

# EFFECTS OF FOREIGN SUBSTANCES IN FOOD PRODUCTS ON THE HUMAN BODY

## EFEITOS DAS SUBSTÂNCIAS ESTRANGEIRAS NOS PRODUTOS ALIMENTÍCIOS NO CORPO HUMANO

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### Abstract

Food additives began to be used in the industry at the end of the 19th century and have now reached their peak worldwide. In rapidly developing food technology, the use of food additives is highly significant for public nutrition. Adding food additives to products to change their appearance and taste, as well as to ensure long-term preservation without spoilage, holds special importance. Objective. The purpose of this study is to raise awareness among consumers about the production and consumption of products with E-indexed additives and to inform regulatory authorities responsible for product quality control, thereby facilitating their work in this field. Materials and Methods. This study is based on materials published in various scientific sources and online resources. The ingredients listed on the labels of locally and internationally produced food products were examined as research material. The study employed theoretical-methodological and empirical research methods. Conclusion. When studying the harmful effects of foreign substances on the human body, not only should a single food product be examined, but also the entire diet, considering the types, quantities, and effects of xenobiotics present. Special attention should be given to the frequency of consumption of a particular food product (whether it is eaten frequently or rarely). In other words, when evaluating the impact of chemical substances on the body, the overall dietary background must be taken into account.

**Keywords:** Food Safety. Food Additives. Nutrition. Xenobiotics. Human Health.

### Resumo

Os aditivos alimentares começaram a ser utilizados na indústria no final do século XIX e atingiram agora o seu pico a nível mundial. Na tecnologia alimentar em rápido desenvolvimento, a utilização de aditivos alimentares é altamente significativa para a nutrição pública. A adição de aditivos alimentares aos produtos para alterar a sua aparência e sabor, bem como para garantir uma conservação a longo prazo sem deterioração, reveste-se de especial importância. Objetivo. O objetivo deste estudo é conscientizar os consumidores sobre a produção e o consumo de produtos com aditivos indexados por E e informar as autoridades regulatórias responsáveis pelo controle de qualidade dos produtos, facilitando assim seu trabalho nessa área. Materiais e métodos. Este estudo baseia-se em materiais publicados em várias fontes científicas e recursos online. Os ingredientes listados nos rótulos de produtos alimentícios produzidos local e internacionalmente foram examinados como material de pesquisa. O estudo empregou métodos de pesquisa teórico-metodológicos e empíricos. Conclusão. Ao estudar os efeitos nocivos de substâncias estranhas no corpo humano, não se deve examinar apenas um único produto alimentício, mas também toda a dieta, considerando os tipos, quantidades e efeitos dos xenobióticos presentes. Deve-se dar atenção especial à frequência de consumo de um determinado produto alimentício (se é consumido com frequência ou raramente). Em outras palavras, ao avaliar o impacto das substâncias químicas no corpo, deve-se levar em consideração o contexto alimentar geral.



*Palavras-chave: Segurança Alimentar. Aditivos Alimentares. Nutrição. Xenobióticos. Saúde Humana.*

## 1 INTRODUCTION

One of the most important issues of our time is ensuring food safety. In addition to increasing the variety of food products, special attention is given to improving their quality indicators, nutritional value, and energy content, as well as eliminating any harmful effects on the human body.

Ensuring food safety requires increasing the production of food products and preventing food losses, as well as preserving the quality of food products from times of abundance to times of scarcity and extending their shelf life. In such cases, the use of food additives becomes inevitable [Bayram, Shahin, 2017].

In addition to various factors, environmental pollution, rapid technological advancements, and the use of chemical substances contribute to the introduction of various foreign compounds—xenobiotics—into food products during the production process [Tea Stefanac, Dijana Grgas, 2021]. The number of xenobiotics is increasing year by year. According to the World Health Organization, humanity has recently been exposed to more than 4 million xenobiotics, with 63,000 new ones entering the human body annually, two-thirds of which remain unstudied. The mechanism by which these substances, entering the body through air, water, and food, affect human health is not universally agreed upon by scientists. However, the majority of researchers attribute the increasing prevalence of oncological diseases, diabetes, gastrointestinal disorders, cardiovascular diseases, blood disorders, and other health issues to the contamination of food with chemical substances [Viktor Tutelyan, Yelena Smirnova, 2014]. This is because most foreign compounds entering the human body—particularly heavy metals, chlorinated organic compounds, nitrites, and toxic elements—are ingested through food [Evaluation of Certain Food Additives and Contaminants: Eightieth Report of the Joint FAO/WHO Expert Committee on Food Additives, 2015].

