microorganisms what, consequently, deterioration of their quality, constituting a hazard to human health and even to life. Impact of oxygen is well visible, especially in the case of meat as the oxidised product changes its colour into grey-brownish and the oxygenation products have unpleasant odour. Therefore, the packaging material for the discussed products must constitute a special protective barrier from the external environment. It may be obtained owing to the application of the advanced packaging systems such as:

- vacuum packaging,
- modified atmosphere packaging (MAP) and
- controlled atmosphere packaging (CAP) [1].

Coating of fruits and vegetables with the edible layer, containing lipid compounds is an interesting solution, prolonging the shelf-life of the products [2]. The mentioned substances limit the migration of water vapour, oxygen, carbon dioxide and aromatic compounds from a given fruit or vegetable and improve its properties. They are employed as preservatives, antioxidants and substances and colour and aroma enhancers. They make also that the appearance of the product is more attractive for the consumer's eyes. The apples may be coated with the discussed substances owing to which they are shining. Another innovation of the similar type includes application of edible films. They are independent structures, formed outside the product and may constitute a protective layer, active component as well as independent packaging. The main problem concerning fruits and vegetables – apart from their short shelf-life – consists in the easiness to be damaged during the transport. It should be also taken into consideration. At the same time, it must be such material which would ensure the possibility of "breathing" to the products. At present, the unit packages are most popular. They include the following solutions:

- perforated polypropylene films (foils) in which the vegetable or the selected fruits are packed; sometimes in order to adapt the packaging to the contemporary demand on eco-friendly solutions – instead of polypropylene, PLA (polylactic acid) is added. It is a biodegradable polymer, obtained from renewable raw materials;
- polystyrene trays, wrapped with stretch-type foil, mainly for fruits and vegetables, e.g. for vegetable mix (in Polish: włoszczyzna);
- wrapping with film, e.g. celery or ice lettuce;
- small trays, wood split baskets and boxes made from cardboard, thermoformed pulp or plastic.

In spite of such possibilities, the customers are urged to buy fruits and vegetables in a "bulk" form, that is, without unit packaging, especially when it is made from eco-unfriendly plastic. It does not mean, however, that in the perspective of several dozen of years the need of producing the packaging for the mentioned products will disappear. At the different small markets and in small vegetable shops, the merchants employ the collective packaging in a form of boxes made from wood, from solid cardboard, woven bags and also, from plastic. At the Polish markets, we cannot, unfortunately, meet many innovations in respect of packaging for fruits and vegetables, in the contrary to the western markets where active and intelligent packaging is used. It is a trend in development which allows prolongation of the shelf-life of the discussed products by twice-three times, with the application of all types of ethylene absorbers. The recent substances are placed in the boxes or in

bulk packaging. The employment of freshness indicators on the product is another interesting solution. In this case, the customer has a chance to buy a product with a specified freshness, that is satisfactory for him, and moreover, he will not throw it away. The submitted example is the answer to the global problem of food wastage. In 2020, it was estimated that in Poland, about 5 million tonnes of food are discarded, including agricultural waste (15%), production waste (the same quantity); 7% of food waste come from trade, more than 60% – from households, and ca. 1% comes from gastronomy and transport [I]. The conducted studies reveal the scale of the appalling phenomenon and, also the need of designing such packaging which will be not only functional but also prolong the shelf-life of the product and give maximum information to the user as to prevent deterioration of a given product. We may, therefore, state that the direction of development of food packaging includes, first of all, active packaging, informing about the shelf life of the product, and intelligent packaging ensuring the information about the product's freshness state and communication with the user. The intelligent packaging appear in a form of the already mentioned indicators of freshness state and, also, as the indicators of the history of TTI (time and temperature indicators) and the sensors of its exceeding e.g. in the packaging of the products intended for their heating up in the microwave kitchen, or thermochromic paints indicating the level of cooling down e.g. of beer, or the indicators of oxygen presence and tightness of the packaging.

Packaging for food and drinks nowadays is more and more subjected to ecological trends. The described solutions – especially in Poland – can be not always defined as those which are not harmful to the environment. Many active packages for meat and dairy products being found in the shop freezers and coolers is produced from plastics which are not biodegradable and additionally, are petrochemical, for example: PE, PP or PET. Due to these reasons, we may observe the ecology-related trends, as affected by numerous studies and opinions on environment protection in packaging sector. The most important include:

- search for replacing materials, being an alternative to traditional, non-ecological polymers;
- employment of raw material from recycling in manufacture of packaging, for example, in 2020, Żywiec Zdrój company produced and sold the bottles for water, being produced from recycling materials;
- production of packaging in the way which makes the smallest carbon print;
- utilization of degradable and compostable materials.

