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Chapter

Food Additives in Food Products: A Case Study

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Abstract

Socioeconomic progress, diseases, and the constantly changing pace of life and lifestyles of consumers worldwide require food to be improved and tailored to meet the needs of purchasers. The produced food is functional, convenient, and enriched. This is achieved, i.e. with food additives. Nowadays, food additives are very widespread in the human diet, but not all of them are synthetic and invasive on human health. All food additives, and their application and dosage, are subject to strict regulations. The purpose of this work was to investigate which food additives are the most common in our everyday diet and how they affect our health.

Keywords: food additives, preservatives, sweeteners, colours

1. Introduction

The history of food additives goes back to ancient times. As great civilisations developed, populations grew and so did the demand for food. In ancient Egypt, where the climate was not conducive to food storage, especially due to the heat, people started looking for ways to extend the usability life of products. Common practices included the addition of salt, drying in the sun, curing/corning, meat and fish smoking, pickling, and burning sulphur during vegetable preservation. The earliest preservatives included sulphur dioxide (E220), acetic acid (E260), and sodium nitrite (E250), while turmeric (E100) and carmine (E120) were among the first colours. Food preservation was also of immense importance during numerous armed conflicts. Both during the Napoleonic wars in Europe and during the American Civil War, seafarers and soldiers needed food. Limited access to fresh food at the front motivated the armed forces to transport their food with them. This is when cans were introduced for food preservation purposes. In the subsequent centuries, ammonium bicarbonate (E503ii), also known as salt of hartshorn, used as a rising agent for baked goods, and sodium hydroxide solution (E524), used in the production of salty sticks, rose to prominence [1, 2].

The nineteenth century saw considerable advancements in the fields of chemistry, biology, and medicine. A name that needs to be mentioned here is Louis Pasteur, a French scientist, who studied microbiology, among other things. He was the first to prove that microorganisms were responsible for food spoilage. At the same time, new chemical compounds were discovered that were able to inhibit the growth of microbes. Some substances, such as picric acid, hydrofluoric acid, and their salts, often had disastrous consequences when added to food. Insufficient

knowledge of toxicology resulted in consumer poisonings and even deaths [1, 3]. At that time, food preservation was the number one priority, which was achieved, for instance, by using salicylic acid, formic acid (E236), benzoic acid (E210), boric acid (E284), propionic acid (E280), sorbic acid (E200) and its potassium salt (E202), and esters of p-hydroxybenzoic acid. Later, food concerns also focused on improving the organoleptic properties of their products and started to enhance food with colours, flavours, and sweeteners, without first researching their effects on human health. For example, such practices involved the use of synthetic colours used in fabric dyeing. This desire to make money on beautiful-looking products led to adulterating food with copper and iron salts, which have a negative impact on the human body. It was as late as in 1907 that the United States studied 90 of the synthetic colours used at that time for food dyeing and found only 7 to be acceptable for further use. Detailed studies and strict regulations on the use of food additives were created almost a century later [1, 4].

Globally, food safety is ensured by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO). In 1962, these organisations established a special agenda—the Codex Alimentarius Commission. The Commission has prepared and updated the Codex Alimentarius, which is not a legal Act per se, but provides a reference for standards on raw materials and food products, acceptable contamination levels, hygienic processing, research methods, and food additives for almost all countries worldwide [5]. In the European Union, the body responsible for improving human health protection and food safety risk mitigation, as well as for taking care of purchaser interests, is the European Food Safety Authority (EFSA). It is a scientific agency established in 2002 pursuant to the Regulation of the European Parliament and of the Council of 28 January 2002. European legislation is based on the Codex Alimentarius but conducts its own complementary research. Therefore, the list of food additives permitted by the European Union is different from the American one [5].

The primary legal Act governing food in Poland is the Food and Nutrition Safety Act of 25 August 2006 (as amended). It specifies the requirements applicable to food and nutrition, concerning product labelling, hygienic conditions throughout the production process, and product replacement rules, as well as requirements concerning the use of food additives. The key document that pertains specifically to food additives is the Regulation of the European Parliament and of the Council of 16 December 2008 on food additives. The EU-approved list of food additives is presented in the Commission Regulation (EU) of 11 November 2011 [4, 5].

A **food additive** (additional substance) is any substance that is not a food in itself or an ingredient in food, but when added to a product for processing purposes, it becomes part of the food [5]. The following are not considered to be food additives: ingredients in food or chemicals to be used in other products, i.e. in particular sweeteners, such as monosaccharides, disaccharides, and oligosaccharides; substances with flavouring, dyeing, and sapid properties (such as dried fruit); glazing and coating substances, which are not intended to be consumed; and chewing gum bases, dextrin, modified starch, ammonium chloride, edible gelatine, milk protein and gluten, blood plasma, casein, and inulin. The law forbids the use of food additives in unprocessed food, honey, non-emulsified oils and fats of an animal or vegetable origin, butter, milk, fermented milk products (unflavoured, with living bacteria cultures), natural mineral and spring water, unflavoured leaf tea, coffee, sugar, dry pasta, and unflavoured buttermilk [5]. Any marketed additive must comply with the requirements of the European Food Safety Authority, i.e. it has to be technologically justified. It must not put consumers' life or health at risk; its use should not mislead the purchaser; its acceptable daily intake (ADI), or *quantum satis*, the smallest amount which is needed to achieve a specific processing objective

for the substance, must be calculable; and, last but not least, such an additive must not adulterate the product it is to be added to. Producers are also required to include information on any food additives on product labelling [6, 7].

EU legislation has approved approximately 330 food additives for use. The primary objectives behind the use of additives are to extend the shelf life and freshness of products, prevent product quality impairment, make the product more attractive to customers, achieve the desired texture, ensure specific product functionality, facilitate production processes, reduce production costs, and enrich the nutritional value of products. In order to harmonise, effectively identify any additives, and ensure smooth exchange of goods, each food additive has its own, standardised, code. This code is consistent with the International Numbering System (INS) and comprises the letter "E" and three or four digits. There are several food additive classifications. One is based on the regulation and differentiates between colours (approx. 40), sweeteners (approx. 16), and other additives (approx. 277) [8, 9].

