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ECOLOGICAL PACKAGING OF THE PRODUCTS OF BAKERY AND CONFECTIONARY INDUSTRY: TECHNOLOGICAL CONSIDERATIONS AND TECHNICAL REGULATION

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Annotation. *Purpose of the study. Scientific substantiation for the use of edible coatings and biodegradable packaging materials, in particular bioplastics, for packaging various types of products in the bakery and confectionary industry. Methods. To carry out the research, a systematic approach to researching factual materials, in particular, scientific and scientific-practical literature, normative legal acts, normative documents, and the like; an abstract-logical approach to the generalization of research results and the formulation of conclusions were used. Research results. Nowadays, edible packaging coatings, biodegradable plastics, and bio-based materials obtained from renewable resources that can be used for a number of food products with a limited shelf life are in practice for packaging bakery and confectionery products. Bio-based materials shall protect products from environmental influences and ensure the preservation of quality during transportation and storage. Critical aspects are mechanical and barrier properties for oxygen, carbon dioxide, water, light and odors. In addition, safety aspects (migration, microbial growth), resistance (heat and chemical) and technological requirements should be taken into account when choosing packaging materials for foods. Now domestic regulatory documents do not contain any norms establishing the rules for ecological packaging (materials, technologies, etc.). To eliminate this discrepancy, guideline has been developed for modifying regulatory documents of various levels, namely, adding rules and requirements for biological packaging of bakery and confectionary products. Conclusions. The developed "Guideline for ecological packaging of bakery and confectionery products" covers the biological and technical basics of ecological biodegradable and edible packaging of*

these goods, as well as promising materials and methods used for the purpose. This Guideline provides guidance on the changes that the standards and specifications must undergo to accommodate regulatory requirements for sustainable packaging of bakery and confectionery products.

Keywords: *biodegradable materials, edible coatings, ecological packaging, biopolymers, bakery products, confectionery products, ecological packaging.*

General formulation of the problem and connection with the most important scientific and practical issues. An important task for food specialists and scientists is to justify, taking into account economic and biological aspects, the needs of consumers in tasty, nutritious and healthy food products. Important, in this sense, is such a technological operation in the production of food products as their packaging, which guarantees the safety and quality of products during the shelf life determined by scientific research and introduced by the regulatory documents in force.

Packaging is the placement of one or more primary packaged food products in another packaging (container), and the primary packaging is packaging of food products in any wrapper or packaging (container), directly in contact with the food product. This definition is contained in the current Law of Ukraine "On basic principles and requirements for food safety and quality", introduced in accordance with [1]. The said Law of Ukraine also states that market operators in the implementation of food packaging, including primary packaging, must ensure compliance with the following requirements: materials used for packaging, including primary packaging, must not be a source of pollution; materials for primary packaging are stored in a manner that makes it impossible for them to be contaminated; packaging, including primary packaging, is carried out in a way that excludes contamination of products and the integrity of the package.

The modern way of living leads to a steady demand for high-quality ready-made food products with a long shelf life, which leads to an increase in anthropogenic load on the environment through an enormous growth in the number of packages, the vast majority of which are made from non-biodegradable polymers. To help in solving this problem can and should be advisable to replace non-biodegradable, usually made from polymers of petrochemical origin, packaging materials with edible coatings-packaging and bioplastics – biodegradable and compostable materials [2].

Analysis of the latest research and publications. Widely spread biodegradable packaging are classified into the following three groups [2–4]:

– plant polymers used alone or in a mixture with biodegradable synthetic polymers;

– microbial polymers obtained by fermentation of agricultural raw materials used as a substrate. Among these polymers, polyhydroxyalkanoates or PHA are also distinguished, the most well known of which is PHBV (polyhydroxybutyrate-co-valerate);

– monomers or oligomers, polymerized by conventional chemical processes and obtained by fermentation of agricultural raw materials used as a substrate. Among the materials in this category, the most well known one is polylactide (PLA).

Another classification [5] embraces also the fourth class of biodegradable packaging:

– products obtained by synthesis from petrochemical raw materials. These are several polymers or subgroups: polycaprolactone (PCL) polyetheramides (PEA) aliphatic copolyester such as polybutylene succinate adipate (PBSA) aromatic copolyester such as polybutylene adipate coterephthalate (PBAT).

Types of biodegradable polymers and of the raw materials used for their production are shown in Fig. 1.