In connection with the mentioned trends, in the nineties of the 20th century, there were introduced bioplastic materials including non-biodegradable plastics, produced from non-renewable and petrochemical resources and the biodegradable ones, obtained from renewable resources. The greatest popularity was obtained by poly (lactic acid), being called polylactide (PLA) and produced from completely renewable resources. It is employed in production of flexible packaging, extrusion of rigid and thermoformed films, for shaping of packaging by the injection method, and lamination of paper by the extrusion method. Other materials, as being more and more universal on the market, include the group of polymer-starch composites under the trade name MateriBi and cellulose foils. MateriBi is currently used for manufacture of flexible and rigid films, and those subjected to thermoforming, destined for trays and the containers or foamed material, filling a free space in transport packaging. Cellulose films are produced from cellulose pulp, obtained from Eucalyptus tree wood and belong to compostable materials. They are characterized by very good optical properties, possessing a good barrier to oxygen and aromas, controlled barrier to water vapour and natural antistatic. Moreover, they are resistant to fats, chemical substances and changes of temperature.

Food packaging will be subjected to transformation due to the EU Directive which was introduced in July 2021 (II). One of the first changes covers elimination of plastic straw, containers for milk type beverages or juices in cardboard packaging of 200 cm3 volume, trays and polystyrene (Styrofoam) containers. The mentioned Directive is focused on recycling, so since 2023, the producers of plastic packaging will have to take care of manufacture from renewable materials at least in 25% and since 2030, the mentioned ratio will be increased at minimum to 30%. Since 2025, the plastic bottles with freely screwed caps will disappear and there will be only those with permanently fixed caps. The additional ecological factor is the Plastic Tax, being imposed by the EU authorities and introduced into effect since January, 1, 2021. Is includes plastics which will be not subjected to recycling. For each kilogram of the unprocessed plastic, it will be necessary to pay 80 Eurocents of tax. In the situation of such legal regulations, the producers of plastic packaging will be forced to concentrate on manufacture of the biodegradable packaging to the possible highest degree; it will be connected, first of all, with higher manufacturing costs.

The most significant properties of packaging intended for food products

To test the preferences of the users in relation to food packaging, the survey was carried out during which it was examined what properties and types of food packaging were most significant from the viewpoint of user of a given packaging. The knowledge of such terms as "active packaging" and

Table 1. The averaged general results of the respondents' answer to the question: "Which properties of food packaging are, in your opinion, most significant?"

Number of respondents	Eco-friendliness	Graphic layout	Safety	Readability of information	Possibility of complete emptying	Convenience of use
100	3.45	3.59	3.88	4.07	4.03	4.08

"intelligent packaging" was checked. The respondents evaluated the packaging in the score scale from 1 to 5 where "1" meant the least significant properties and "5" was referred to the most significant ones. The answers of the Respondents were given in tables 1–9 and in diagrams 1–5. In tables 1–4, general answers were illustrated, according to gender, age and education of the examined persons.

On the grounds of the results of the survey, we may conclude that the convenience of use of food packaging, possibility of reading out the information and the possibility of complete emptying of the package were the most important factors of choice. Eco-friendliness was the least important aspect.

From the analysis of the results, shown in the above table it is followed that women – when choosing food packaging – focus their attention on readable information about the product inside and they are less interested in graphic layout and eco-friendliness of the packaging. In turn, men pay greater attention to convenience of use of the packaging and eco-friendliness is for them the least important aspect.

On the grounds of the results, presented in the above table, it may be concluded as follows: the friendliness of packaging is most important for the persons between 26th and 35th year of life; however, it is not most important aspect for them. The persons younger than 18 years and those between 45 and 60 years of life do not pay much attention to eco-friendliness. Graphic layout is more attractive for the underage youth and the least attractive for the persons between 36 and 45 years of life. Safety of food packaging seems to be most important for the persons at the age of 36–45 years and the least significant for the youth below 18th year of life. For the young people, the aspect of the possibility of complete emptying the packaging is least important but the mentioned aspect is most significant for the persons above 60 years of life. For this latter age group, the convenience of use of the packaging is also the most important issue. The recent aspect is least significant for the persons at the age of 45–60 years

Table 2. The averaged results of the respondents' answer to the question: "Which properties of food packaging are most important for you?" according to gender

Gender	Women	Men
Number of respondents	52	48
Eco-friendliness	3.81	3.06
Graphic layout	3.65	3.52
Safety	4.15	3.58
Readability of information	4.27	3.85
Possibility of complete emptying	4.17	3.88
Convenience of use	4.17	3.98

Table 3. The averaged results of the respondents' answer to the question: "Which properties of food packaging are, in your opinion, most important?" according to age

