

FOOD PACKAGING: USAGE FEATURES AND PROCESSING

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ABSTRACT. *The article deals with the peculiarities of polymer packaging for food products, as well as the possible risks that arise in the process of use and its processing.*

The Aim of the Article. *Determine the toxic substances of the packaging component composition and carry out comprehensive analytical control on the content of priority pollutants to prevent adverse effects on food products, the environment, the human body, and outline the possible risks of polymeric food packaging recycling.*

Methods and Materials. *To identify and define the levels of chemical substances and toxic elements migration from different polymeric material types and products from them. The methods of gas chromatography, high performance liquid chromatography, atomic absorption spectrophotometry, mass-spectrometry were applied using modern validated methods.*

Results and Discussion. *According to the results of the researches, it is established that a large group of chemicals gets from the polymeric packaging to the contacting media, and in some cases their number exceeds the hygienic standard – ANM (acceptable number of migration).*

The increase in the number of chemicals migrating from the packaging material, as well as the levels of content of new excipients (dyes, decomposition products, impurities) that are formed after recycling of polymeric materials, is evidenced by the results of many research works.

Conclusions. *Careful monitoring of the migration levels of toxic components from different types of packaging materials and products into contact media should be carried out to assess the risks and their negative effects on food and human health. At the legislative level, control over the processing of plastic packaging for food should also be realized, taking into account the possibility of the formation of new chemicals and toxic elements.*

Key Words: *packaging, safety, food products, risks.*

Introduction. The intensive development of the packaging materials industry requires particular attention to food packaging for its safe use, impact on the product itself, human health and the environment.

At present, it is impossible to imagine high-quality food products without the appropriate packaging, which is made from various materials by using new modern technologies.

Unfortunately, no matter how perfect the packaging could be, products over time lose their nutritional properties due to the physical, biochemical, chemical processes caused by various factors.

Recently, polymeric materials have been ranked first among other materials, their output is growing at a rate of 8–10% per year worldwide. This is due to a very wide range of properties: durability, ductility, heat resistance and more. Due to this, new possibilities of storage and

reduction of losses of food products, as well as ensuring higher consumer properties of packaged products, are emerging.

Therefore, polymer packaging is an integral part of packaged food. That is why the issue of food products' quality, their safe effect on the human body cannot be considered separately from the packaging. Its chemical composition, polymer structure, presence of functional groups, crystallinity, lyophilicity, lyophobic behavior and other determine the properties of the polymer packaging.

Aim. The interaction of the packaging material and the food product is determined by the rate of movement of gases, water vapor, moisture, low molecular weight substances from the food through the layer of packaging, into the environment. From it through the packaging to the food product, from which to the packaging material. And finally, from the packaging material to the

food. This interaction can lead to significant changes in the properties of both the food product itself and the packaging. It should also be borne in mind that the chemical constituents of food products are able to interact with the ingredients of the packaging forming other toxic chemicals.

The wide variety of food packaging materials and the wide range of food products that are packaged in these materials and products requires a particular approach to this important procedure.

Methods and Materials. In today's unfavorable environmental conditions, characterized by environmental pollution by xenobiotics, much attention is paid to increasing the barrier properties of packaging materials intended for the protection of food products. Obtaining quality nutrient-specific packaging material depends essentially on the base polymer and the auxiliaries used to create the finished packaging product. Much in demand today are multilayered materials consisting of different layers (from 5 to 15), joined by adhesives. Most barrier films that are produced are based on polyethylene terephthalate, polyester, polyamide, ethylene vinyl alcohol, polypropylene, polyethylene and more. Flexible polymeric materials have high barrier properties, mechanical, optical characteristics and are widely used for protection of food products from electromagnetic radiation, solar radiation, and thermal radiation. Such packaging protects against the penetration of gases, water vapor, used for sealing in the packaging of the smell or aroma of food products.

In many cases, different types of polyurethane adhesives are used for the lamination of multilayer packaging materials. So, recently polymeric materials that are intended for packaging chips, cookies, sauces, mayonnaise, sugar, etc., make lamination films with the help of new generation polyurethane adhesives based on isocyanates.

Two-component polyurethane adhesives of Liofol brand solvent-based and non-solvent-based are very quickly polymerized and have low isocyanate content (<1%). However, it should be noted that in Ukraine cheap adhesives for technical purposes are often used for the lamination of films, which can cause a great danger in the case of using these films for food packaging. Such films can be a source of contamination of food products with toxicants as a result of migration from the glue of aromatic diamines – products of

hydrolysis of isocyanates. Therefore, on the basis of ecological safety requirements, the question of determining the residual content of aromatic diamines in food products is extremely urgent.

It is known that the ingredients of polymeric packaging materials are diverse in their physicochemical properties, toxicity and are a large group of organic and inorganic compounds. These are aldehydes, ketones, alcohols, esters of organic acids, amines, heavy metals and their oxides and others.