Biodegradable materials used for food packaging are made from proteins – both of plant (soy, corn, wheat, peas, etc.) and animal (casein, collagen, whey, keratin, gelatin, etc.) origin [7–9]. Biodegradable polymers PCL and PLA are the most widespread on the market, second only to starch composites [10]. Despite numerous negative traits, starch has been the most widely spread raw material for biodegradable polymers as its composites appear to show satisfactory technological characteristics [13, 14]. However, starch is rather to demonstrate thermoplasticity at high temperatures and shear stress values [15].

So, to sum up the issues outlined above, proper materials shall be sought and found these being biodegradable and sturdy enough for packaging bread and confectionary products. Herewith adequate ways to lay down requirements for such materials and corresponding packaging items shall be developed.

Formation of the goals of the article. So, the purpose of the article is to analyze possible and feasible options for the use of ecological packaging materials in relation to food, in particular bakery and confectionery products. Also, the tasks of the article include the development of proposals for setting out the requirements for environmental (edible and biodegradable) packaging of bakery and confectionery products in regulatory documents: national standards of Ukraine, specifications and standards of enterprises. In particular, an important practical task is to draw up an algorithm for modifying existing regulatory documents to properly take into account the environmental requirements for packaging.

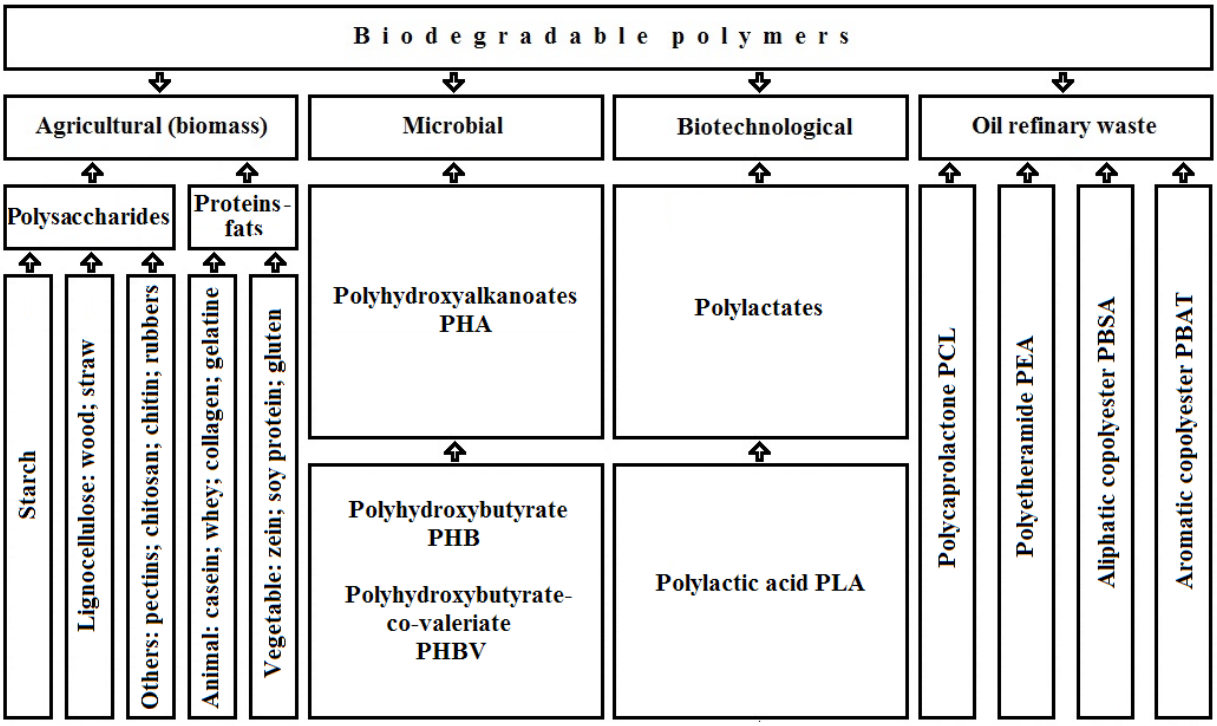

Fig. 1. Nomenclature of biodegradable polymers – adopted from [2, 5, 6]

