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Review

Sodium Hydrosulfite (Blankit) in Iranian food as a threat to human health: a review

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ABSTRACT

Sodium hydrosulfite is called blankit with the chemical formula $Na_2S_2O_4$ is a toxic food additive employed in the food industry to improve the apparent quality of food. Adverse effects of blankit include the elimination and damage of villi in the stomach and intestines in the long term, therefore, it can cause the development of gastrointestinal cancer. It is also known to be an effective factor in causing diabetes. In this study, based on searches in PubMed, Google Scholar, Elsevier, SID databases and keywords studies on the use of sodium hydrosulfite and its health effects were reviewed from 2008 to 2018 According to the results of studies conducted, it was found that the amount of this substance is used more than the maximum allowed in some food, which requires more monitoring of the quality of food produced.

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1. Introduction

Population growth and lifestyle changes have led to significant changes in food processing and new formulations. Also, changes in food habits and needs of consumers caused a significant change in the food industry including food additives to food product.

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A wide range of chemical additives as enhancers (1), improve physicochemical, sensory and microbiological properties, bleaching, overall quality and stability, and extend expiration date (2).

According to the codex, food and agriculture organization of the United Nations/World Health Organization, there are about 25 classes of food additives that are used in each country according to specific laws and food safety policy (3,4). Food additives are used and recommend on the maximum allowable amount of them, which based on the level of consumers must be consideration. Also, ensuring that any illegal additives are avoided requires careful evaluation.Toxic chemical cheating in food has increased and this problem has been known as a silent killer. Food contamination with low levels of toxic chemicals is a serious threat to public health. Consumption of these foods can have different effects. The immediate effect of eating contaminated foods may be life-threatening diarrhea (5). In the long time, these chemicals negatively affect vital organs such as the liver and kidneys, resulting in organ damage and/or cancer (6).

Sodium hydrosulfite ($Na_2S_2O_4$) (DOT No. UN 1384 and CAS Number: 7775-14-6), also known as sodium dithionite or hydrose, is a white crystalline powder containing inorganic sulfur compounds (6). This compound is one of the chemicals on the standard system for the identification of the hazards of materials for emergency response (NFPA) and DOT list of health hazards. This has flash point of 100°C, melting point of 70 to 130°C and a molecular weight of 174.114 g/mol. Sodium hydrosulfite is highly reactive and decomposes on contact with water, humid air, and heat above 60°C (7). Sodium hydrosulfite is oxidized and may release toxic sulfur dioxide during very acidic and anaerobic conditions (such as the gastrointestinal tract), then hydrogen sulfite and thiosulfate can be formed, thus it is possible that hydrogen sulfite absorbed by the gastrointestinal tract (8).

Formulations of food additives such as soda, sodium hydrosulfite and surfactants containing sodium hydrosulfite (more than 30%) (9). Sodium hydrosulfite is a very strong reducing agent and is one of the sulfur compounds that is widely used as a bleaching compound in various industries including textile and dyeing industries. Also, this chemical is employed as a commercial cleaner. In the food industry, sodium hydrosulfite is used in nuts, sugar and also to prevent browning and bleaching agent and regeneration of cellulose fibers (10). In addition, the sodium hydrosulfite is applied in the preparation of sugar molasse to reduce the color of it, increase its apparent acceptability and then price (6). The usage of sodium hydrosulfite as an additive in Iranian bread due to accelerate the production process, to compensate for defects of lack of natural fermentation and poor flour quality so cover the apparent defects of bread (11). As well these compounds as a bleaching agent in industries such as food drying; sugar loaf; textile, paper and dye of cellulose fibers are used (12). It should be noted that sulfites reduce the amount of thiamine in food, accordingly affecting the quality of food (13,14).

To the best of our knowledge, there are no reports on the investigation of permissible sulfur compounds, especially sodium hydrosulfite, and its applications as an unauthorized additive in food, as well as its harmful effects on human health and food safety and identification methods.

Table 1. Classification of permitted sulfur compounds recognized by Codex and European Union as food additive

Compound	INS number	E number	Chemical formulation	application	Codex ADI (mg/kg/bw)	EU ADI (mg/kg/bw)
Sulfur dioxide	220	220	SO_2	Antioxidant-bleach-preservative	0-0.7	0.7
Sodium sulfite	221	221	Na_2SO_3	Antioxidant-bleach-preservative	0-0.7	0.7
Sodium *Hydrogen* sulfite	222	222	$NaHSO_3$	Antioxidant-bleach-preservative	0-0.7	0.7
Sodium metabisulfite	223	223	$Na_2S_2O_5$	Antioxidant-bleach-preservative	0-0.7	0.7
Potassium metabisulfite	224	224	$K_2S_2O_5$	Antioxidant-bleach-preservative	0-0.7	0.7
Calcium sulfite	-	226	$CaSO_3$, $CaSO_3$ _ $2H_2O$	Antioxidant-bleach-preservative	-	0.7
Calcium *Hydrogen* sulfite	-	227	$Ca(HSO_3)_2$	Antioxidant-bleach-preservative	-	0.7
Potassium *Hydrogen* sulfite	-	228	$KHSO_3$	Antioxidant-bleach-preservative	-	0.7
Potassium sulfite	225	-	K_2SO_3	Antioxidant-bleach-preservative	0-0.7	-
Sodium thiosulfate	539	-	$Na_2S_2O_3$	Antioxidant-chelating	0-0.7	-