Additional substances can also be categorised on the basis of code numbers:

1. Colours—E100–E199

2. Preservatives and acidity regulators—E200–E299

3. Antioxidants and synergists—E300–E399

4. Stabilising, thickening, emulsifying, coating, and bulking substances—E400–E499

5. Other substances—E500 and above

Food additives can also be divided into four major groups, based on their processing purpose. These are substances that prevent food spoilage, those which improve sensory features, firming additives and excipients. The most numerous group among additives that slow down food spoilage are **preservatives**. These are either natural or synthetic chemical compounds added to food to restrict as much as possible the biological processes that take place in the product, e.g. the development of microflora and pathogenic microbes, and the effects of enzymes that affect food freshness and quality. In food products, preservatives change the permeability of cytoplasmic membranes or cell walls, damage the genetic system, and deactivate some enzymes. Food is preserved using antiseptics or antibiotics. The former are synthetically produced simple compounds that often have natural correlates, and they make up no more than 0.2% of the product. Antibiotics, or substances produced by microorganisms, are used in very small, yet effective, doses. The effectiveness of preservatives depends primarily on their effect on a specific type of microorganism, which is why it is vital to select the appropriate preservative based on the microbes found in the product (bacteria, mould, or yeast). Other factors that determine the effectiveness of preservatives include the pH value (a low pH is desirable), temperature, the addition of other substances, and the chemical composition of the product. Preservatives constitute an alternative to physical and biological product freshness stabilisation methods, such as drying, pickling, sterilising, freezing, cooling, and thickening. Consumer objections concerning the widespread use of chemical preservatives and their effects on human health have motivated producers to develop new food preservation procedures. These include radiation, packaging, and storing products in a modified atmosphere, using aseptic technology. Products that are most commonly preserved include ready-made dishes and sauces, meat and fish products, fizzy drinks, and ready-made deserts [9, 10].

Other substances used as preservatives are **acids** and **acidity regulators**. These substances lower the pH level and slow down the growth of enzymes, which hampers the development of microbes. They are used mainly in the production of marinades. For a specific acid or acidity regulator to fulfil its role as a preservative, it needs to be added in highly concentrated form, but acetic acid, for instance, can irritate mucous membranes when its concentration exceeds 3%. Acids and acidity regulators are also used to enhance flavour (usually in fruit or vegetable products, or beverages, to bring out their sour taste) or to facilitate gelatinisation and frothing during food processing [11, 12].

Not only microorganisms but also oxygen is responsible for food spoilage. Products such as oils, fats, and dry goods (flour, semolina) oxidise when they come into contact with atmospheric oxygen. Fat oxidisation (rancidification) occurs in oils, lard, flour, and milk powder. The browning of fruit, vegetables, and meat, on the other hand, is the result of non-fat substance oxidisation. These oxidisation processes can be slowed down or eliminated completely using **antioxidants**. There are natural and synthetic antioxidants and synergists. Synthetic antioxidants are primarily esters (BHA, BHT, propyl gallate). These are used to stabilise fats used to fry, e.g. crisps and chips. The most common natural antioxidants are tocopherols, i.e. vitamin E. Other antioxidants include phenolic compounds, such as flavonoids and phenolic acids. Synthetic antioxidants are more potent and resistant to processing. Synergists are substances that support and extend the functioning of antioxidants. They can form complexes with heavy metal ions, which retard the oxidisation process. The most frequently used synergists are EDTA, citric acid, and ascorbic acid. Antioxidants do not pose a risk to human health. In fact, they can be beneficial. Antioxidants prevent unfavourable interactions between free radicals and tissue and slow down ageing processes and the development of some diseases [12, 13].

In order to extend the freshness of consumer goods, products are also packaged in a modified atmosphere. As part of this process, the oxygen content inside the packaging is reduced and replaced with other **gases**, such as nitrogen, argon, helium, and hydrogen. Furthermore, products in the form of aerosol sprays, such as whipped cream, have nitrous oxide, butane, or propane added to them. All these gases are also food additives with their own E codes [5, 11].

The organoleptic properties of consumer goods are very important to consumers. Visual appeal is considered to be as important as taste or smell. This is where **food colours** come into play. These are used to add colour to transparent products (e.g. some beverages), intensify or bring out product colour (beverages, sweets), preserve or reproduce colours that have faded as a result of processing, ensure that all product batches have a specific colour, and provide the products that are diluted after purchase with strong colour. In order to add colour to a product, manufacturers use natural, nature-identical, synthetic, and inorganic colours. Natural colours are produced from edible plant parts (fruits, flowers, roots, leaves) and from animal raw materials, such as blood, chitinous exoskeletons of insects, and muscle tissue. New technologies have also made it possible to obtain colours from algae, fungi, and mould. Natural colouring substances include carotenoids that provide a spectrum of yellow and orange colours (carrot, citrus fruit skin), flavonoids that give products blue and navy-blue colours (grapes, currants, chokeberry, elder), betalains that give products a red colour (beetroot, capsicum), and chlorophyll that lends green colours (salad, parsley), as well as riboflavin (vitamin B_2), curcumin, and caramel. Natural colours are desirable for consumers, as they do not show any negative effects on health. However, a significant drawback to using natural colours is that they are very sensitive to environmental factors, such as pH, ambient temperature, oxygen content, or sun exposure, which is why they are not durable when it comes to processing and storage. Moreover, the cost of obtaining such colouring

substances is rather high. The list of additives contains 17 natural colours, and their market share in 2012 was approx. 31% and was subject to an upward trend [6, 8].

Synthetic food colours are very competitive compared to natural ones. They offer a wide spectrum of colours, including those that are not available in nature, provide strong colouring, and are resistant to environmental factors, so they do not fade during processing. Furthermore, they are not expensive to produce, which contributes to low end-product prices. Synthetic colours can be divided into organic and inorganic, with organic constituting the considerable majority in terms of food colouring. In the past, chemical colours were made of coal, while now crude oil is used for this purpose. EU law approves 15 synthetic colours, including the so-called Southampton colours. A study conducted in 2007 in the United Kingdom (in Southampton, hence the name) showed the particularly negative effects of six colours on children's health [10]. Specifically, tartrazine (E102), quinoline yellow (E104), sunset yellow (E110), azorubine (E122), cochineal red (E124), and Allura red AC (E129) were found to cause hyperactivity. As a result, since 2010, manufacturers which add at least one of their products have been required to provide label information about their negative effects on concentration and brain functioning in children. Acceptable daily doses of these colours have also been reassessed and updated. Moreover, research conducted on lab animals has shown that the long-term use of synthetic colours, and especially the three that account for 90% of the use of all synthetic colours (Allura red, tartrazine, and sunset yellow), can cause cancer, allergies, and chromosome mutations. Products that are most often synthetically coloured include candy, wine gums, ready-made desserts, and refreshing beverages [8, 10].