Presentation of the main research material. To begin with ecological packages for bakery and confectionary products edible films and coatings shall be mentioned these extending the shelf life of perishable and / or minimally processed food products. Proper mechanical and barrier properties of the said films and coatings depend on the properties of all components [16], and their composition can include various polymers, for example, proteins (gelatin, casein, wheat gluten, zein), polysaccharides (starch, pectin, cellulose, alginate, carrageenan) and lipids (stearic acid, waxes and fatty acid esters) [16–18]. An edible film or coating being consumed with the product, its properties and composition must meet the requirements established for foods. Such films and coatings can contain one or more components in dry, wet, single or multi-layer form. To use such materials in the manufacturing process of foods, all the components should be analyzed taking into account their chemical, physical and biochemical properties, such as: water content, pH, chemical composition, storage requirements, etc. [19]. More detailed characteristic of the edible films and coatings of foods can be found in [2].

As well as for dairy products [20, 21], the biodegradable packaging materials to be used in bakery and confectionary production must protect a product from environmental influences and ensure the preservation of quality during transportation and storage. In the case, mechanical and barrier properties for oxygen, carbon dioxide, water, light and odors, safety aspects (migration, microbial growth), resistance (heat resistance and chemical), technological requirements (suitability for welding and forming), convenience and compliance with marketing principles (communication, printing options) shall be considered [2].

For bakery and confectionary products it is essential that mechanical properties of the packag-

ing would protect the said products even during long-term storage and transportation. Polymers can be adapted to some extent to suit certain mechanical properties, for example, by choosing raw materials or mixing with other polymers or fillers, by adding fibers, plasticizing, and the like. Sufficient mechanical properties are typical for PLA in semi-crystalline form. There are various processing parameters that can be varied to obtain certain mechanical properties of biopolymers equal to the properties of conventional oil-based polymers, such as rigid (polyethylene terephthalate, PET) and flexible materials (e.g. polyethylene, PE). The hot processing of the products as well as the hot processing packaging materials (shaping, sealing) when they are exposed to high temperatures is typical. Hover, the field of thermal application of biological packaging materials will be relatively limited, as their stability decreases with increasing temperature, as was observed for PLA especially when exposed to high humidity. Food ontainers made of PLA remain stable only up to 55 °C, while materials based on starch-PCL mixtures – between 60 and 90 °C [5, 20, 22].

The coatings act as barriers to water loss and gas exchange while controlling the transfer of moisture, oxygen, lipids and flavor components (Fig. 2) with an effect similar to the effect contributing to the preservation of properties under controlled conditions or in a modified atmosphere [15, 16].

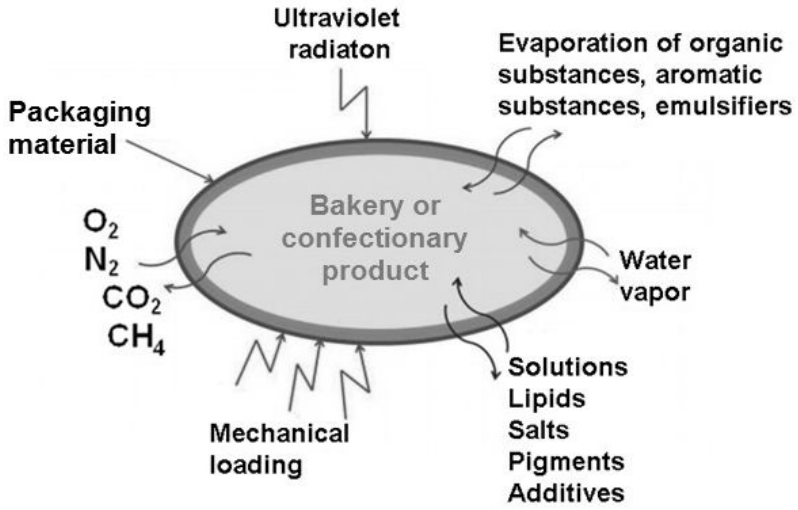

Fig. 2. Factors by which biodegradable materials used for packaging bakery and confectionary products shall have barrier properties [5, 23]