## 2 MATERIALS AND METHODS

The research was conducted using materials published in various scientific sources and internet resources. The ingredients listed on the labels of locally and internationally produced food products were analyzed as research material [EFSA Panel on Food Additives and Nutrient Sources added to Food (ANS), 2016; Nedra Karunaratne, Geethi Pamunuwa, 2017; Nils Gunnar Ilbäck, Leif Busk, 2000; Hend M. Elsherif, et al., 2023].

The study employed both theoretical-methodological and empirical research methods.

## 3 DISCUSSION OF RESULTS

Foreign substances are components that are not characteristic of food products in terms of quantity and nature but are used alongside them as part of their composition. The term "foreign" also includes secondary products formed due to transformations or interactions among food components during chemical or thermal processing. These are sometimes referred to as external products [Mine Yurttagul, Aylin Ayaz, 2012]. Based on their source of entry into the body, contaminants in food products can be divided into two main groups: 1) **Additives intentionally added to food products** – These are used to enhance the commercial appearance of the product, extend its shelf life, or improve its taste, aroma, and texture. Such substances include preservatives, colorants, antioxidants, flavoring agents, enzymes, physiologically active substances, amino acids, trace elements, and others. 2) The second category includes foreign, extraneous substances that accidentally enter food products. These substances include preparations used for the intensive development of agriculture—pesticides, herbicides, disinfectants, fungicides, insecticides, antibiotics, estrogens, etc.—as well as toxic substances resulting from industrial and household waste, and toxic compounds formed due to violations of production technology [*Fatih Gultekin, 2017*].

Contaminants enter food products in various ways:

1. During the treatment of agricultural crops and animals with chemicals to eliminate insects-pests and blood-sucking insects-facilitate harvesting, and enhance soil fertility by applying mineral fertilizers.

2. Some contaminants are added to food products to improve their appearance, taste, smell, and consistency, as well as to increase their shelf life. These include preservatives, colorants, flavor enhancers, antioxidants, antibiotics, emulsifiers, thickeners, etc. [*Msagati, Titus A.M., 2013*].
3. Some compounds enter or form in products during technological processing (such as smoking, ultraviolet and ionizing radiation, use of ultrasound, fattening of animals and poultry, and processing of plants (growth regulators)).
4. Some contaminants are natural additives in food. These may include excess amounts of trace elements (selenium, iodine, fluorine, boron, molybdenum) [*Tania Gomez Sierra, et al., 2022*].
5. Residues of cleaning and disinfecting agents, components of containers, and particles from containers and equipment can enter food products.

If any contaminant accumulates in the initial link of the "food chain," its concentration, when transferred from one link to another, for example, from plants to animals and from animals to humans, increases exponentially. The "food chain" occurs in all biological environments of ecosystems. Many substances that enter the human body over long periods, even in small quantities, can manifest as food poisoning, chronic conditions, or other negative effects.

Contaminants entering the body through food substances, known as xenobiotics, can cause a range of deficiencies, defects, and diseases in humans. This is precisely why this issue constantly concerns scientists and experts. They aim to ensure that additives in food products are derived from natural, non-toxic substances, and that the quantity of chemical contaminants from the environment is significantly reduced. However, this remains an unresolved and pressing problem.

Xenobiotics are defined as "chemical substances found in organisms or the environment, but not produced by them." Some natural chemical substances (endobiotics) can become xenobiotics when present in excessive concentrations in the environment. Xenobiotics can be found in air, soil, water, plants, animals, and humans. Foreign mixtures are classified as pesticides, pharmaceutical compounds, personal care items, illegally produced drugs, industrial products, and nuclear waste.

Most xenobiotics entering the organism through various routes are absorbed in the digestive system and then enter the liver. In the liver, they undergo biotransformation and detoxification reactions with the help of various enzymes. Even when everything

proceeds as it should, these enzymatic reactions do not always produce completely non-toxic products. Less toxic, more toxic, or completely inert end products can be formed, which may then show harmful effects in target organs. The xenobiotic itself is not dangerous, but its toxicity arises due to a complex reaction between the foreign substance and the molecular structure of the organism to which it binds [Ozgun D., Seylam Kushumler A., 2020].