Age	<18 years	18-25 years	26-35 years	36-45 years	45-60 years	>60 years
Number of respondents	9	43	13	20	9	6
Eco-friendliness	2.44	3.78	4.22	4	2.67	4.17
Graphic layout	4.22	3.51	3.92	3.35	3.44	3.5
Safety	3.22	3.77	4.08	4.35	3.56	4.17
Readability of information	3.22	4.28	4.85	4.15	3.78	4.5
Possibility of complete emptying	3.44	4.21	4.31	4.05	3.77	4.5
Convenience of use	3.78	4.33	4	3.85	3.44	4.67

Table 4. The averaged results of the respondents' answer to the question: "Which properties of food packaging are, in your opinion, most significant?" according to education

Education	Lack	Basic	Vocational	Secondary	Uncompleted higher	Higher
Number of respondents	7	6	7	19	32	29
Eco-friendliness	2.86	1.87	3.00	3.44	4.00	3.67
Graphic layout	4.00	3.67	3.43	3.00	3.63	3.86
Safety	3.71	2.33	4.00	3.58	3.81	4.48
Readability of information	3.71	2.50	3.71	4.37	4.06	4.38
Possibility of complete emptying	3.86	2.50	3.57	4.26	3.94	4.45
Convenience of use	3.57	3.33	3.29	3.95	4.28	4.41

Graphic layout is the most important aspect of food packaging for the persons with lack of education; eco-friendliness is least significant for them. For the persons with vocational education, safety of packaging is most important and ecological problems are also least significant. The persons with the secondary education are mostly focused on readability of information and graphic layout is less significant for them. The convenience of use is most important for the persons with uncompleted higher and higher education; graphic layout is least important for them. Additionally, the persons with higher education focus mostly their attention on the possibility of complete emptying of the packaging and pay the smallest attention to eco-friendliness of the packaging.

The knowledge of term: "active packaging"

Within the frames of the conducted questionnaire, the awareness of the respondents in respect of active packaging was carried out. The results are given in tab. 5 and circular diagram 1.

Table 5. Presentation of the respondents' answer to the question: " Do you know the term: "active packaging?", in figures

YES	22
NO	69
I DO NOT KNOW	9

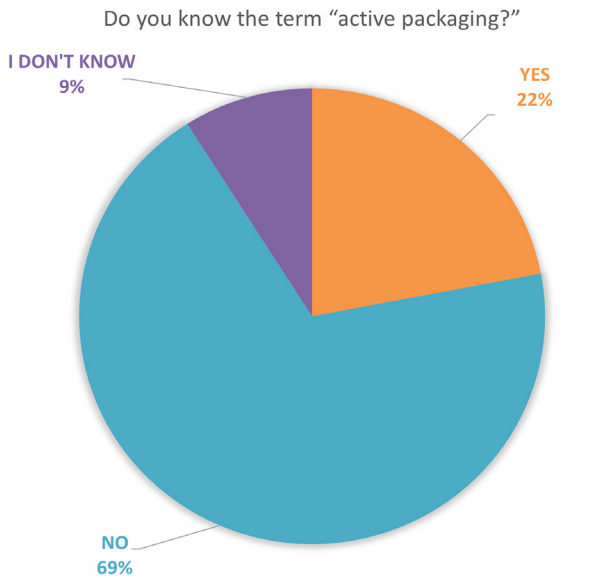

Fig. 1. Presentation of the respondents' answers to the question: "Do you know the term "active packaging?", in %

As it can be seen in tab. 5 and diagram 1, almost 80% of the respondents did not have any contact with active packaging or they do not know whether they had it. Only 22% of the respondents know what the active packaging is.

Meaning of active packaging

In this part of the questionnaire, the respondents indicated the properties of active packaging which, in their opinion, are most important. Only those persons who marked a positive answer in the previous question could answer this question. The answers have been given in tab. 6 and diagram 2.

Table 6. Presentation of the respondents' answer to the question: "Which aspects of active packaging are important for you?"

Prolongation of shelf- life of the product	9
Improvement of the product's quality	10
Separation of the product from the environment	12
Safety of active packaging	11
Improvement of sensory properties of the product	5

Fig. 2. Presentation of the respondents' answer to the question: " Which aspects of active packaging are important for you?" in a form of columns

In the opinion of the Respondents, the most important aspect is whether active packaging is able to separate the product from the environment and whether it is safe for the consumers. The improvement of sensory properties occurred to be least significant for the consumers.

Knowledge of the term "intelligent packaging"

The questionnaire contained the question concerning the awareness of the respondents in respect of intelligent packaging. The results are given in tab.7 and circular diagram 3.

