FOOD PRESERVATIVE RISK ASSESSMENT

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ABSTRACT

Sulfitizing agents such as sulfur dioxide and sodium and potassium salts of bisulfite, sulfite, and metabisulfite are used as preservatives in food, beverages, and pharmaceuticals. It is known that patients with allergic diseases, including bronchial asthma, often experience clinical symptoms after eating foods containing sulfonating substances. In many regions of the world, sulfites are now among the potential allergens that should be labeled on food and beverages.

Relevance of the problem. To date, various food additives are used for preserving, coloring and sweetening, slowing down the spoilage of products. They are added during the preparation, packaging, transportation or storage of food and are part of the food. Preservatives promote long-term food storage, eliminate decomposition, and slow down the rotting process caused by bacteria, mold, or yeast [36].

В качестве консервантов в продуктах питания, напитках и фармацевтических препаратах применяются cSulfitizing substances such as sulfur dioxide and sodium and potassium salts of bisulfite, sulfite, and metabisulfite are used as preservatives in food, beverages, and pharmaceuticals. It is known that patients with allergic diseases, including bronchial asthma, often experience clinical symptoms after eating foods containing sulfonating substances. [14].

Sulfur dioxide is a category of chemical compounds widely used as additives in the food industry. SO far, the use$_{of}$ SO2 in the fruit and vegetable industry has been indispensable, although its safety has been controversial. In order to fully understand the benefits and risks of $SO2_2$, more research is needed to evaluate the molecular mechanisms of $SO2_2$ metabolism in fruit and vegetable cells and tissues, and to uncover the mechanisms of interaction between $SO2_2$ and fruit and vegetable components, as well as the efficacy and safety of bound $SO2_2$ https://doi.org/10.1080/10408398.2023.2203737. [19, 37].

CUlfites are used in the food and alcohol industry as preservatives and antioxidants. They are often usedт in the pharmaceutical industry [21].

In addition, it should be taken into account that endogense sulfitescan be formed as a result of the processing of sulfur-containing amino acids by the body. Sulfites occur as a result of fermentation and are also naturally found in a number of foods and beverages. Currently, sulfites are used for a variety of preservative properties, including controlling microbial

growth, preventing browning and spoilage, and bleaching certain foods. The exact mechanisms of sensitivity reactions are not fully elucidated [17].

Beer, wine, dried, canned, or frozen fruits often contain sulfites, and seafood and fried potatoes are often prepared using these substances. Sulfites are also present as pollutants in the atmosphere. The frequency of occurrence of sensitivity to sulfites is unknown, but this condition is recognized more and more often. Clinical management is based on avoiding intense physical activity on days when air pollution is high, and avoiding foods and medicines containing sulfites [11].

Sulfite and related chemicals, such as sulfite salts and sulfur dioxide, have been used as a preservative in food and medicine. This molecule was also produced by the catabolism of sulfur-containing amino acids. Sulfite is a highly reactive and potentially toxic molecule and must be detoxified by the enzyme sulfite oxidase [22].

Sulfites are widely used as preservatives in the food and pharmaceutical industries. In the United States, more than 250 cases of sulfite-related adverse reactions have been reported, including anaphylactic shock, asthma attacks, hives and angioedema, nausea, abdominal pain and diarrhea, seizures, and death, including 6 deaths suspected to be related to restaurant food containing sulfites. In Canada, 10 sulfite-related adverse reactions were reported, witha suspected sulfite-, предположительно связанный с сульфитамиrelated death[34].

Recently, food and drug additives that have reached medical awareness as a cause of sensitivity are sulfitizing agents. Sulfites are widely used in the food and alcohol industry as preservatives and antioxidants. They are also used in the pharmaceutical industry. [21].

Sulfitizing agents, including sulfur dioxide, potassium metabisulfite, sodium sulfite, sodium metabisulfite, sodium bisulfite, and potassium bisulfite, are effective antioxidants. As such, they are widely used as additives in processed beverages and foods, including fruit juices, soft drinks, wines, beer, cider, vinegar, potato chips, dried fruits, and vegetables. Their anti-browning properties make them useful for preventing spoilage of commercially prepared or marketed fresh produce, such as ingredients in salad bars, sauces, seafood (especially shrimp), fruits and vegetables. Sulfur dioxide also occurs as a common air pollutant [23].