Sufficient water vapor barrier properties are critical in the packaging the products, where preventing moisture loss and surface drying is key. On the other hand, packaging for products with a short shelf life at low temperatures is less critical in the case. A thin layer of PE is a sufficient moisture barrier in the cartons of liquid and liquid-like products. Gas barrier properties also depend on the nature of the product. For example, high barrier properties are necessary for packaging products in a modified environment, but a less dense gas barrier is sufficient for packaging products with a short shelf life. In general, bio-based polymers are hydrophilic, but when comparing the water vapor transmission rates (WVTR) of packaging biomaterials with materials based on mineral oils, it becomes clear that biomaterials can be used for short-term storage of foods. Research and development work is now focused on improving the vapor barrier for bio-based materials, and future materials may well have vapor barrier properties similar to conventional materials [20]. Such material as PLA provides better protection against water vapor than starch based materials. In [24] it is noted that WVTR of PLA films were only 4 times more than in conventional films with polyvinylidene chloride (PVDC) and low density polyethylene LDPE, two times more than that of PS cups, and 40-60 times more than that of PE cups and polystyrene (PS). Polyhydroxyalkanoates (PHA) have low values of the WVTR, which makes these materials promising as a moisture barrier in milk cartons or butter wrappers. The oxygen transmission rates (OTR) of most biomaterials correspond

to the indicated indicator of most traditional materials based on mineral oils. Packaging films with a thickness of 20 μm based on PLA, a mixture of wheat starch and PCL, as well as a mixture of corn starch and PCL had a OTR, which was significantly lower than in LDPE and HDPE films [24]. The selectivity (level of permeability) of bio-based materials for other gases is in the range that is typical for conventional packaging materials used in the food industry. Humidity does not affect the OTR during refrigerated storage of food products. The odor barrier is an important characteristic for the most of foods. Unfortunately, there are practically no data on the permeability of aroma. Experiments have shown, however, that PLA is an effective barrier to ethyl acetate and D-limonene, and thus is expected to be a good barrier to odors [25].

The effects of oils and acids on packaging materials can reduce the effectiveness of the polymer. Food products are often acidic, salty or high in fat, it is important to evaluate the chemical resistance of the materials. When comparing oriented film of PLA (OPLA) with PET and oriented polystyrene (OPS), it was found that exposure to acids (pH 6 to 2) and vegetable oils resulted in only minimal deterioration in strength, but addition of 40 % of secondary raw materials, in fact, showed an improvement of [26].

Microorganisms can use bio-based packaging materials as energy sources. This can pose a potential risk of unwanted mold and bacteria growth on the packaging, and if the packaging degrades during storage of food, external microbial migration may occur, leading to food contamination. There are only a few reports of an increase in the number of microorganisms on bio-based packaging materials. Films with PLA and PHB prevent the appearance of molds [27], but packaging materials based on starch-PCL promote the growth of mold fungi that can affect food products – therefore it is advisable to include antimicrobial compounds in the material.

In the sense of food packaging, “migration” term is used as a definition of the transfer of packaging substances to the products, which is an important aspect that should be considered when using packaging materials. According to European Union standards, the total migration should not exceed the limit of 10 mg/dm^2. Migrants from bio-packaging materials can include, for example, lactic acid, linear and cyclic dimer of lactide, various PLA oligomers, food and hydrolyzed starch. These migrants can be found naturally in food and therefore can be considered safe for food packaging purposes. According to EU legislation, the categories lactide, food and hydrolyzed starch and PHB (polyhydroxybutyrate) are used without any special restrictions.

During biodegradation, enzymes hydrolytically decompose polymers. PLA hydrolyzes without any help from hydrolytic enzymes in the presence of moisture. In addition to moisture (water activity), such parameters as pH, available nutrients, oxygen, storage and temperature are also important for the biodegradation process.

The general principles of packaging bakery and confectionery products do not differ from those for food products of other groups, however, the products of the bakery and confectionery industry have certain features associated with the technical and technological characteristics of the food masses used for their manufacture [28]. A number of bakery and confectionery products contain perishable ingredients that affect the overall shelf life of the product. This fully applies to the biodegradable plastics used in these sectors of the food industry. Based on the above, for perishable bakery products, it is possible to recommend biopolymer packaging materials based on PLA (the most practical material), PHA and polyglycolide (PGL), multilayer films with the use of these materials, paper-polymer packaging, shipping containers using chitosan. This group includes such products as bakery products, short-term storage – general purpose and produced for special nutrition (dietary, health-improving, therapeutic). Among confectionery products, a number of flour products, as well as confectionery products with cream and fillings, their semi-finished products, and the like belong to products of short storage. Another group of confectionery products of non-durable storage are confectionery and culinary flour products of a high degree of readiness and dough, in particular, quick-frozen semi-finished products.