During consumption, one can experience product taste, smell, and consistency. These three sensations are referred to as palatability and are caused by **flavours**. Taste is experienced by taste buds located in the tongue. Adult individuals have approximately 10,000 such receptors. There are four primary tastes, namely, salty, sweet, bitter, and sour. There is also an additional type, referred to as *umami*, which is Japanese for "savoury, meaty". This taste experience is provided by monosodium glutamate. Smell is experienced through volatile compounds that go directly through the nasal or oral cavity and throat to smell receptors. Taste and smell provide a ready source of information on whether the product is fresh, whether it has specific characteristics, and whether it has been adulterated. Flavours are mixtures of many compounds, in which the specific characteristic smell is produced by a single compound or several indispensable compounds. These are added to enhance the taste or smell of the product or to give something the flavour or aroma that has been lost during product processing [6, 7, 11]. There are natural, nature-identical, and synthetic flavours. Natural flavours are obtained from parts of fruits and vegetables, spices, and their flavouring compounds, such as lactones (found in fruits and nuts), terpenes (in essential oils, found in almost every plant), and carbonyl compounds (fermented dairy products). Nature-identical flavours are compounds originally found in a given raw material that can be recreated in the lab. Synthetic flavours are compounds that have been chemically created and produced and do not have their equivalent in nature. Similarly to natural colours, natural flavours are easily degraded during processing, and their extraction is costly, which is why the food industry generally uses synthetic substances to provide products with specific taste and odour. Moreover, synthetic compounds are capable of giving products much stronger flavours than natural ones [6–7, 13].

A separate group that enhances the sensory properties of food are **sweeteners**. Formerly, in order to make products sweet, manufacturers used sucrose, commonly known just as sugar, obtained from sugar beet or sugarcane. Now large-scale methods are commonly used, such as chemical production and the extraction of intensively sweetening substances, known as sweeteners, from specific plants.

What is characteristic about such substances is that they are much more potent as sweeteners compared to sucrose, and, at the same time, their calorific value is close to zero. Natural sweeteners include glucose-fructose syrup (or syrup based on one of those sugars), thaumatin, neohesperidin DC, stevia, and xylitol. Synthetic sweeteners include acesulfame K, aspartame (and the salts of these two compounds), sucralose, cyclamates, saccharin, and neotame. Sweeteners are used in the production of beverages, juices, dairy products, spirits, sweets, marmalade, and chewing gum [14, 15]. In contrast to sucrose, the majority of synthetic sweeteners do not increase blood sugar level and do not cause tooth decay. These substances are attractive for producers because the cost of their production is low, and even small amounts of such compounds are able to ensure the desired sweetness of the product, so these are economical to use. In addition, most sweetener additives remain functional during processing, although some compounds are not resistant to high temperatures. A study conducted in 2010 on lab animals raises some concerns when it comes to sweetener safety in relation to human health [20]. Its findings showed that regular consumption of sweeteners in large quantities caused obesity and neoplasms in animals. Sweetener additives in consumer goods have been considered safe for humans [10]. Each such additive has a specific ADI value and amount (in milligrammes) that can be added to 1 kg (or 1 dm^3) of product [13–15].

The additives that are vital in terms of processing are **firming additives**. They create or stabilise the desirable product structure and consistency. Firming agents include gelling, thickening, emulsifying, bulking, binding, and rising agents, humectants, and modified starches. The highest status among these substances is enjoyed by hydrocolloids. **Hydrocolloids**, known as gums, are polysaccharides of plant, animal, or microbiological origin. There are natural (guar gum, agar, curdlan), chemically and physically modified (modified starches), and synthetic gums. With their macromolecular structure, they are able to bind water, improve solution viscosity, and create gels and spongiform masses. Hydrocolloids are used as gelling (e.g. in the production of jelly, desserts, pudding, and fruit-flavoured starch jelly), thickening (ready-made sauces, vegetable products), water-binding (powdered products to be consumed with water, frozen food), and emulsifying agents (to create oil-in-water-type emulsions). They also act as emulsion stabilisers. Hydrocolloids are considered safe for human health, although some of them can cause allergies. Consumed in large quantities, they can have laxative effects [12].

What is also important in creating product structure are **emulsifiers** and the emulsification method. Emulsifiers are compounds which facilitate emulsification. There are water-in-oil (margarine) and oil-in-water (mayonnaise) type of emulsions. Emulsifiers position themselves at the interface between two different phases to stabilise the emulsion. There are natural emulgents, with lecithin as the most common, and synthetic emulgents (glycerol and its esters) [1]. Product consistency and texture are also adjusted using **modified starches**. Such starches are usually obtained from potatoes or corn (also genetically modified one) with chemically altered composition. Similarly to hydrocolloids, such substances can bind water and produce gels and are also resistant to high temperatures [11, 12]. Modified starches are added to ready-made sauces and dishes (such as frozen pizza), frozen goods, bread, and desserts (also powdered) to thicken and maintain product consistency after thermal processing. In order to enhance starch properties, phosphates are often added during starch modification. The human body needs phosphorus, but its excess can negatively affect the bones, kidneys, and the circulatory system [7, 11, 12].

Nowadays, consumer goods are widely available, and consumers are provided with a broad range of products to choose from. The continuously growing number of world population (approximately 7 billion in 2011) has made supply on the food market exceed demand. This situation is characteristic of countries with a high GDP.

Food producers examine consumer behaviour patterns to see what encourages them to make a purchase, and also the purchase itself and its consequences, and then analyse these processes to launch a new product or a substitute for an already existing one. To sum up, the market has provided more food products than consumers are able to purchase, which results in unimaginable food wastage. Each year, approximately 100 million tonnes of food goes to waste in Europe. This quantity does not include agricultural and food waste or fish discards [13].

2. Materials and methods

The methodology of this study was based on the information contained on the labels. The chemical composition of the investigated food products was presented. Interview with the store's seller concerned the popularity and frequency of sales listed in the product tables. It should be noted that the examined store is representative when it comes to this type of stores in the majority of small towns in south-eastern Poland.

This study was based on data on the most frequently chosen consumer goods in a store in a small town in Poland. The town is located in a commune that has 5300 residents. Data were obtained by monitoring the sales over the course of 12 months. These products are presented in **Tables 2–6** and classified into the following categories: (i) meat and fish; (ii) beverages; (iii) condiments; (iv) ready-made sauces, soups, and dishes; and (v) sweets and desserts. The main classification criterion was segregation into primary food groups. The chemical composition of each product, as listed on the packaging, was included in a table and then assessed against the presence of any food additives. Sixteen most common additives were selected in all the investigated products; only chemical compounds that were found in at least four food products were taken into consideration. The most common food additives were

Name	Symbol	Number of products
Citric acid	E330	15
Monosodium glutamate	E621	10
Guar gum	E412	8
Sodium nitrite	E250	7
Disodium 5′-ribonucleotides	E635	6
Sodium erythorbate	E316	5
Glucose-fructose syrup	Not considered an additive	5
Soy lecithin	Not considered an additive	5
Maltodextrin	Not considered an additive	5
Triphosphates	E451	4
Xanthan gum	E415	4
Carrageenan	E407	4
Tocopherols	E306	4
Glucose syrup	Not considered an additive	4
Sodium benzoate	E211	4
Ammonia caramel	E150c	4

Table 1.
The most common food additives and ingredients.

highlighted in Holt in the "product composition" column and presented in **Table 1**, together with their E codes. Then, based on the literature, the study described the most common additional substances.

