SODIUM HYDROGEN SULFATE
Chemical and Technical Assessment (CTA)

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1. Summary

At the seventy-first meeting of JECFA, the Committee evaluated the safety, dietary intake and revision of specifications of sodium hydrogen sulfate ($NaHSO_4$) at the request of the Codex Committee on Food Additives for its use as an acidifier. The Committee, at its sixty-eighth meeting (FAO/WHO, 2007), established specifications for sodium hydrogen sulfate for use in the preparation of acidified sodium chlorite, an antimicrobial washing solution. Sodium hydrogen sulfate, when added to food products containing water, ionizes to sodium ions, hydrogen ions, and sulfate ions. Since Acceptable Daily Intakes (ADIs) have been previously established for these ions, sodium hydrogen sulfate was not evaluated at the sixty-eighth meeting of the Committee. This document summarizes chemical and technical information on sodium hydrogen sulfate, partly based on information submitted by Jones-Hamilton Co.[1].

2. Description

Sodium hydrogen sulfate ($NaHSO_4$, CAS No. 7681-38-1) is a colourless crystalline compound which is freely soluble in water. Sodium hydrogen sulfate, when added to food products containing water, ionizes to sodium ions, hydrogen ions, and sulfate ions. In addition to its use as an acidifier in foods (including its use in the preparation of acidified sodium chlorite), it also is used as an acidifier in pet foods, for pH control in swimming pools and SPAs, for ammonia control in livestock operations, and as an acid-type cleaner for commercial purposes.

3. Methods of Manufacture

Sodium chloride and sulfuric acid are the starting materials in the manufacture of sodium hydrogen sulfate. Sodium chloride is first dissolved in water and then re-crystallized to produce a food-grade salt. Sulfuric acid is obtained from the roasting of natural sulfur-containing ores, resulting in the production of sulfur oxides that are dissolved in water to produce sulfuric acid. The salt and sulfuric acid are combined at elevated temperatures to produce molten sodium hydrogen sulfate according to the following reaction:

$$NaCl + H_2SO_4 \xrightarrow{\text{Heat}} NaHSO_4 + HCl$$

Once the reaction is complete, the molten sodium hydrogen sulfate is sprayed and cooled in order to form a solid beaded product. The final product is inspected for consistent particle size and packed in appropriate containers.

4. Chemical Characterization

4.1 Composition

In commercial products, sodium hydrogen sulfate is present at levels ranging between 85.4 and 95.2%. The purity of sodium hydrogen sulfate is further ensured by limiting the content of water insoluble matter.

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[1] JONES-HAMILTON CO., 30354, Tracy Rd., Walbridge, OH 43465, United States of America.

4.2 Possible impurities

Levels of lead and selenium occurring in the final product are as a result of their occurrence in the starting materials, obtained from natural sources, and are limited by the specifications parameters which indicate the limits of not more than 2 and 5 mg/kg, respectively.

4.3 Rationale for proposed specifications

Three non-consecutive lots of sodium hydrogen sulfate were tested to verify that the manufacturing process produces a consistent product that falls within the limits of the proposed specifications. Results of the analysis are presented in Table 1. The analytical data demonstrates that the manufacturing process consistently produces a uniform final product. Moreover, the proposed specifications for sodium hydrogen sulfate are supported by the results of the analysis of the composition of these lots. The proposed specifications were in harmony with other regional and national specifications and with the limits in the JECFA specifications monograph for sodium hydrogen sulphate prepared at the sixty-eighth meeting of the Committee.

Table 1. Analytical results for 3 batches of sodium hydrogen sulfate

Test	Lot 1	Lot 2	Lot 3
Assay (% as $NaHSO_4$)	93.8	94.0	93.8
Lead (mg/kg)	<0.5	<0.5	<0.4
Loss on drying (%)	0.4	0.16	<0.14
Selenium (mg/kg)	0.3	<1.0	<2.0
Water-insoluble substances (%)	0.019	<0.05	<0.05

4.4 Analytical methods

The majority of analytical methods used are the standard test methods, published in the Combined Compendium of Food Additive Specifications (FAO JECFA Monographs 1, Volume 4, 2006). Other methods are based on the Food Chemicals Codex (FCC, 2008) and the British Pharmacopoeia (BP, 2007).