Sulfur dioxide(SO2), which is used as a food preservative in the sulfurization of apricots and several artificial foods, is a common air pollutant. $SO2_2$ has a strong mutagenicity and can cause genetic damage leading to malignant neoplasms [26].

Components (including food additives, flavorings), biologically active additives, the use of which may cause allergic reactions or is contraindicated in certain types of diseases and which are listed in paragraph 32 of the Technical Regulations, are indicated in the composition of food products, regardless of their quantity. The most common components, the use of which can cause allergic reactions or is contraindicated in certain types of diseases, include: sulfur dioxide and sulfites, if their total content is more than 10 milligrams per kilogram or 10 milligrams per liter in terms of sulfur dioxide [1].

Sulfur dioxide and sulfites inhibit the darkening of plant raw materials by interacting with reducing sugars, carbonyl compounds, melanoidins and other chemical compounds. ИStudies have shown that the mass fraction of sulfur dioxide in confectionery products is in wide ranges and can reach up to 1.8 g / kg and, therefore, it should be indicated in the

composition of food products when labeling. Various methods have been developed for the determination of sulfur dioxide in food.

Manufacturers of confectionery products, including cookies, often do not have information about the content of sulfur dioxide in the raw materials used and do not assume the presence of this substance in finished products, which leads to a violation of the requirements of the regulations [4].

When exposed to sulfites orally or parenterally, sensitive people experience clinical symptoms of dermatitis, urticaria, hypotension, asthma attacks, abdominal pain and diarrhea, even anaphylactic reactions. When exposed to food or drugs containing sulfites, skin or respiratory reactions often occur, which are often episodic or acute, and sulfites can cause chronic skin and respiratory symptoms [28].

In the literature, allergic sensitivity to certain components of beer, spirits, and distilled beverages is described. Wine is also the most commonly reported trigger of adverse reactions that result from intolerance to certain components, such as biogenic amines and sulfite additives. Wines contain histamine, which contributes to allergic reactions, the occurrence of adverse symptoms, including sneezing, rhinitis, itching, headache and asthma. Sulfite additives are added to the wine, which can worsen asthma symptoms. The etiology of wine-induced asthmatic reactions can be complex and may include several concomitant factors [27].

Hypersensitivity reactions to alcoholic beverages (especially red wine) are relatively common, affecting 10% of the general population. Hypersensitivity reactions caused by alcoholic beverages, mainly in the form of respiratory tract reactions (rhinitis and asthma), are significantly more common in people with pre - existing rhinitis and asthma. From the point of view of pathogenesis, it is necessary to distinguish between immunological, mainly IgE-mediated, hypersensitivity reactions (wine allergy) and intolerance reactions, in which it is not possible to detect causal allergen-specific immune mechanisms. Type 1 allergic reactions (positive prik tests) have been described for inorganic components such as ethanol, acetaldehyde, acetic acid, and sulfites, but no specific serum IgE has been detected. Ethanol, acetaldehyde and acetic acid, flavonoids (anthocyanins and catechins), sulfites, histamine and other biogenic amines are the main causative agents of intolerance reactions (pseudo-allergic reactions) to wine. The most frequent reactions of sulfite intolerance occur, in particular, after taking white wine and in patients with asthma. Reactions of intolerance to histamine and other biogenic amines occur mainly after ingestion of red wine and in individuals with diamine oxidase deficiency [33].

Sulfites are widely usedются as additives in the food industry due to their antimicrobial, color-stabilizing, fire-fighting and antioxidant properties. As a result of these pleiotropic functions, they can be added to a wide range of foods, including dried fruits and vegetables, seafood, juices, alcoholic and non-alcoholic beverages, and some meat products. Taking sulfites correlates with several adverse and toxic reactions, such as hypersensitivity, allergic diseases, vitamin deficiencies, and can lead to dysbiotic phenomena in the intestinal and oral microbiota. In many countries, these additives are strictly regulated, and in meat products, legislation restricts their use. Several studies have been conducted to study the sulfite content in meat and meat products, and many of them have shown that some meat products are one of the main sources of SO_2 exposure, especially in adults and young adults [10].