3. Results and discussion

Table 1 shows 16 of the most popular substances found in food. The majority of these substances are food additives; four other substances are not considered in the European Union as food additives. The additives that are the most frequently found in the food products examined in this study are citric acid (E330), monosodium glutamate (E621), and guar gum (E412). In Ref. [16] it is reported that the most popular preservatives found in food are the mixture of sodium benzoate and potassium sorbate, or potassium sorbate (E202) and sodium benzoate (E211) used separately, and also ulphur dioxide (E220). Data presented in **Table 1** shows that, compared to citric acid, another preservative, sodium benzoate, is used rarer. No potassium sorbate was found in any of the products examined in this study. In Ref. [13] it can be concluded that the most commonly used preservatives and antioxidants are sorbic acid and its salts (E200-203), benzoic acid and its salts (E210-213), sulfur dioxide (E220), sodium nitrite (E250), lactic acid (E270), citric acid (E330) and tocopherols (E306). The majority of the additives listed in Ref. [13] can be found in **Table 1**.

Table 2 shows 10 meat and fish products and their composition, as specified on the label. Each of the investigated items contained at least 1 of the 16 most common food additives (**Table 1**). As much as 50% of meat and fish products contained four or more of such additives. The highest number of additives (seven) was found in "Z doliny Karol" mortadella. "Masarnia u Józefa" crispy ham and "Lipsko" Śląska sausage contained six different food additives. Seventy percent of the examined products had had sodium nitrite (E250) added. This means that this preservative is frequently added to meat products, as confirmed in Ref. [9]. Other widespread preservatives mentioned in Ref. [9] include lactic acid (E270), sodium benzoate (E211), sorbic acid (E200), and sulphur dioxide (E220). In Ref. [9] it also mentions other additives frequently added to meat and fish products; these include carrageenan, gum arabic, and xanthan gum. In this study, 50% of the examined items contain one or two gums, and carrageenan is present in only three in ten products. A study in Ref. [17] demonstrates that fish products are the second leading food (after edible fats) in terms of preservative content.

Table 3 shows ten non-alcoholic beverages, six of which contain at least one common food additive (**Table 1**). Foreign substances that are most frequently found in this food group are citric acid (E330), sodium benzoate (E211), and glucose-fructose syrup. A study in Refs. [18–19] shows that the most popular sweeteners in non-alcoholic beverages are glucose, fructose, and glucose-fructose syrups. As shown on product label, 100% juice by brands such as "Hortex" and "Tymbark", as well as "Cisowianka" and "Kubuś" mineral waters, is additive free. Pursuant to the Regulation of the European Parliament and of the Council (EC) of 16 December 2008, no food additives may be used in mineral and spring bottled water. The beverage to contain the largest number of additive substances was white orangeade by "Hellena".

Table 4 shows 12 food items, such as ketchup, mustard, herbs and spices, and tomato concentrates, together with their composition. Only four products in this group contain a food additive, of which three are preserved using citric acid (E330). In this group of products, the products to contain the most common additive substances were the ketchup and the Kucharek seasoning by "Prymat". Pursuant to

Product	Ingredients	Product	Ingredients
Szynka krucha (ham) Masarnia u Józefa	Pork ham, salt, pork protein, **carrageenan**, potassium acetate, potassium lactate, smoke flavouring, **monosodium glutamate**, diphosphates, **triphosphates**, flavourings, **sodium erythorbate**, **tocopherols**, **sodium nitrite**	Pasztet podlaski (pâté) 155 g Drosed	Water, mechanically separated chicken meat, rapeseed oil, chicken liver and skin, cream of wheat, salt, soy protein, potato starch, dried vegetables, spices, powdered milk, (milk) whey, sugar, **maltodextrin**, plant protein hydrolysate, yeast extract
Kiełbasa śląska (sausage) Lipsko	Pork 60%, pig fat 17%, water, mechanically deboned chicken meat, fibre, pork skin emulsion, potato starch, milk proteins, **triphosphates**, tara gum, **xanthan gum**, sodium erythorbate, aluminium ammonium sulphate, salt, glucose, flavourings, carmine, spice extracts, **maltodextrin**, **monosodium glutamate**, soy protein, **sodium nitrite**	Łuków przysmak kanapkowy (tinned meat) 300 g	Pork meat 30%, water, beef meat 18%, pig fat, soy protein, salt, beef fat, **triphosphates**, spices, pork gelatine, flavouring, **sodium nitrite**, tinned high-yield luncheon meat
Mortadela doliny (mortadella) Karol	Water, pork 20%, mechanically separated chicken meat 15%, pig fat, pork connective tissue, cream of wheat, acetylated starch, polyphosphates, **triphosphates**, diphosphates, sodium citrate, calcium lactate, sodium lactate, salt, soy protein concentrate, pork protein, wheat fibre, spices (including mustard seeds, corn, and legumes), spice extracts, yeast extract, flavourings, **glucose syrup**, glucose, vinegar, **sodium erythorbate**, ascorbic acid, **guar gum, disodium 5′-ribonucleotides, monosodium glutamate**, **sodium nitrite**	Agrovit duże porcje konserwa tyrolska (tinned meat) 400 g	Water, mechanically separated chicken meat 23%, pork raw materials 23%, modified (corn) starch, wheat fibre, pea fibre, salt, **carrageenan**, processed Eucheuma seaweed, spices, spice extracts, **monosodium glutamate, sodium erythorbate, sodium nitrite**
Mięso mielone wieprzowe (ground pork) Adrian	Pork meat 65%, pig fat 34%, salt, **xanthan gum, carrageenan**, konjac, starch, **sodium nitrite**	Euro Fish szprot w sosie pomidorowym (sprat in tomato sauce) 170 g	Fish—sprat without heads—tomato sauce, water, tomato concentrate, sugar, rapeseed oil, salt, modified starch, dried onion, **guar gum, xanthan gum**, spice extracts, acetic acid
Parówki (frankfurters) Indykpol	Chicken meat 25.9%, mechanically separated turkey meat 17%, mechanically separated chicken meat 17.3%, water, poultry fat, pork, corn flour, chicken skins, pig fat, pork skins, potato starch, soy protein, salt, spices, spice extracts, flavourings**, monosodium glutamate**, acetylated distarch adipate, **guar gum**, potassium acetate, potassium lactate, diphosphates, ascorbic acid, **sodium erythorbate, sodium nitrite**	Graal Flet z makreli w sosie pomidorowym (mackerel fillet in tomato sauce) 170 g	Mackerel fillets 60%, tomato sauce, water, tomato concentrate, sugar, rapeseed oil, modified starch, spirit vinegar, salt, powdered tomatoes, dried onion, spice extract, spices, **guar gum, xanthan gum**, pepper extract, **maltodextrin**