Table 7. Presentation of the respondents' answers to the question: "Do you know the term "intelligent packaging?" in figures

YES	28
NO	62
I DO NOT KNOW	10

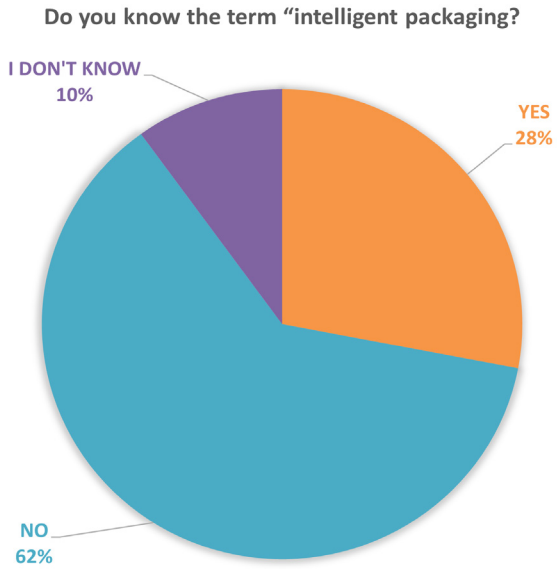

Fig. 3. Presentation of the respondents' answers to the question: "Do you know the term "intelligent packaging?" in %

As it can be seen in tab. 7 and fig. 3, almost 80% of the respondents did not have any contact with the intelligent packaging or they do not know whether they had it. Only 22% of the respondents know what the active packaging is.

Meaning of intelligent packaging

In this part of the questionnaire, the respondents indicated the properties of intelligent packaging which, in their opinion, are most important. Only those persons who marked a positive answer in the previous question could answer this question. The answers have been given in tab. 8 and diagram 4.

Table 8. Presentation of the respondents' answer to the question: "Which aspects of intelligent packaging are important for you?"

Control of suitbaility of the product to use	22
Safety of intelligent packaging	16
Temperature of the product	10
Control of tightness of the packaging	11
Other	1

Fig. 4. Presentation of the respondents' answer to the question: "Which aspects of intelligent packaging are important for you?"

According to the results submitted in diagram 4, it is most important for the respondents that the intelligent packaging could indicate whether a given product is suitable for consumption. Indication of the product's temperature is the least significant aspect.

The most suitable types of packaging for food products

In the successive part of the questionnaire, the respondents indicated the types of packaging for food products which suited them best. The question was not obligatory; therefore, not every respondent answered it. It was dictated by the fact that not everyone uses the submitted types of packaging. The answers of the respondents have been shown in tab. 9 and diagram 5.

Table 9. Presentation of the respondents' answer to the question: "Which types of food packaging suit you best?", as expressed in figures

Type of packaging	Number of respondents	Mean score evaluation
Bags	96	3.63
Tubes	79	3.02
Cardboard packaging	91	4.11
Bottles	89	3.54
Containers	87	2.76
Cans	86	3.67
Jars	82	3.98

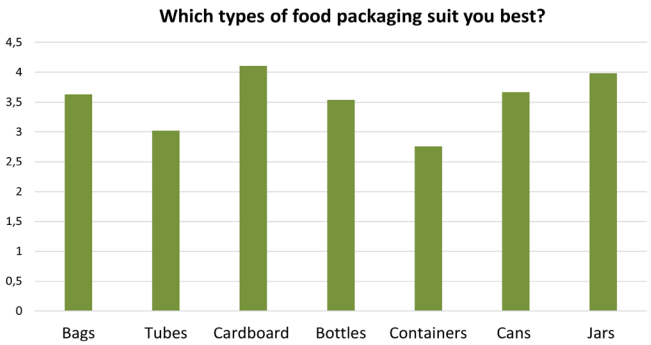

Fig. 5. Presentation of the respondents' answer to the question: "Which types of food packaging suit you best?", as expressed in columns

Summary

The respondents preferred the most cardboard packaging and jars as type of food packaging. The least preferred were containers, especially the thermoformed ones, for example for packing of cake. Apart from the submitted types of food packaging, there were suggestions of using returnable glass bottles, Ziploc bags, and paper bags, and of creating the packaging by wrapping the product with aluminium foil of breakfast paper.

For the users of food packaging, the most important aspects include convenience of use and readability of information. The mentioned aspects were highest rated by the majority of the respondents. What surprising, the eco-friendliness and graphic outlay of the packaging were least significant. The cardboard packaging and jars were the types which suited best the responders. The containers for food are the least popular type of package. Perhaps it results from the fact that it is easy to open them and often their contents get outside. The examples include cake or small fragile cakes, packed in thermoformed container. Besides it, they cannot be crushed by any heavy object as they may crack. A very high percentage of the respondents do not know the terms "active packaging" and "intelligent packaging". The most important aspect of active packaging was the ability to separate the food product from the environment and the safety of the consumer. The improvement of sensory properties of the product occurred to be least significant aspect of active packaging. In the case of intelligent packaging, the most desirable properties consisted in the indication whether a given product is suitable for consumption and least one includes indication of the product's temperature in the packaging.

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