A typical recommendation for bio-packaging bakery products of low humidity and long-term storage is the use of films with PHA – for long-term storage (better barrier properties), in economically and technically justified cases – natural materials for shipping containers with the use of chitosan. The specified group of bakery products consists of crispy bread, crackers, croutons and

similar products; matzo; unleavened bread for communion; cachets suitable for pharmaceutical use; sealing wafers; rice paper and the like.

For groups of confectionery flour products such as gingerbread; butter biscuits and wafers, fully or partially covered with chocolate or other mixtures, containing cocoa; butter biscuits (in particular biscuits with a filling), except for fully or partially covered with chocolate or other mixtures, with a cocoa content and wafers with a water content of more than 10 % (by mass) of the finished product (except for ice cream cones, waffles with a layer, other similar products); wafers, except for completely or partially covered with chocolate or other mixtures containing cocoa, it is possible to recommend bio-packaging based on films with PHA – for long-term storage (better barrier properties), in economically and technically justified cases – natural materials, edible coating based on proteins, fats and polysaccharides, as well as shipping containers using chitosan. The specified bio-packaging is acceptable (in certain cases, except for edible packaging-coatings) also for such groups of products as extruded cookies (except for those completely or partially covered with chocolate or other mixtures, containing cocoa, butter cookies, waffles and wafer wafers), spicy or salted products; bakery products (in particular pancakes, pies, casseroles, pizza), except for sandwiches, crisp bread, wafers, rusks, toasts, spicy or salted extruded products.

A large group of confectionery products, which includes chocolate and similar products, containing cocoa components, in blocks, sticks, bars weighing more than 2 kg or in liquid, pasty forms, in powdery, granular, in other bulk forms, in containers or in primary packaging weighing more than 2 kg, with a content of cocoa components of at least 18 % (by mass); crumbs of milk chocolate with a cocoa butter content of at least 18 % (by mass) and in packages weighing more than 2 kg; chocolate glaze, with a cocoa butter content of at least 18 % (by mass) and in packages weighing more than 2 kg; ready-made food products with a cocoa butter content of at least 18 % (by mass) and in packages weighing more than 2 kg (except for chocolate glaze, milk chocolate crumbs), biopackaging is allowed with the use of paper with layers of biopolymer films, multilayer films with PLA, PHA, as well as transport containers based on the material of chitosan. These types of biopackaging are also used for chocolate and ready-made food products containing cocoa products (except for sweetened cocoa powder), except for bulk products. This group includes chocolate, in blocks, sticks or bars with a filling (in particular with cream, liqueur or fruit paste), other than chocolate chip cookies; chocolate, in blocks, sticks or bars with the addition of cereals, fruits or nuts (except for chocolate with a filling, chocolate biscuits); chocolate, in blocks, sticks or bars (except for chocolate with a filling, with the addition of cereals, fruits or nuts, chocolate cookies); chocolate products with alcohol content (except for products in blocks, sticks or bars); chocolate products (except for products containing alcohol, products in blocks, bars or bars) chocolate confectionery products with filling (except for products in blocks, sticks or bars, chocolate cookies, chocolates); chocolate confectionery products (except for products with filling, in blocks, sticks or bars, chocolate biscuits, chocolates); sugar confectionery products and their substitutes made from sugar substitute products containing cocoa components (in particular, chocolate nougat), except for white chocolate; chocolate pastes; finished products, containing cocoa products, for making drinks; food products containing cocoa components (except for cocoa liquor, cocoa butter, cocoa powder, products in blocks, sticks, bars, liquid, pasty, powdery, granular, in other non-standard forms, in packages of at least 2 kg, products for making drinks, chocolate spreads).

Sugar confectionery products (in particular white chocolate), without cocoa powder and cocoa liquor, cover such product groups as chewing gum; cakes with liquorice extract; blocks, sticks and lozenges with a sucrose content of more than 10% (by mass); but without the contents of any other substance; white chocolate; confectionery pastes, sugar pastes, in primary packages with a net weight of at least 1 kg (in particular marzipan, fondant, nougat and almond paste) lozenges for sore throat and cough drops, which mainly contain sugar and flavorings (except for lozenges and drops containing flavors with medicinal properties) candied products (dragees), including candied almonds; chewy candies; fruit jellies and fruit pastes as sugar products (excluding chewing gum); hard candy; iris; caramels and similar sweets; compressed tablets from sugar confectionery (in particular, breath freshening tablets). For products of the indicated groups belonging to perishable, it is possible to recommend bio-

polymer packaging materials based on PLA (the most practical material), PHA and PGL, multilayer films with the use of these materials, paper-polymer packaging, and for long-term storage products – paper with layers of biopolymer films , multilayer films with PLA, PHA. For all confectionery sugar confectionary products (in particular, white chocolate) without the contents of cocoa powder and cocoa liquor, it is acceptable to use transport containers based on chitosan.