Table 2.
Food additives and ingredients in the studied meat and fish products.

the Regulation of the European Parliament and of the Council (EC) of 16 December 2008, tomato products (such as concentrates) must not contain food colours. They may, however, contain other additives. The ketchup has no colours, but contains

Product	Ingredients	Product	Ingredients
Woda mineralna gazowana (carbonated mineral water) Cisownianka 1.5 L	Natural mineral water, unsaturated with carbon dioxide, moderately mineralised	Woda mineralna niegazowana (non-carbonated mineral water) Kubuś water 0.5 L	Water, cane sugar, apple juice from concentrated apple juice, lemon juice from concentrated lemon juice, flavouring
Sok jabłko (apple juice) 100% 1 L Hortex	100% apple juice from concentrated apple juice	Coca cola 1.5 L	Water, sugar, carbon dioxide, **sulphite ammonia caramel**, phosphoric acid, natural flavourings, including caffeine
Sok multiwitamina (multivitamin juice) 100% 1 L Tymbark	Juices from concentrated apple juice 60% and orange juice 22%, carrot juice from concentrated juice 12%, purées from banana 3%, peach, guava, papaya, juices from concentrated pineapple juice 2%, mango juice 0.5%, passion fruit juice 0.1%, lychee juice 0.05%, cactus fig juice, kiwi fruit juice and lime juice, vitamins A, C, E, B6, and B12, thiamine, riboflavin, niacin, biotin, folic acid, pantothenic acid	Tymbark 2 L jabłko-pomarańcza (apple-orange)	Water, orange juice from concentrated juice 19%, **glucose-fructose syrup**, sugar, peach juice from concentrated juice 1%, lemon concentrate, flavourings, ascorbic acid, carotenes
Volcano 2 L cola	Spring water, carbon dioxide, sulphite ammonia caramel, phosphoric acid, **citric acid**, sodium citrates, flavourings (including caffeine), gum arabic, aspartame, saccharin, **sodium benzoate**, potassium sorbate	Volcano 2 L pomarańcza (orange)	Spring water, carbon dioxide, orange juice 0.3% from concentrated orange juice, **citric acid**, gum arabic, glycerol and plant resin esters, flavouring, cyclamates, saccharin, aspartame, acesulfame K, **sodium benzoate**, potassium sorbate, ascorbic acid, carotenes, beta-apo-8′-carotenal
Hellena 1.25 L oranżada biała (white orangeade)	Sugar, water, **glucose-fructose syrup,** carbon dioxide, **citric acid,** flavouring, **sodium benzoate**	Kubuś marchew, jabłko, pomarańcza, sok (carrot, apple, and orange juice) 330 mL	Purées and juices (59%), water, **glucose-fructose syrup, citric acid,** vitamin C, flavouring

Table 3.
Food ingredients in the studied non-alcoholic beverages.

other food additives. Studies in Ref. [17] demonstrate that mayonnaises and mustards are the fourth most often preserved product group, with ready-made concentrates ranking seventh. One of the two mustards examined in this paper contained a preservative, and two of the presented tomato concentrates had not had any food additives added to them.

Table 5 shows 12 products categorised into ready-made dishes, soups and sauces, and their chemical composition. Each of these products contains at least one common additive. Citric acid (E330) was added to nearly 67% of the products in this category. Only five in twelve items (including four instant soups and stock cubes) contain the three most popular food additive substances (**Table 1**). A study in Ref. [13] shows that the most common additives in ready-made dishes are citric acid (E330), sunset yellow (E110), guar gum (E412), disodium guanylate (E627), disodium inosinate (E631), and monosodium glutamate (E621).

Table 6 shows 10 food items classified as sweets and desserts. As many as nine products in this group contained at least one of the most common food

Product	Ingredients	Product	Ingredients
Koncentrat pomidorowy (tomato concentrate) Aro 190 g	30% tomato concentrate	Koncentrat pomidorowy (tomato concentrate) Pudliszki	30% tomato concentrate
Ketchup łagodny (mild ketchup) 470 g	37% tomato concentrate, water, sugar, vinegar, modified starch, salt, **citric acid, sodium benzoate**, thyme, oregano, savoury, sage, coriander, flavouring	Ketchup Pudliszki łgodny (mild ketchup) 480 g	Tomatoes, sugar, vinegar, salt, modified starch, natural flavouring
Musztarda Parczew kremska (Krems mustard) 180 g	Water, mustard seeds, vinegar, sugar, salt, spices	Musztarda Roleski stołowa (table mustard)	Water, mustard seeds, sugar, spirit vinegar, salt, spices, turmeric extract, **citric acid**, natural flavouring
Zioła prowansalskie (Herbes de Provence) Prymat	Basil, marjoram, rosemary, savoury, sage, thyme, oregano, mint	Przyprawa do kurczaka (chicken seasoning) Goleo	Salt, garlic, white mustard seeds, sweet pepper, carrot, coriander, fenugreek, caraway, chilli, turmeric, cinnamon
Przyprawa Tzatziki (tzatziki seasoning) Prymat	Garlic, salt, sugar, onion, **citric acid**, onion extract, dill extract, dill leaves, pepper extract, black pepper	Kucharek Prymat 250 g	Salt, died vegetables, **monosodium glutamate, disodium 5′-ribonucleotides**, sugar, starch, black pepper, riboflavin

Table 4.
Food ingredients in the studied condiments.

additives (**Table 1**). Glucose-fructose or glucose syrups were found in six of the examined items. A study in Ref. [19] shows that sweets often include the so-called Southampton colours, such as quinoline yellow and tartrazine. However, the study reports that the amounts of these substances added to sweets are much lower than the maximum values allowed by the applicable law.