The potential danger is related to the presence of technological additives and degradation products (oligomers, secondary metabolites), which are formed during the storage and exploitation of polymeric materials. Activation of this process is associated with high temperatures and long application times.

Modern technologies of packaging materials production with the use of innovative approaches do not exclude the possibility of toxic components release into objects of environment, food, drinks, negatively affecting the human body. This risk can be greatly reduced if the polymer packaging is used only for its intended purpose, adhering to the conditions of exploitation and storage.

The issue of determining the levels of migration of toxic ingredients from different types of polymeric materials and objects intended to come into contact with food products into model environments that mimic certain foods is of particular importance and relevance.

Concerning the potential danger of the packaging materials in question or the possibility of their safe use, conclusions can only be drawn from complex studies: organoleptic, sanitary-chemical, microbiological, radiological.

We have conducted studies of laminated multilayer materials (films) for the packaging of mayonnaise, milk, cheese, meat products in order to identify aromatic diamines, which are constituents of synthetic polyurethane adhesives and to assess the risk taking into account possible contamination.

In order to control the level of release of toxic components of the glue into food products, a method for determining the mass concentration of aromatic diamines (2,4-diaminotoluene (2,4-TDA); 2,6-diaminotoluene (2,6-TDA); 4,4' diaminodiphenylmethane (4,4' MDA); 2,4'-diaminodiphenylmethane (2,4'-MDA); 2,2'-diamin-

odiphenylmethane (2,2'-MDA) in migration solutions.

The content of aromatic diamines in the model solution was determined in the films immediately after their manufacture, as well as in the dynamics on the 1st, 3rd and 14th days using the method of high-performance liquid chromatography.

Results and Discussion. Studies have shown that the content of aromatic diamine in films immediately after their production exceeds the ANM 5-10 times or more. However, after 14 days after the production of films using two-component polyurethane adhesive migration was absent.

The results obtained are presented in Table.

Investigations of different types of packaging materials and products using gas (GC) and high-performance liquid chromatography (HPLC) methods, mass spectrometry, atomic absorption spectrometry have allowed us to identify a group of priority pollutants that are capable of releasing into the environment, food and negatively affect human health.

It was determined that formaldehyde, phenol, styrene, diphenylolpropane, aromatic diamines, acrylonitrile, alcohols and other toxic substances are most often migrated from the polymer packaging to the contact media. Since the level of excretion of these toxicants in some cases reaches a significant excess of the hygienic standard (ANM – acceptable number of migration), it is necessary to conduct constant analytical control of the polymer packaging.

Polymeric materials are becoming more valuable as recyclables. Therefore, the issue of obtaining high quality recyclables is of great importance. Increasing the share of recyclables in polymer products has a huge positive impact on the development of the polymer industry. In this connection, there is a question worldwide regarding the use of packaging waste for the manufacture of new packaging intended for food contact.

For processing it is necessary to use products made of polymeric materials that are allowed for contact with food.

However, it should be noted that the use of packaging waste to make new packaging intended for contact with food products can lead to an increase in the amount of chemicals migrating from the packaging material, as well as the levels of the content of other excipients (dyes, impurities and their decay products). It should be remembered that the regulatory requirements for food packaging in Europe and the USA provide the same level of safety for chemicals migrating to food, for both processed and primary materials. Acceptable levels of chemical migration in the European Union and the US are being revised towards tougher indicators.

After polymeric materials recycling according to the research results obtained from public Internet sources, the following chemicals and toxic elements were found:

- flavors from previous applications (characteristic of polyethylene terephthalate (PET));
- essential oils (characteristic of PET);
- oligomers are intentional by-products formed during the synthesis of plastics (characteristic of PET);
- acetophenone and benzaldehyde are oxygen-containing styrene derivatives that have been identified in higher relative amounts in processed than in primary polystyrene samples;
- plasticizers, antioxidants, UV absorbers (characteristic of PET, polyphenols);
- inorganic elements, most of all aluminum and iron.

The levels of inorganic elements were usually lower in recycled high-density polyethylene than in polyethylene terephthalate.