Due to its antioxidant and antimicrobial properties, sulfur dioxide is widely used in food and beverages to prevent the growth of microorganisms and preserve the color and taste of fruits. Theresults show that sulfurization of apricot in high concentrations, such as 3500 ppm, can lead to problems with male fertility in the long term through mechanisms such as oxidative stress, apoptosis of spermatogenic cells, and inhibition of steroidogenesis [35].

Theabsence of NaF and $SO2_2$ not only causes damage to kidney tissue, but also affects the integrity of DNA. In addition, this combined effect exhibits a synergistic effect characterized by dose dependence and temporal correlation. These results may provide new insights into impaired DNA damage and its functions as a potentially novel mechanism that requires careful interpretation of the combined effects of NaF and $SO2_2$that have developed in both animals and humans [12].

The metabolism of sulfite and the role of sulfite oxidase in detoxification of exogenous sulfite are considered in connection with the etiology of hypersensitivity to sulfite [14].

Sulfites can be lost as a result of auto-oxidation, such as when a bag or jar is opened and exposed to air. Packaging can also affect the level of sulfites, since plastic bottles can cause complete loss of sulfites, whereas glass bottles seem to prevent the loss of sulfites [14].

Hence, the lack of enzymatic cofactors may also be a contributing factor. Researchers have suggested that $SO2_2$ may have a detrimental effect on the overall detoxification of xenobiotic compounds, which are usually detoxified in the glutathione conjugation pathway involving GST [18].

They suggest that it may deplete the glutathione supply and may be a contributing factor to sulfite sensitivity [8].

In recent years, worldwide interest in the biological control of microorganisms that cause food spoilage has increased significantly over the past decade. Wine is no exception to this trend, as consumer demand for wines without preservatives, which are considered harmful to human health, is growing. Biological control during wine fermentation is aimed at producing high-quality wines, while minimizing or even eliminating the use of chemical additives. Its success lies in inoculating micro-organisms to prevent, suppress or kill unwanted microbes, thereby keeping wine spoilage at its lowest level. The food industry is already using this practice, and special commercial microbes are already available on the market. Commercial microbes are currently being studied in winemaking, in particular, with the aim of reducing or replacing the use of sulfur dioxide [13].

Sulfur toxicity is mainly associated with high levels of the element and its toxic volatiles in the environment. Sulfur dioxide, as аня air pollutant, can negatively affect human health, causing bronchitis, bronchoconstriction, and increased lung resistance. Each population in an ecosystem has a range of tolerance to changes in its physical and chemical environment. When the body's tolerance limit is exceeded, a small change in homeostasis triggers a threshold effect. This effect may explain why many environmental problems seem to arise suddenly, such as forest loss, declining fish populations, and many diseases among humans and animals [20].

The state of sulfur dioxide in partially dehydrated or dehydrated food products is complex and depends on the pH, ionic strength, activity and concentration of water, as well as on the effect of anions and cations on the solubility of sulfite and disulfite salts. The chemical basis of the preservative's action is explained in terms of the nucleophilicity of the sulfite ion,

and the possible consequences of changes in the state of the additive during dehydration are evaluated. The significance of auto-oxidation of the sulfite ion for its fate in food and its role as an antioxidant or pro-oxidant is critically discussed. The most widely studied reaction of sulfur dioxide in food is its inhibition of nonenzymatic browning; this explains the current state of knowledge about the mechanism of this action.

The loss of sulfur dioxide during dehydration of vegetables follows first-order kinetics. This observation is considered from the point of view of known first-order reactions in food products and processes that are limited by the diffusion rate. There is still insufficient data to suggest ways in which food composition could be modified to reduce its need for sulfur dioxide during dehydration [32].

Foods fermented in the microbiome that are high in sucrose or fructose, such as soft drinks, bread, cookies, cakes, crackers, bananas, and breakfast cereals, usually cause symptoms associated with foodintolerance [2].

Knowledge of sensitizing properties and cross-reactions between allergens, individual approach to diet selection, as well as timely in in vitro diagnosis of" guilty " allergens prevents food allergy complications. [6].