Citric acid (E330) is a natural compound found in citrus fruits. It is also the by-product of digestive processes in the human body. However, on the industrial scale, the substance is produced using the *Aspergillus niger* mould. Citric acid is used in food as an acidity regulator, preservative, and flavour enhancer. Outside the food industry, the acid is added to cleaning agents and acts as a decalcifying agent. Citric acid in food is a safe additive and is added to food on the *quantum satis* basis; nevertheless its widespread use constitutes a risk. This substance is found in many food products, such as beverages, juices, lemonades, sweets, ice creams, canned goods, and even bread, so customers consume it in large quantities everyday [20]. When consumed frequently in excess, citric acid can lead to enamel degradation and teeth deterioration. This additive also supports the absorption of heavy metals, which, in turn, might lead to brain impairment. It can also affect the kidneys and liver [13, 15].

Monosodium glutamate (E621) is the most widespread flavour enhancer. It is even considered to be one of the five basic tastes (*umami*). Glutamic acid and its (magnesium, potassium, and calcium) salts lend a meaty flavour to products. The substance was first extracted from algae by a Japanese scientist, but now it is generally produced by biotechnological means using microorganisms that can be genetically modified [6]. Another commonly used flavour enhancer is chemically produced **disodium 5′-ribonucleotides (E635)**. These additives can be found in ready-made dishes, sauces, meat and fish products, instant soups, crisps, and cakes. These flavour enhancers are the not inert in relation to the neurological system [16].

Product	Ingredients	Product	Ingredients
Rosół drobiowy kucharek (chicken soup) 60 g	Salt, palm fat, partially hydrogenated, starch, **monosodium glutamate, disodium 5′-ribonucleotides**, rapeseed oil, dried vegetables, sugar, flavourings, chicken fat, turmeric, **citric acid**, dried chicken meat	Rosół drobiowy Winiary (chicken soup) 60 g	Salt, **monosodium glutamate, disodium 5′-ribonucleotides**, starch, fully hydrogenated palm fat, flavourings, sugar, chicken fat, spices, dried vegetables, **citric acid**, dried chicken meat
Vifon kurczak Carry (curry chicken)	Noodles (92.1%), wheat flour, plant fat, tapioca, modified starch, acetylated starch, sugar, stabilisers (pentasodium triphosphate, **guar gum**, rising substances: sodium carbonate, potassium carbonate, turmeric), flavouring additives (7.9%) (refined palm oil, salt, sugar), flavour enhancers (**monosodium glutamate**, disodium guanylate, disodium inosinate, dried vegetables (carrot, green onion, coriander), powdered curry (flavour additive content 6%), turmeric, aniseed, clove, coriander seed, cinnamon, pepper, garlic, chilli, lemongrass, flavouring), colour (beta-carotene, antioxidant **tocopherols**)	Amino zupa błyskawiczna gulaszowa (instant goulash soup)	Noodles (85%), wheat flour, palm fat, modified starch, salt, rapeseed oil, **tocopherols**, fatty acid and ascorbic acid esters; flavouring mix: salt, starch, paprika, **monosodium glutamate**, disodium guanylate and disodium inosinate, tomato concentrate, onion, flavourings, palm fat, Cayenne pepper, garlic, caraway, hydrolysed plant protein, dried pork, parsley, **ammonia caramel**
Sos Winiary Italia boloński (Bolognese sauce)	Dried vegetables, modified starch, sugar, salt, spices, flavourings, sunflower oil, **citric acid**, spices, beetroot juice concentrate, olive oil	Sos Winiary pieczeniowy ciemny (dark roasting sauce)	Potato starch, modified starch, salt, dried vegetables, flavourings, sugar, yeast extracts, fully hydrogenated palm fat, palm oil, rice flour, **ammonia caramel**, wheat protein hydrolysate, spices, **citric acid**
Sos Winiary borowikowy (bolete sauce)	Corn starch, wheat flour, powdered cream, palm oil, sunflower oil, **maltodextrin**, dried mushroom, salt, flavourings, lactose, yeast extract, sugar, dried fried onion, dried onion, milk proteins, spices, wheat protein hydrolysate, **ammonia caramel**, bolete extract	Zupa Winiary barszcz biały (white borscht)	Wheat flour, skimmed powdered milk, salt, potato starch, sugar, smoked pig fat, citric acid, dried vegetables, yeast extract, herbs, spices, smoke flavour
Zupa Winiary jak u mamy pieczarkowa (champignon soup)	Corn starch, skimmed powdered milk, wheat flour, powdered cream, dried champignons, yeast extracts, salt, potato starch, dried vegetables, flavourings, sunflower oil, wheat protein hydrolysate, parsley, black pepper, **citric acid**	Łowicz sos boloński (Bolognese sauce) 350 g	Tomatoes, water, vegetables, **glucose-fructose syrup**, apple purée, modified corn starch, salt, sugar, **guar gum, citric acid**, rapeseed oil, spices, herbs, flavourings, ground dried parsley, garlic and paprika, leek and carrot extracts
Danie gotowe Flaczki (ready-made tripe) Pamapol	Water, beef rumen 305, wheat flour, carrot, parsley, celeriac, tomato concentrate, onion, salt, pork gelatine, sugar, soy protein hydrolysate, dried vegetables, yeast extract, spices, **disodium 5′-ribonucleotides, ammonia caramel**, flavourings, partially hydrogenated palm and rapeseed fats	Pomysł na soczystą karkówkę z ziemniakami (pork shoulder with potatoes seasoning) Winiary	Wheat flour, vegetables, salt, modified starch, yeast extract, herbs, **maltodextrin**, plant oil, spices, flavourings, wheat protein hydrolysate, **citric acid**

Table 5.
Food ingredients and additives in the studied ready-made dishes, soups, and sauces.

This can affect brain cells and lead to headaches, heart palpitations, excessive sweating, listlessness, nausea, and skin lesions. Such anomalies, which could have been caused by the excessive consumption of products rich in glutamates, are referred to