Sulfur additives in the food industry

The term "sulfites" or "sulfur compounds" is generally called for a variety of sulfur-based compounds. These compounds have been applied in various forms in food during centuries (15). Among the organic and sulfur compounds that are classified in the food industry as additives and in the category of healthy substances, can be sulfur dioxide, sodium sulfite, sodium hydrogen sulfite, sodium metabisulphite, potassium metabisulfite, potassium sulfite (Table 1).

Sulfurizing is one of the first and most effective methods of preserving food. Extensive use of sulfur compounds in food can be attributed to the high solubility of these compounds in water, their role in inhibiting the growth of molds and bacteria, inactivating enzymatic and non-enzymatic reactions, and helping to stability of vitamin C and other food-sensitive compounds. In the food processing industries, sulfur compounds are commonly used as disinfectants, preservatives, bleachers, and antioxidants (15).

But in other industries, such as refining sugar beet, it is only needed to change color and has significant applications. In addition, it plays an important role as an inhibitor of enzymatic and non-enzymatic browning reactions, inhibiting a wide range of enzymes including proteases, oxidases, peroxidases and preventing oxidative damage (16). Sodium hydrosulfite is also used in raw food products or 30 mg/kg as a preservative in cooked food products. The codex committee on food additives and contaminants (CCFAC) limit of sulfur dioxide is 30 mg/kg, based on SO2 (17,18).

Sodium hydrosulfite is not considered as a permitted food additive. The FAO/WHO Joint committee (JECFA) has not evaluated the health effects of sodium hydrosulfite as a food additive. Sodium hydrosulfite is not currently authorized by Codex as a food additive, but is permitted under food regulations in Canada, Japan and Korea (19). According to the national laws of each country, some countries such as Japan, Korea, China, New Zealand and Canada (70 mg/kg in free form and 300 mg/kg in complex form) of sodium hydrosulfite as a decolorizing agent in some seafood products use food products such as sugar and canned food (20). According to the European Parliament's food additives regulation, the sulfur dioxide content should not exceed 10 mg/kg (14). According to the Institute of Standards and Industrial Research of Iran (ISIRI) the maximum residual amount of sodium hydrosulfite in sugar is defined as 10 ppm (12,21). However, according to the international association of agricultural chemists (AOAC) and the international codex standard, the maximum residual maximum is 15 ppm (17,22,23).

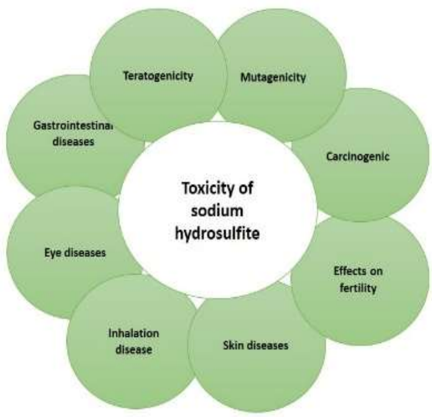
3. Toxicity of sodium hydrosulfite

Studies by researchers in the field of medical and health sciences have shown that receiving excessive amounts of sulfur compounds causes gastrointestinal (24), inhalation (25), skin (26) and eye (27) diseases. Sodium hydrosulfite is an anionic compound that is converted to various forms of sulfur in environments with various pH due to oxidation and reduction reactions such as sulfur dioxide, sulfite, hydrogen sulfite, thiosulfate and sulfate, which are highly carcinogenic (28). Residual sodium hydrosulfite after entering the gastrointestinal tract, destroys the villi of the stomach and intestines and in the long time, by eliminating antioxidants, leads to accelerated gastrointestinal cancer (29-31). Sodium hydrogen sulfite is also effective in blocking the body's enzymes, especially insulin; therefore, it directly accelerates diabetes in individuals (32,33). Reliable toxicity information on sodium hydrosulfite is available regarding acute toxicity, skin and eye irritation, sensitization, and its potential for inducing gene mutations. This substance has not been tested with repeated doses due to its potential for chromosomal abnormalities, effects on fertility and growth (12).