Unfortunately, permitted food additives in the food industry—such as colorants, preservatives, stabilizers, etc.—are also xenobiotics. Since fragrant substances and colorants added to food products are used in very small quantities, their effects on the organism have long been overlooked. Since the idea was proposed that artificial and synthetic fragrances and colorants could be used to flavor and color food, research has started on how these substances affect the organism. It should also be noted that when studying the effects of artificial fragrances and colorants on the body, there has been no unified approach or research method regarding how these substances enter the body, in what amounts, the condition and function of the organs involved, and other related issues [Sonia Morya, Ankit Sharma, 2019].

Based on the results of various studies conducted using different methods, opinions were formed regarding the effects of individual fragrances and colorants on the organism. However, this often did not allow for the acquisition of accurate information. For example, when studying the effect of "naphthol" colorant, which was added to food products to give them a yellow color starting in 1956, no negative results were observed. However, at the international symposium held in Rome in 1956, dedicated to studying the potential of various food additives and xenobiotics to cause cancer, the negative effects of "naphthol" colorant on the organism, particularly its carcinogenic properties, were proven [Ukwo S.P., Ndaeyo N., 2022].

After the use of this colorant was banned in food production, it was replaced with the colorant "tartrazine" (E-102). In a short period, tartrazine was widely used to color many food products, such as creamy confectionery, caramel, some non-alcoholic beverages, jelly, and others. Research conducted at the time showed that tartrazine was harmless.

The amount of tartrazine used was not strictly regulated by law. However, it was later determined that tartrazine, when ingested through food, disrupts the metabolism of vitamin A in the body and significantly increases the amount of glutathione in the liver

and spleen. It is now clear that tartrazine is a highly harmful colorant, and its use has been banned [Reza Abedi Firoozjah, Milad Tavassoli, 2024].

In recent years, a lot of information has been obtained regarding the effects of ingredients used as colorants in food products on the organism. However, it is regrettable to note that the use of artificial and synthetic colorants, which are considered economically cost-effective but lack biological value and have negative effects on the organism, continues to this day.

Considering that most consumers are unaware of such ingredients added to food products, it seems appropriate to provide some information on this matter.

With the expansion of entrepreneurial activities, various types of food products from many countries around the world are entering our republic. In the past, each of these ingredients had long names. However, since it was difficult to adapt them to product descriptions and place them on labels, it was decided to mark them with numbers indicating their category. This system was first implemented by the European Union, where the letter "E" representing Europe was added. Over time, other countries adopted this labeling system, making it international. For example, indices such as E 103, E 211, E 213, E 214, E 330, E 400, etc., indicate the type of ingredients added to food products. Debates about these ingredients and their use have been raised in Russia since 1993. However, in our republic, attention to this issue began only in 1997. Interestingly, many food products containing these ingredients, when consumed regularly, cause persistent symptoms such as dizziness, headaches, digestive disorders, liver diseases, and so on. In many civilized countries, people refuse to buy products with such indices on the label [Seren Baydan, Aybuke Ceyhun Sezgin, 2021].

So, what do these indices indicate? The World Health Organization (WHO), with members from over 170 countries, specifies the use of such indices as food additives to ensure the proper preservation of food products, maintain their nutritional properties, and improve their appearance.

Table 1: Groups of Food Additives.

<b>№</b>	<b>Contaminants</b>	<b>Characteristics</b>	<b>E-code</b>
1	E1 - Colorants	Gives products a rich color.	E 100-182
2	E2 - Preservatives	Prevents the growth of microorganisms and fungi, extends shelf life.	E 200-299
3	E3 - Antioxidants	Slows oxidation, extends shelf life.	E 300-399
4	E4 - Stabilizers	Maintains the volume and appearance of the product.	E 400-499

5	E5 - Emulsifiers	Preserves the structure of the product.	E 500-599
6	E6 - Flavor and fragrance enhancers	Gives products specific taste and fragrance.	E 600-699
7	E7 - Other additives	For example, antibiotics, bread quality enhancers.	E 700-....