Sulfur dioxide is used in the confectionery industry, so20-25% of white sugar and 60-70% of flour are used to make sugar cookies, which are the main sources of sulfur dioxide intake. White sugar and flour are characterized by wide ranges of sulfur dioxide content from 1.4 to 9.4 and from 9.0 to 15.0 mg per kg, respectively. Therefore, its content in products can also be in wide ranges. Large additions, such as prunes, dried apricots, and dried grapes, increase the sulfur dioxide content of various chocolate products. At the same time, the sugar content affects the content of sulfur dioxide in such products. Fruit fillings, flour and sugar are sources of sulfur dioxide in the production of gingerbread fillings. Ensuring the level of sulfur dioxide content of less than 10 mg / kg is achieved by using raw materials with a low content of sulfur dioxide and technological methods (desulfitation). The results allow us to make an approximate forecast of the content of sulfur dioxide and control its presence in confectionery products, contributing to improving their safety [5].

Codex Standart for sugar CODEX STAN 212-1999 and interstate standard G 33222-2015 "Withahar white. TTechnical conditions " regulates the content of sulfur dioxide for sugar no more than 15 mg/kg. Taking sulfites correlates with several adverse and toxic reactions, such as hypersensitivity, allergic diseases, vitamin deficiencies, and can lead to dysbiotic phenomena in the intestinal and oral microbiota. In many countries, these additives are strictly regulated, and in meat products, legislation restricts their use. Several studies have been conducted to study the sulfite content in meat and meat products, and many of them have shown that some meat products are one of the main sources of SO2 exposure$_{2,}$especially in adults and young adults [25].

Components that can cause allergic reactions or are contraindicated in certain types of diseases
are sulfur dioxide and sulfites. They belong to approved food additives and have codes from E220 to E228 assigned by the European Union Regulation. Since all food additives with codes E220-E228 can be converted to sulfur dioxide, sulfites are measured and expressed as sulfur dioxide. Due to its wide range of applications , sulfites are added to a wide range of food products (juices, wines, dried fruits,

fruit and vegetable products, flour confectionery and bakery products, seafood, etc.) as preservatives, antioxidants and enzyme inhibitors that help improve the appearance of food and prevent its discoloration and reactions of enzymatic and non-enzymatic darkening during processing. processing time and xproduct hits. The presence of sulfites in food can have a negative impact on human health: cause breathing problems, stomach irritation, asthmatic and allergic reactions. There are documented side effects associated with the loss of nutritional value of foods, namely reduced bioavailability of vitamins: thiamine (B1), folic acid (B9),
pyridoxine (B6) and nicotinamide (B3). In this regard, the content of sulfites in food products should be monitored to ensure that they do not exceed the permissible daily norm (ADI – 0.7 mg per 1 kg of body weight). In many countries, standards for the content of sulfites in food products are established by law, but their quantitative rationing and labeling rules differ [3].

Sulfur dioxide and several forms of sulfites that generate sulfur dioxide when used in food can be used as sulfitizing agents. These include sulfur dioxide (E220), potassium bisulfite (potassium hydrosulfite) (E228), potassium metabisulfite (E224), sodium bisulfite (sodium hydrosulfite) (E222), sodium metabisulfite (E223), sodium sulfite (E221), calcium sulfite (E226) and calcium hydrosulfite (E227) after the Directive № 95/2 / EC (EC, 1995). Since all of the above can be converted to sulfur dioxide, sulfites are measured and expressed as sulfur dioxide. The sulfur dioxide contained in beer occurs not only due to the addition of sulfitizing agents (exogenous $SO2_2$), but also due to yeast metabolism or as a component of clarification or priming (endogenous$_2$SO2) [38].

Thus, inmany regions of the world, sulfites are now among the potential allergens (along with the likes of peanuts, fish, crustaceans, gluten, and milk) that should be labeled on food and beverages. In the European Union (EU), levels in food and beverages above 10 mg/kg or 10 mg per litre must be labelled. Warning labels are now commonplace, but in practice there is still a huge amount of ignorance and misinformation about the use of sulfites in food, beverages, and pharmaceutical products. Therefore, clinicians should be aware of the sensitivity to sulfites in order to be able to make a correct diagnosis and provide treatment recommendations [8].

Control over the use of food additives is carried out by the competent national authorities, which must control the food industry for the safe use of these substances [36].

Conclusions. Thus, the control of the content of preservatives, including sulfur dioxide in food is important for the prevention of food allergies, bronchial asthma and other respiratory and skin diseases. In addition, the identification of sulfur dioxide in food and the labeling of this allergen helps to prevent unwanted allergic reactions among consumers.

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