Product	Ingredients	Product	Ingredients
Lód Top milker (ice cream) Koral	Skimmed reconstituted milk, sugar, cocoa oil, **glucose syrup**, skimmed powdered milk, mono- and diglycerides of fatty acids, locust bean flour, **guar gum**, powdered cream, natural vanilla, flavourings	Baton 3bit (candy bar)	Sugar, biscuit 14% [wheat flour, sugar, plant fat, powdered whey, **glucose-fructose syrup**, whole powdered milk, salt, rising agents (sodium bicarbonate, ammonium bicarbonate), acidity regulator (**citric acid**), skimmed powdered milk (13. 5% in filling), plant fat, cocoa fat, cocoa paste, powdered whey, plant oil, milk fat, emulsifiers (**soy lecithin**, polyglycerol polyricinoleate), flavourings, salt. Cocoa mass in chocolate—minimum 30%
7 days	Wheat flour, cocoa filling 25% [(sugar, partially hydrogenated plant fats, water, low-fat powdered cocoa 7%, skimmed powdered milk, ethyl alcohol, emulsifier (lactic acid esters of mono- and diglycerides of fatty acids), vanilla flavouring, gelling agent (sodium alginate), preservative (potassium sorbate 0.1%)], margarine [partially hydrogenated plant fats, water, salt, emulsifier (mono- and diglycerides of fatty acids), acidity regulator, flavouring, preservative (potassium sorbate 0.1%)], sugar, stabiliser (mono- and diglycerides of fatty acids), **glucose-fructose syrup**, yeast, skimmed powdered milk, salt, vanilla flavouring, preservative (calcium propionate 0.1%), soy flour, emulsifier (**soy lecithin**)	Lód rożek truskawkowy (ice cream cone) Koral	Skimmed reconstituted milk, cornet 14% [wheat flour, sugar, palm fat, potato starch, emulsifier (**soy lecithin**, wheat fibre, salt), colour (sulphite ammonia caramel], sugar, coconut oil, strawberry sauce 7% [strawberries 42%, sugar, **glucose syrup**, water, thickening agent (hydroxypropyl distarch glycerol), acidity regulator (**citric acid**, flavouring], coating for cornet waterproofing [sugar, coconut and palm fats, reduced-fat powdered cocoa (10–12%), emulsifier (**soy lecithin**)], water, **glucose syrup**, strawberry purée 1%, emulsifier (mono- and diglycerides of fatty acids), stabilisers (**Guar gum**, cellulose gum, **carrageenan**, locust bean flour), acidity regulator (**citric acid)**, colours (betanin, annatto, flavourings)
Baton Milky way (candy bar)	Sugar, **glucose syrup**, skimmed powdered milk, cocoa fat, palm fat, cocoa mass, milk fat, lactose, powdered (milk) whey, barley malt extract, salt, emulsifier (**soy lecithin**), powdered egg white, hydrolysed milk protein, natural vanilla extract	Mlekołaki Lubella muszelki (cereal) 250 g	Wholemeal wheat, wheat, and corn flours, sugar, glucose, reduced-fat cocoa, cocoa, barley malt extract, milk chocolate, palm fat, salt, **soy lecithin**, flavourings, vitamin C, niacin, pantothenic acid, vitamin B, riboflavin, thiamine, folic acid, vitamin B12, calcium, iron
Nestlé Corn Flakes 600 g	Corn grits, sugar, salt, glucose, brown sugar, invert sugar syrup, cane sugar molasses, sodium phosphates, niacin, pantothenic acid, riboflavin, vitamin B6, folic acid	Nestlé Frutina 250 g	Wheat flakes (wholemeal wheat, sugar, wheat bran, barley malt extract, invert sugar syrup, salt, cane sugar molasses, **glucose syrup**, sodium phosphates, **tocopherols**), raisins, cut dried apples, sodium metabisulphite, niacin, pantothenic acid, vitamin B6, riboflavin, folic acid, calcium, iron
Lays zielona cebulka (crisps) 150 g	Potatoes, palm oil, sunflower oil, flavouring, powdered onion, powdered milk whey, powdered milk lactose, sugar, powdered milk, **monosodium glutamate**, **disodium 5′-ribonucleotides**, flavourings, powdered milk cheese, **citric acid**, malic acid, annatto, pepper extract, powdered garlic, **maltodextrin**, salt	Star chips paprika (crisps) 170 g	Potatoes, palm fat, flavourings, wheat breadcrumbs, glucose, sugar, **monosodium glutamate**, pepper extract, **citric acid**, salt

Table 6.
Food additives and ingredients in the studied sweets.

as the Chinese restaurant syndrome [20]. Flavour enhancers can also serve a positive function by increasing appetite in the sick or the elderly [20]. Other additional substances commonly found in foodstuffs are polysaccharides:

Guar gum (E412) and **xanthan gum (E415)**. These are referred to as hydrocolloids, i.e. substances that bind water, are easily soluble in both cold and warm water, and improve mixture viscosity. Guar gum is a polysaccharide obtained from guar, a leguminous plant grown in India and Pakistan [14]. Xanthan gum is a polysaccharide of microbiological origin. On the industrial scale, it is obtained as a result of *Xanthomonas campestris* bacteria fermenting the sugar contained in corn (often genetically modified). Both these additives are approved for use in all food products as thickening, firming, and stabilising agents, on the *quantum satis* basis. Guar gum and xanthan gum can be found mainly in bread, cakes, ready-made sauces and dishes, and powdered food, where they ensure the appropriate consistency. Moreover, they prevent the crystallisation of water in ice cream and frozen food and the separation of fluids in dairy products and juices. The human body is not capable of digesting, breaking down, or absorbing these gums. These substances swell in the intestines, which can cause flatulence and stomach ache. In addition, guar gum can cause allergies [13–15].

A commonly found preservative is **sodium nitrite (E250)**. It is a salty and white or yellowish crystalline powder, obtained by the chemical processing of nitric acid or some lyes and gases [9]. This additive is generally used in the meat industry to inhibit botulinum toxin and *Staphylococcus aureus* bacteria, slow down fat rancidification, maintain the pink red colour of meat, and provide meat with a specific flavour. It does not, however, prevent the growth of yeast or mould. Sodium nitrite is toxic, oxidising, and dangerous to the environment, so it must not be added to food in its pure form. This additive is used in very small doses (0.5–0.6%) in the form of a mixture with domestic salt [9] in amounts up to 150 mL per L or mg kg^{-1}. When consumed in large quantities, nitrites can cause cyanosis, whose symptoms include blue coloration of the skin, lips, and mucous membranes. During digestion, nitrites are transformed into carcinogenic nitrosamines. Moreover, they are particularly dangerous for children, since they stop erythrocytes from binding oxygen, which can lead to death by suffocation [11].

A common ingredient in food is **maltodextrin**, which in the European Union is not considered as a food additive, but as an ingredient. Therefore, within the community, maltodextrin has no E code, while in Sweden it is considered an additive and identified as E1400 [18]. Maltodextrin is a disaccharide obtained from corn starch, but it is not sweet in taste. Nevertheless, it provides greater sweetness than normal sugar or grape sugar (the glycaemic index of maltodextrin is 120, that of normal sugar is 70, and that of grape sugar is 100). It is used as a thickening agent, stabiliser, bulking agent, and even as a fat substitute in low-calorie products. It is added to products for athletes and children, to instant soups, sweets, and meat products [10]. Maltodextrin does not affect the natural product taste or flavour, while it provides human body with carbohydrates and energy. Due to the fact that glucose particles in maltodextrin are broken down only in the intestines, it can also support metabolism. A negative aspect of its use is tooth decay [10, 18].