Source: Authors

Some food additives have an even more harmful effect on the human organism. It is acceptable to consume food products containing harmful food additives as long as the amount does not exceed the established limit. However, when a person consumes food with large amounts of additives daily or even several times a day, the situation becomes particularly dangerous. According to the World Health Organization, the unlimited use of food additives can lead to serious consequences and harm health [Eroghlu, E. I., & Ayaz, A., 2018].

- ✓ **Monosodium glutamate (E621) in chips** – Flavor enhancer. **Side effects:** Reduced sensitivity of taste buds, gastritis, development of stomach and duodenal ulcers.
- ✓ **Aspartame (E951) in soft drinks** – Sweetener. **Side effects:** Headaches, allergies, sleep disturbances, and a depressed mental state. The phenylalanine in aspartame disrupts chemical processes in the brain, affecting the nervous system and human hormonal levels.
- ✓ **Soy lecithin (E322) in many types of chocolate** – Used to thicken and add viscosity to the product. **Side effects:** Endocrine system disruption, metabolic disorders, liver and kidney enlargement.
- ✓ **Tartrazine (E102) in ice cream, confectionery products, drinks, jams, juices, and chewing gum** – Coloring agent. **Side effects:** Allergies, deterioration of brain function.
- ✓ **Phosphoric acid (E338) in canned goods, marinades, cheeses, jelly, and pickles** – Acidulant and stabilizer. **Side effects:** Disruption of the body's acid-base balance, leading to increased acidity.
- ✓ **Sorbitol (E420) in candies, desserts, marmalades, and jelly** – Emulsifier and sweetener. **Side effects:** Visual disturbances, diabetic retinopathy, gastrointestinal disorders, and flatulence. The use of sorbitol in infant food production is prohibited.

The application of such additives to food products is authorized by the Food Commission of the UN and the Joint Expert Committee on Food Additives (JECFA) of

the World Health Organization. This committee, abbreviated as "JECFA," operates within the framework of the European Union as well.

The committee determines the allowable doses of food additives that can be safely consumed daily by humans, based on experimental results conducted on animals. These are established by reducing the amounts of substances deemed harmless after these tests.

According to the decision No. 42, dated March 5, 2024, from the Collegium of the Food Safety Agency of the Republic of Azerbaijan, "Sanitary Norms and Regulations on Food Additives" have been approved. The regulations set the list of authorized food additives in food products, specify the conditions for their use in food products, food additives, food enzymes, and flavoring agents, and establish requirements for their labeling. This is done to ensure the protection of public health, consumer interests, and rights [*Sanitary Norms and Rules on Food Additives, 2024*].

The food additives that are authorized for use are added to food products in very small amounts. This is sufficient to achieve the desired result in the technological process. Typically, the dosage and names of the additives are not listed on the label due to limited space, and the names of the substances are often too long. Therefore, each additive is assigned a corresponding numerical "E" code on the label.

As mentioned earlier, there are thousands of known food additives today. However, not all of them are used equally in different countries. For example, some additives used in the United States are not used in Europe and vice versa. In Russia, nearly 300 food additives are used.

Considering the wide variety and the different mechanisms through which they affect the human organism, food additives can be classified into the following four groups: Group 1: Those that are carcinogenic and can induce the formation of malignant tumors. Group 2: Those that cause diseases in the digestive system, especially in the stomach and intestines. Group 3: Those that cause allergies. Group 4: Those that cause kidney and liver diseases [*Desta Dugassa Fufa, 2023; Baygut, H., & Bilici, S. 2022*].

Antioxidants and preservatives are considered the most harmful additives worldwide. Their excessive and prolonged consumption can lead to cancer. They often contribute to mutations and the development of chronic diseases affecting various organs and systems. For example, xylitol (E968) negatively affects health. Research has shown that when regularly consumed for six months or more, it has a detrimental effect on the

liver. Among food colorants, E123 and E121 are considered the most harmful additives, frequently used to color ice cream and sweet carbonated drinks.

In recent years, significant research has been conducted on the effects of antioxidants, preservatives, and other chemical substances used in the production, storage, and transportation of food products. It has been determined that xenobiotics present in food differ in their time and rate of impact on the body. Some xenobiotics in food start affecting the body immediately upon ingestion, while others exert their effects after a certain period [Shodiyev, D.A., & Najmitdinova, G.K., 2021; Shodiyev, D.A., & Najmitdinova, 2019].