Now in Ukraine, the harmonization of directives and other normative documents of the European Union on packaging and packaging waste is being carried out at an accelerated pace, in particular, on reducing the use of thin plastic bags. Legislators have prepared a number of draft laws of Ukraine regarding the implementation of these European requirements. We hope that soon there will be radical changes in the use of packaging materials in domestic practice. In particular, it is planned to introduce regulatory restrictions on the use of plastic bags, in addition to biodegradable plastic and ultralight ones, to determine the requirements for biodegradable plastic bags, as well as their labeling [29].

Unfortunately, domestic normative documents of different levels, which in detail regulate general technical conditions or technical conditions for the production of food products, in particular their packaging, do not contain any norms establishing the rules of ecological packaging (materials, technologies, etc.). To eliminate this discrepancy, researchers of the Institute of Food Resources of the NAAS performed a series of works, the results of which made it possible to draw up practical recommendations for modifying regulatory documents of various levels, namely, adding rules and requirements for biological packaging. In particular, such recommendations have been formulated regarding the packaging of dairy products.

Taking the above information and the rules of the National Standardization of Ukraine in force we have developed "Guideline on the ecological packaging of bakery and confectionary products" (hereafter – Guideline). It postulates the following. When it is necessary to modify national standards in order to attract the requirements of ecological packaging of bakery and confectionary products by developing amendments to national standards, or reviewing national standards in the manner specified by DSTU 1.2:2015 "National Standardization. Rules of works on national standardization" [30]. Specific requirements for the presentation and modification of regulatory texts are established by the fundamental national standard DSTU 1.5:2015 "National Standardization. Rules of development, formulation and presentation of national normative documents" [31], therefore, it is necessary to consistently comply with the requirements and guidelines on the content and form of the regulatory document to which the amendment is being developed, or which is being revised [32].

In the Guideline the amendment of the standards of the type of specifications or general specifications for bakery and confectionary products is recommended to be fulfilled in the manner described below.

If necessary, the component "Terms and definitions" shall be supplemented with terms and definitions of concepts in order to modify the national standard in the sense of adding to it the requirements for ecological packaging of food products:

ecological packaging

Packaging bakery and confectionary products in a manner that makes it impossible or at least minimizes the harmful effects of the packaging used and the materials used for packaging on the environment, in particular from the disposal and / or destruction of used packaging.

ecological packages

Items and materials used for the packaging bakery and confectionary products these items and products meeting the conditions of ecological packaging.

degradation

Changes in initial properties due to chemical decomposition of macromolecules that form a polymer element, regardless of the decomposition mechanism.

biodegradation

Changing the initial properties of a polymer element using a cell-mediated phenomenon.

biodegradable packages

Materials that are fully biodegradable or packaging items made from such materials.

food (edible) coating

A layer of edible material applied to the surface of a bakery and confectionary product for technological purposes that can be consumed with the processed product.

Other relevant terms and definitions may be also given in accordance with the objectives and content of the standards, and are being modified.

The component **"Requirements/provisions for the object of standardization"**, in the sense of compliance with the requirements of ecological packaging, should be supplemented with requirements and provisions for:

– a specific nomenclature of bakery and confectionary products that can / should be packed using ecological packaging;

– physical, chemical, structural and mechanical and other relevant parameters of bakery and confectionary products, which are subject to the standards for environmental packaging;

– terms, temperature and humidity and other relevant parameters of storage of bakery and confectionary products, packaged with the use of ecological packaging;

– conditions for the transportation and sale of bakery and confectionary products packed with the use of ecological packaging;

– other relevant parameters.

The above requirements, in addition to the structural element **"Requirements/provisions for the object of standardization"**, shall also be specified in the structural elements **"Packaging"**, **"Transportation and storage rules"**, **"Control methods"** and **"Acceptance rules"**.

The structural element **"Packaging"** shall be supplemented with provisions on the procedure for packaging a bakery and confectionary product using ecological packaging and contain the following norms:

– a nomenclature of possible ways of ecological packaging;

– the range of materials and packaging products used for ecological packaging;

– technical and technological requirements for the process of ecological packaging;

– other relevant parameters.