Acute oral LD_{50} for sodium hydrosulfite in mice is estimated at approximately 2500 mg per kg body weight. At doses close to or above LD_{50}, weakness, gastrointestinal irritation, diarrhea, and shortness of breath are known to be clinical and pathological symptoms. Sulfur dioxide, the most well-known cause of respiratory irritation in humans, is released under acidic conditions (11). Regarding the acute toxicity of this substance, oral, dermal and respiratory LD_{50} in rats were estimated at 2500, 2, and 5.5 mg/kg body weight in 4 h, respectively. Regarding the health effects of this substance, we can mention redness, tears, blurred vision, irritation and eye damage. As a result, prolonged repetition and exposure will lead to dryness, skin irritation and eventually skin dermatitis. High concentrations of sodium hydrogen sulfite vapors can irritate the nose and throat, cause coughing, wheezing, and shortness of breath. Gastrointestinal effects include gastrointestinal irritation, nausea, diarrhea, abdominal pain, loss of intestinal villi, and antioxidants. Little information is available on the carcinogenic, mutagenic, teratogenic, reproductive toxicity and endocrine disrupting effects due to lack of studies (8,13).

Sodium hydrosulphite overshadows human health due to sulfite-induced asthma, irritating effects on the eyes, and chromosomal abnormalities in the body. The main exposure workers to encounter this compound is through the respiratory tract and skin. Consumers of foods with this compound also come in contact with the substance through the skin. Therefore, it is necessary to evaluate the exposure to this substance while conducting extensive studies on animals about its health effects, and then to evaluate its risk in various food products, home and work environment of workers working in food factories (34) (Fig. 1).

Figure 1. Toxicity of sodium hydrosulfite in human healthy



4. Measurement and identification methods

In general, different methods are used to measure sulfur factors in food, such as titration (35), spectrophotometric methods (36), liquid and gas chromatography (37), high performance ion chromatography (38), iodometric method (39,40), electroanalysis methods include the study of the electrical activity of sulfites, voltammetry (41), amprometric, potentiometric and the method of general evaluation of sulfites in the automated system (42). Other methods used to measure the residual sodium hydrogen sulfite in food can be measured by measuring the sulfite/rosanilin color complex (after reaction with formaldehyde) by a spectrophotometer at 560 nm (43) and pointed to the polarographic method (44).

5.Examination of sodium hydrosulfite residues in Iranian food

Some studies have been assessed residual blankit in Iranian food and summarized in Table 2. In the study of Mohseni et al. (2014) used to measure the residual blankit in sugar loaf a sensitive and accurate polarography method. Among the sugar manufactories in Zanjan province, 17 sugar samples were selected according to the standard sampling method of Iran. Polarography analysis showed that the residual amount of blankit in sugar samples were varied in the range of less than 1.40 ppm to 13.24 ppm. However, in 6% of samples, the amount of blankit was reported to be higher than the maximum allowed (10 ppm Iranian standard and 15 ppm in AOAC and USDA) (45). In the study of Asgari et al. (2018) measured the concentration of blankit in *Lavash, Barbari* and *Sangak* breads produced in Hamedan, Iran at 560 nm using a spectrophotometer. In 97% of the samples, there was no blankit and the highest amount of blankit in *Lavash* breads was from 0 to 10.2 ppm. The results of this study showed that the addition of blankit in bread processing and its removal by heat does not pose a risk to human health (11). In another study of Salimi et al. (2017) was assessed the amount of sulfur anhydride residue as an indicator of the presence of blankit in 88 samples of sugar products (48 samples of sugar loaf, 11 samples of sugar-cheese and 29 samples of traditional candies) using iodometric method in Ardabil province, Iran. The results showed that the amount of blankit residue in more than one third of sugar products and was higher than the Iranian standard, i.e. more than 10 ppm (33.3% sugar loaf and 36.4% cheese-sugar). The amount of blankit reside in all traditional plant samples was reported as standard (below 10 ppm). Seidmohammadi et al. (2018) performed to determine the concentration of blankit in the Rock Candies Produced in Hamadan, Iran by a spectrophotometer at 560 nm. The results of the study showed that in 37.5% of the total samples, the concentration blankit was above the standard value. Also, the highest and lowest values of blankit were 23.85 and 3.2 mg/kg, respectively (46). In another research, (48) in a study diagnosed the level of blankit in the sugar using a spectrophotometer. According to the results obtained, from 46 samples, were determined blankit agreeing the national standard 73.7% and non-compliant samples 26.3% (47).

Table 2. Studies in the literature related to the use of blanket in food in Iran

Food product	Sample size	Over limit	Measurement	Reference
Sugar Loaf	17	6%	Polarography	Mohseni et al. (2014)
Bread	85	3%	Spectrophotometry	Asgari et al. (2018)
Sugar loaf	48	33.3%	Idiometry	Salimi et al.(2017)
Sugar-chease	11	36.4%		
Traditional candy	29	0%		
Rock Candy	80	37.5%	Spectrophotometry	Mohammadi et al. (2017)
Rock Candy	120	10%	Spectrophotometry	Mohammadi-Thani et al. (2008)
Sugar Loaf	46	26.3%	Spectrophotometry	Rahimi Rad et al. (2009)

6. Conclusion

According to the findings of studies on sodium hydrosulfite on the human health, the use of sodium hydrosulfite due to gastrointestinal cancer and diabetes should be reviewed more in future studies. Also, in the studies performed on the residue of this substance in food, it was found that in a few samples and higher than the standards, which requires careful monitoring of food quality.

Conflict of interest

The authors have no conflict of interest.

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