The pesticide “Benlout,” used to combat various diseases in the cultivation of apples, grapes, cucumbers, beets, tomatoes, and cereal crops, does not cause noticeable changes in the body for six months after ingestion. However, after six months, it significantly weakens the activity of acetylcholinesterase in the gonads and liver, and after eleven months, it markedly reduces the activity of the key enzyme glucose-6-phosphate dehydrogenase.

Most xenobiotics present in food directly exert harmful effects on the body [Sezgin, A.C., & Ayyıldız, S., 2019; Sena Yaren Sarıcan, et al., 2024]. However, some xenobiotics become harmful only after undergoing secondary, tertiary, or subsequent transformations through reactions with other substances. For instance, the xenobiotic 2-naphthylamine itself is not carcinogenic and does not induce tumor formation. However, its metabolites, 2-amino-1-naphthol, can cause cancer in the bladder, abdominal region, and subcutaneous tissues. Another metabolite of 2-naphthylamine, 2-naphthylhydroxylate, also exhibits similar carcinogenic effects [S.M. Bilash, et al., 2024; Peter Pressman, et al., 2017].

The xenobiotic “Sevin,” commonly found in agricultural food products, also affects future generations. Research has shown that when 2 mg/kg of Sevin enters the body, no changes occur in the first and second generations. However, in the third generation, 4% of newborns die within the same month, increasing to 10% in the fourth generation and 18% in the fifth generation. While no noticeable changes in lifespan or tissue mobility are observed in the first generation, the lifespan shortens, and tissue mobility significantly weakens in the second, third, and fourth generations.

Most scientific studies on the effects of xenobiotics in food focus on the impact of a single xenobiotic in a given product [Donchenko, L.V., & Nadykta, V.D., 2019].

However, food products may contain multiple xenobiotics at the same time. In such cases, the combined effects of these compounds on the body will undoubtedly differ from the impact of each substance individually.

#### 4 CONCLUSION

When studying the harmful effects of contaminants on the human body, it is essential to consider not only a single food product but also the types, amounts, and effects of xenobiotics present in all foods included in the diet. Special attention should be given to the frequency of consumption of a particular food item (whether it is eaten frequently or rarely). In other words, the overall dietary background must be taken into account when assessing the impact of chemical substances on the body [*Kurbanov, N.G., Musaev, N.Kh., 2015; Pogožheva, A.V., & Smirnova, E.A. 2020*].

Particular importance should be given to understanding the metabolic transformations of chemical substances used in agriculture and the food industry that enter food products. This is crucial because, ultimately, the body absorbs these metabolic byproducts.

It should be noted that during the production, storage, transportation, sale, and thermal processing of food in the kitchen, multiple chemical substances may enter the product, and it may also be exposed to various physical processes. In our opinion, priority should be given to studying which contaminants are present in food at the moment of consumption and in what quantities.

As seen, the number of food additives is vast, and their applications are widespread. However, this does not mean that all countries use them to the same extent. The Council of Europe, in coordination with several global health organizations, has established maximum permissible levels for additives in food products. Depending on the type of product, the allowable level varies between 1–2000 mg/kg or mg/L. These dosage limits have been reflected in specific regulatory documents.

With the rise in the production of processed and packaged foods, the use of preservative food additives has accelerated. The addition of these substances to food serves to protect products from microbial spoilage, extend shelf life, and preserve their natural color and aroma.

Each country regulates the types of foods that may contain preservative additives and determines the permissible dosage according to its own standards. When preservative food additives are used beyond the recommended limits, they can cause allergic reactions such as edema, chronic urticaria, atopic dermatitis, rashes, abdominal pain, diarrhea, hypotension, asthma, anaphylactic reactions, hyperactivity, skin rashes, and itching.

The aim of this study is to raise consumer awareness regarding the production and consumption of E-indexed products and to assist regulatory authorities overseeing product quality by providing them with relevant information, thereby facilitating their work in this field.

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### **Authors' Contribution**

Both authors contributed equally to the development of this article.

### **Data availability**

All datasets relevant to this study's findings are fully available within the article.

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