The Guideline is supplemented with the Annex A, where the methods of ecological packaging of bakery and confectionary products are listed. This information can be used by the specialists implementing the norms for ecological packaging of bakery and confectionary products in standards and specifications. The heading and a fragment of the said Annex is shown in Fig. 3.

ANNEX A. Appropriate methods of ecological packaging of bakery and confectionary products, as well as materials used for these purposes

Group 10.7 Bakery, pasta, confectionery and culinary products, flour products in accordance with DK 016: 2010 "State classifier of products and services"		Methods of ecological packaging of bakery and confectionery products, materials used
Code	Designation	
1	2	3
10.71	Bakery, confectionery and culinary products, short-term storage	
10.71.11	Bakery products, short-term storage	
10.71.11-00.10	Bakery products, short-term storage, for special nutrition (dietary, health-improving, prophylactic)	Biopolymer packaging materials based on PLA (the most practical material), PHA and PCL, multilayer films with the use of these materials, paper-polymer packaging, transport container with the use of chitosan
10.71.11-00.90	Bakery products, short-term storage, others	
10.71.12	Confectionery and culinary products, flour, short-term storage; confectionery products with cream and fillings and their semi-finished products	
10.71.12-00.10	Confectionery and culinary products, flour, with cream and fillings	Biopolymer packaging materials based on PLA (the most practical material), PHA and PCL, multilayer film[illegible] of these

Fig. 3. Fragment of the appropriate methods list of ecological packaging of bakery and confectionary products – an annex to "Guideline on the ecological packaging of bakery and confectionary products"

The Law of Ukraine "On standardization" [33], in addition to national standards, also provides for the development and implementation of *enterprise standards*, the said process being carried out legally according to the norms, introduced by the enterprises themselves. In general, in order to implement the requirements of ecological food packaging, standards of this level should be used according to the rules and methodological techniques used for national level standards.

The Law of Ukraine [33], in addition to standards, also provides for the possibility of developing and putting into effect *specifications*, which is carried out on the same principles as the enterprise standards. In general, to bring food safety requirements into the specified regulatory documents one should adopt the rules and methodological techniques used for national standards. A useful source of information on operating with normative texts of documents at the level of specifications is DSTU 1.3:2004 "National standardization. Rules for the construction, presentation, execution, approval, acceptance and designation of technical conditions" [34] (canceled due to a change in the domestic concept of technical regulation), as well as the draft guideline DSTU-N 1.3:2015 "National Standardization. Guidelines. Specifications of Ukraine. Guidelines on the development" [35]. The standard of the level of the organization standard of Ukraine (SOU) was developed by the SE "Ukrmetrteststandart" – this is SOU KZPS 74.9-02568182-003:2016 "Specifications of Ukraine. Recommendations for a typical construction, presentation of design, designation, adoption and implementation" [36], which provides methodological recommendations for the development, construction, presentation, design, designation of technical specifications for products, processes, services, as well as on the provision of their force, check, revise, amend and cancel.

Conclusions on these problems and prospects for further research in this direction. A proper solution to the crucial environmental problem of the food industry, particularly of bakery / confectionary industry, a significant increase in the volume of used packaging, can be facilitated by the widespread use of biodegradable packaging made from bioplastics. Bio-based materials shall protect bakery and confectionary products from environmental influences and maintain quality during transport and storage. Critical, in this sense, are the mechanical and barrier properties of oxygen, carbon dioxide, water, light and odor stability (thermal and chemical), technological requirements. Such bioplastics as PLA and starch-PCL fully meet these criteria, but the mechanical strength and stability of natural starch do not always meet the packaging requirements.

The developed "Guideline on the ecological packaging of bakery and confectionery products" covers the biological and technical basics of ecological biodegradable and edible packaging of these products, as well as promising materials and methods used for this purpose. The said Guideline provides recommendations on the necessary and appropriate changes that should be made to the National Standards of Ukraine, enterprise standards and documents of the level of specifications for taking the regulatory requirements for environmental packaging of bakery and confectionery products into account.

As the next step in implementing norms for ecological packaging of food products, incl. bakery and confectionary, developing specialized normative documents these entirely focused on the issues of ecological packaging can be recommended.