Conclusions

1. Consideration is given to the use of different types of polymeric materials for food packaging.

Table

The results obtained investigation of the packaging materials

Name of the packaging material		Content of aromatic diamines, mcg / l	ANM, mcg / l
Films™ "SOLAN"	Sample №1	19,5	2,0
	Sample №2	20,5	2,0
	Sample №3	21,1	2,0
Film for mayonnaise packaging "Rodyna"		8,4	2,0

- ing and the potential for adverse effects of chemicals and their ingredient composition on food, environmental and human health. The necessity of introducing a comprehensive approach to the determination of the content of toxic substances and elements using different methods of analysis is shown.
- In the course of the conducted researches the absence of migration of aromatic diamines from the laminated films to model solutions simulating food product was found, after 14 days after the films were made.
 - The conducted researches allowed to establish the hygienic standard of ANM of aromatic diamines in model environments and food-stuffs at the level of 2 mcg / l, mcg / kg, which was approved at the meeting of the hygiene regulation commission of the Ministry of Health of Ukraine.
 - Manufacturing and processing require a fairly stringent regulatory framework. For recycling, products made of different materials should be used that are allowed to come into contact with food, which will increase the safety of recycled materials such as paper and cardboard.
 - Operator companies need to be as informed as possible about the consequences of such decisions, to fully evaluate the risks associated with them, especially with the direct impact of packaging on human health.

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УПАКОВКА ДЛЯ ХАРЧОВИХ ПРОДУКТІВ: ОСОБЛИВОСТІ ВИКОРИСТАННЯ ТА ПЕРЕРОБКИ

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РЕЗЮМЕ. У статті розглядаються особливості полімерної упаковки для харчових продуктів, а також можливі ризики, які виникають у процесі використання та її переробки.

Мета. Визначити токсичні речовини компонентного складу упаковки та провести комплексний аналітичний контроль за вмістом пріоритетних забруднювачів, аби попередити негативний вплив на харчові продукти, об'єкти довкілля, організм людини, а також окреслити можливі ризики щодо вторинної переробки полімерної упаковки для харчових продуктів.

Методи. Для ідентифікації та встановлення рівнів міграції хімічних речовин та токсичних елементів із різних типів полімерних матеріалів та виробів з них застосовували методи газової хроматографії, високоефективної рідинної хроматографії, атомно-абсорбційної спектроскопії, мас-спектрометрії, використовуючи сучасні валідовані методики.

Результати. За результатами проведених досліджень встановлено, що із полімерної упаковки до контактуючих середовищ потрапляє велика група хімічних речовин, а в деяких випадках їх кількість перевищує гігієнічний норматив – ДКМ (допустиму кількість міграції).

Про збільшення кількості хімічних речовин, що мігрують із матеріалу упаковки, а також рівнів вмісту нових допоміжних речовин (барвників, продуктів розпаду, домішок), які утворюються після вторинної переробки полімерних матеріалів, свідчать результати багатьох дослідницьких робіт.

Висновки. Необхідно проводити ретельний контроль за рівнями міграції токсичних інгредієнтів з різних типів пакувальних матеріалів та виробів до контактуючих середовищ, щоб оцінити ризики та їх негативний вплив на харчові продукти і здоров'я людини. На законодавчому рівні також має бути здійснений контроль за переробкою полімерної упаковки для харчових продуктів, враховуючи можливість утворення нових хімічних речовин та токсичних елементів.

Ключові слова: упаковка, безпека, продукти харчування, ризики.

УПАКОВКА ДЛЯ ПИЩЕВЫХ ПРОДУКТОВ: ОСОБЕННОСТИ ИСПОЛЬЗОВАНИЯ И ПЕРЕРАБОТКИ

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РЕЗЮМЕ. В статье рассматриваются особенности использования полимерной упаковки для пищевых продуктов, возможные риски в процессе использования и переработки.

Цель. Определение токсичных веществ компонентного состава упаковки и проведение комплексного аналитического контроля за содержанием приоритетных загрязнителей с целью предупреждения негативного влияния на пищевые продукты, объекты окружающей среды, организм человека, а также обозначить проблемы риска вторичной переработки полимерной упаковки для пищевых продуктов.

Методы. Для идентификации и определения уровней миграции химических веществ и токсических элементов из разных типов полимерных материалов и изделий использовали методы газовой хроматографии, высокоэффективной жидкостной хроматографии, атомно-абсорбционной спектрометрии, масс-спектрометрии с использованием современных валидированных методик.

Результаты. По результатам проведенных исследований установлено, что из полимерной упаковки в контактирующие среды попадает большая группа химических веществ, в некоторых случаях их количество превышает гигиенический норматив (ДКМ – допустимое количество миграции). Об увеличении количества химических веществ, мигрирующих из материала упаковки, и уровнях содержания новых вспомогательных веществ (красителей, продуктов разложения, добавок), которые образуются после вторичной переработки полимерных материалов, свидетельствуют результаты исследовательских работ.

Выводы. Необходимо проводить тщательный контроль за уровнями миграции токсических ингредиентов из разных типов упаковочных материалов и изделий в контактирующие среды с целью оценки рисков и их негативного влияния на пищевые продукты и здоровье человека. На законодательном уровне также должен осуществляться контроль за переработкой полимерной упаковки для пищевых продуктов, учитывая возможность образования новых химических веществ и токсичных элементов.

Ключевые слова: упаковка, безопасность, продукты питания, риски.

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