What frequently occurs in consumer goods is **glucose-fructose syrup**. Similarly to maltodextrin, it is not considered to be a food additive, but, due to its widespread application, it is important to mention it here. Glucose-fructose syrup, also known as high-fructose corn syrup (HFCS), replaces traditional sugar in many products, such as beverages, sweets, jams, fruit products, and liqueurs, and in the United States and Canada is the dominant sweetener [19]. Sucrose is a disaccharide composed of glucose and fructose, which are joined with alpha-1,4-glycosidic bond, and HFCS contains free fructose and free glucose in specific proportions. The name

of this substance depends on the proportion of its ingredients. When the syrup contains more fructose, it is referred to as fructose-glucose syrup [12]. It is obtained mainly from corn starch as a result of acid or enzymatic hydrolysis. Glucose-fructose syrup is much sweeter and cheaper than traditional sugar, it does not crystallise, and it has a liquid form, which makes it functional during processing. Nevertheless, there are some disturbing aspects of using this substance. During the consumption of products with glucose-fructose syrup, the body receives unnatural amounts of fructose, which is broken down in the liver in a manner similar to alcohol. Therefore, its excessive amounts can cause fatty liver and overburden this organ. This has even been named "non-alcoholic fatty liver disease". In addition, heavy consumption of monosaccharides has been found to contribute to obesity, which, in turn, can cause high blood pressure and diabetes. Fructose affects the lipid metabolism and disrupts the perception of hunger and satiety. Labels do not provide the exact HFCS content, but it is estimated that the consumption of a single product with this substance satisfies the acceptable daily monosaccharide intake [5–6, 11, 13].

Another frequently added substance is **sodium erythorbate (E316)**. This synthetic compound is used as an antioxidant and stabiliser in meat and fish products and is useful for ham and sausage pickling [13]. It has similar properties to ascorbic acid, but it is not effective as vitamin C. Sodium erythorbate is considered to be noninvasive in the human body [12–13].

The most widespread natural emulsifier is **soy lecithin**. Etymologically, the word "lecithin" can be traced back to *lekythos*, Greek for egg yolk, but this compound is actually found in any plant or animal cell. Lecithin is produced from eggs, sunflower and rapeseed oils, and soybeans [11–13]. This additive is identified as E322 and is used for the production of mayonnaise, ice creams, margarine, ready-made desserts, sauces, and instant soups. Products with added lecithin dissolve in water more easily. EU law does not impose any limits on the use of E322. Only in products for children, lecithin content must not exceed 1 g per L.

Triphosphates (E451), as well as diphosphates and polyphosphates, are used as preservatives, flavour enhancers, stabilisers, and rising and water-binding agents. Triphosphates are produced chemically and have a broad application. They are added to sauces, meats and meat products, desserts, bread, pâtés, fish products, ice creams, and non-alcoholic beverages [21]. The human body needs phosphorus in specific amounts, but the widespread use of phosphoric acids and phosphates in food makes people likely to consume this element in excess. When consumed regularly, increased doses of phosphates can lead to osteoporosis or contribute to kidney dysfunction and affect the circulatory system [13, 21]. A popular hydrocolloid found in food is **carrageenan (E407)**. This substance is extracted from *Eucheuma*, a tribe of red algae. Carrageenan is highly soluble in water and is used as a bulking agent in dietary products, and it is also added to beverages, ice creams, sauces, marmalades, and powdered milk [6, 7]. Carrageenan can be used on the *quantum satis* basis. Usually, it is combined with other hydrocolloids. This additive is not digestible by the human body. There are certain objections concerning the consumption of carrageenan, e.g. it can cause intestinal cancer and stomach ulcers [11–13].

Tocopherols (E306) are commonly known as vitamin E, insoluble in water and soluble in fats. It is used as a preservative, stabiliser, and potent antioxidant in such products as oils, margarines, desserts, meat products, and alcoholic beverages. Tocopherols are produced synthetically or obtained from plant oils, but natural vitamin E is twice as easily absorbed by the human body [21].

Common preservatives include benzoic acid and its salts, of which the most frequently used is **sodium benzoate (E211)**. Negligible amounts of these substances are naturally found in berries, mushrooms, and fermented milk-based drinks. On

an industrial scale, it is produced synthetically from toluene obtained from crude oil [3, 12]. What is characteristic of sodium benzoate is that it slows down the growth of mould and yeast, but does not prevent the growth of bacteria, which is why it is often used with other preservatives, such as sulphur dioxide (E220). It is commonly used in products with acidic pH, such as marinades, fruit juices, and products with mayonnaise, such as vegetable salads. Sodium benzoate can cause allergies [6, 13]. Our own study (see "Results and discussion") showed that **ammonia caramel (E150c)** and sulphite ammonia caramel (E150d) are fairly common colours. It adds brown to black colours to products. Under natural conditions, this substance is created when sugar is heated. As a food additive, it is produced chemically using ammonia, as well as phosphates, sulphates, and sulphites (sulphite ammonia caramel is produced) [19]. This substance is approved for use under EU law [5]; however, there are studies that have confirmed that it negatively affects human health. It has been proven that this colour can cause hyperactivity and liver, thyroid, and lung neoplasms and also impair immunity. Ammonia caramel is used to dye non-alcoholic beverages, such as cola and marmalades [10, 11].

The external aspect that is most crucial for buyers when it comes to food selection is its freshness. Buyers assess the best before date against the possibility of consuming the food quickly or storing it for future use. Another determinant is the value of the item. Any consumer will pay attention to the price of the product they buy. Another factor is the product ingredients specified on the packaging. Buyers have been observed to have developed a habit of reading labels before buying anything. Some customers also pay attention to the country of origin or brand [22]. Men and women who are determined to stay fit will also consider nutritional value. The factors that are not considered that are relevant include net product weight, information about any genetically modified raw material content, and notices about any implemented quality management systems. Moreover, consumers are likely to be affected by marketing devices, such as advertisements or special offers, used by producers. A temporary reduction in price, or the opportunity to buy two items for the price of one, encourages customers to make a purchase [3, 4]. What is also vital is whether the food is functional. Many people live at a fast pace, work a lot, or get stuck in traffic jams, and the lack of free time pushes them to buy ready-made dishes to be heated up at home or food that can be prepared in an instant [4, 13, 22].

Nowadays, food additives are very widespread in the everyday human diet, but not all of them are synthetic and invasive to human health. Products which must not contain foreign substances do not contain food additives. The explorations undertaken by this and other studies confirm the widespread use of the investigated additives, except for citric acid, which is less popular an additive than sodium benzoate and potassium sorbate. This study shows that when adopting a healthy lifestyle, consumers can choose from a range of food and pharmaceutical products that either contain a limited amount of unconventional substances or do not contain such substances at all.

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