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Анотація. *Мета дослідження. Наукове обґрунтування використання їстівних покриттів і біорозкладних пакувальних матеріалів, зокрема біопластиків, для пакування різних видів продукції хлібопекарської та кондитерської промисловості. Методи. Для виконання досліджень використовували системний підхід до досліджень фактологічних матеріалів, зокрема наукової та науково-практичної літератури, нормативно-правових актів, нормативних документів тощо, абстрактно-логічний підхід щодо узагальнення результатів дослідження та формулювання висновків. Результати дослідження. Наразі в практиці пакування хлібобулочних і кондитерських продуктів застосовують їстівні покриття-пакування, біорозкладні пластмаси, а також матеріали на біологічній основі, отримані з поновлюваних ресурсів, що можуть використовуватися для низки харчових продуктів з обмеженим терміном придатності. Матеріали на біологічній основі повинні захищати продукт від впливу довкілля та забезпечувати збереження якості під час транспортування та зберігання. Критичними аспектами є механічні та бар'єрні властивості щодо кисню, вуглекислого газу, води, світла та запахів. Крім того, під час вибору пакувальних матеріалів для харчових продуктів слід враховувати аспекти безпеки (міграція, ріст мікробів), стійкість (термостійкість і хімічна) та технологічні вимоги. Наразі вітчизняні нормативні документи не містять жодних норм, що встановлюють правила екологічного пакування (матеріалів, технологій та ін.). Для усунення зазначеної невідповідності розроблено настанову щодо модифікування нормативних документів різного рівня, а саме долучення правил і вимог щодо біологічного пакування продукції хлібопекарської та кондитерської промисловості. Висновки. Розроблена «Настанова з екологічного пакування хлібобулочних і кондитерських продуктів» охоплює біологічні та технічні основи екологічної біорозкладної та їстівної упаковки цих продуктів, а також перспективні матеріали та методи, що використовуються з цією метою. У зазначеній Настанові містяться рекомендації щодо змін, яких повинні зазнати стандарти та технічні умови для врахування нормативних вимог до екологічного пакування хлібобулочних і кондитерських продуктів.*

Ключові слова: *біорозкладні матеріали, їстівні покриття, екологічні пакування, біополімери, хлібобулочні вироби, кондитерські вироби, екологічне пакування.*

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Анотация. *Цель исследования. Научное обоснование использования съедобных покрытий и биоразлагаемых упаковочных материалов, в частности биопластика, для упаковки различных видов продукции хлебопекарной и кондитерской промышленности. Методы. Для выполнения исследований использовали системный подход к исследованиям фактологических материалов, в частности научной и научно-практической литературы, нормативно-правовых актов, нормативных документов и т.д., абстрактно-логический подход к обобщению результатов исследования и формулирование выводов. Результаты исследования. Сегодня на практике для упаковывания хлебобулочных и кондитерских продуктов используют съедобные покрытия-упаковки, биоразлагаемые пластмассы, а также материалы на биологической основе, полученные из возобновляемых ресурсов, которые могут применяться для ряда пищевых продуктов с ограниченным сроком годности. Материалы на биологической основе должны защищать продукт от воздействия окружающей среды и обеспечивать сохранение качества во время транспортирования и хранения. Критическими аспектами являются механические и барьерные свойства по отношению к кислороду, углекислому газу, воде, свету и запахам. Кроме того, при выборе упаковочных материалов для пищевых продуктов следует учитывать аспекты безопасности (миграция, рост микробов), устойчивость (термостойкость и химическая) и технологические требования. Сегодня отечественные нормативные документы не содержат норм, устанавливающих правила экологической упаковки (материалов, технологий и др.). Для устранения указанного несоответствия разработано руководство по модификации нормативных документов различного уровня путем добавления к ним правил и требований по биологическому упаковыванию продукции хлебопекарной и кондитерской промышленности. Выводы. Разработано «Руководство по экологическому упаковыванию хлебобулочных и кондитерских продуктов», охватывающее биологические и технические основы экологической биоразлагаемой и съедобной упаковки этих продуктов, а также перспективные материалы и методы, используемые с этой целью. В указанном Руководстве содержатся рекомендации относительно изменений, которые должны быть внесены в стандарты, и технические условия для учета нормативных требований к экологическому упаковыванию хлебобулочных и кондитерских продуктов.*

Ключевые слова: *биоразлагаемые материалы, съедобные покрытия, экологическая упаковка, биополимеры, хлебобулочные изделия, кондитерские изделия, экологическое упаковывание.*