5. Functional uses

5.1 Technological functions

Sodium hydrogen sulfate, when added to food products containing water, first ionizes to sodium and hydrogen sulfate ions. Hydrogen sulfate ion further dissociates in water to sulfate and hydronium ions.

$$NaHSO_4 \rightarrow Na^+ + HSO_4^-$$
$$HSO_4^- + H_2O \leftrightarrows H_3O^+ + SO_4^{-2}$$

Sodium hydrogen sulfate can be used as an acidifier in foods as well as in the preparation of acidified sodium chlorite, an antimicrobial washing solution. The pKa values of various food acids are given below.

Compound	pKa value
Sodium hydrogen sulfate	1.99
Phosphoric Acid (pKa_1)	2.16
Lactic Acid	3.08
Citric Acid (pKa_1)	3.14
Malic Acid (pKa_1)	3.40
Acetic Acid	4.75

Sodium hydrogen sulfate has the lowest pKa value which makes it unique among the conventional food acids. Due to low pKa of HSO_4^-, less quantity of sodium hydrogen sulfate is required to reach a low pH in a food or beverage system as compared to other food acids, which makes for its ability to lower the pH without imparting a sour taste. Other acidifying substances such as citric, malic and phosphoric acids impart their characteristic sourness to the food. Because of its unique characteristics, sodium hydrogen sulfate creates new opportunities in product development and product improvement. Other uses of sodium hydrogen sulfate include (a) use in the preparation of acidified sodium chlorite, an antimicrobial washing solution, (b) an acidifier in pet foods, (c) for pH control in swimming pools and spas, (d) for ammonia control in livestock operations, and as an acid-type cleaner for commercial purposes.

5.2 Food categories and use levels

Acids are added to foods for pH regulation and impart/modify flavour characteristics. The final pH is a limiting factor for the amount of the acid added. Since sodium hydrogen sulfate is a strong acid, less is required to bring about the required pH as compared to other acidifiers. For example, to achieve a standard beverage pH of 3.2, it requires half the amount of sodium hydrogen sulfate as compared to citric acid. At this rate of addition, it contributes 480 mg/l sulfate, which is below the United States and Canadian guidelines for drinking water, 115 mg/l sodium, and 5 mg/l hydrogen ion, all are relatively at low levels. The typical use levels of sodium hydrogen sulfate in various foods are shown below:

Food category	**Typical use level (%)**
Beverages	0.06
Confectionary, filling and syrups	0.1
Processed cheeses	0.4
Dressing and sauces	0.2
Jams and jellies	0.08
Processed vegetable and vegetable juices	0.3
Soup and soup mixes	0.4
Salsa	0.05

6. Reactions and fate in foods

The highest usage level for sodium hydrogen sulfate in foods is 0.4%. At this level of addition, the final concentration for these contaminants in the food would be 0.008 mg/kg lead and 0.02 mg/kg selenium. Normal food processes have no effect on these contaminants.

7. References

British Pharmacopoeia (BP), 2007. British Pharmacopoeia Commission Office, The Stationery Office on Behalf of the Medicines and Healthcare Products Regulatory Agency (MHRA), London, United Kingdom.

FAO, 2006. Combined compendium of food additive specifications. FAO JECFA Monographs, No. 1, Volume 4. Rome, Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/ag/agn/jecfa-additives/search.html?lang=en; http://www.fao.org/docrep/009/a0691e/a0691e00.HTM (Accessed 14 September 2009).

Food Chemicals Codex (FCC), 2008. 6th Ed., United States Pharmacopeia, Rockville, MD, United States of America.

FAO/WHO, 2007. Evaluation of certain food additives (Sixty-eighth report of the Joint FAO/WHO Expert Committee on Food Additives). Geneva, World Health Organization (WHO Technical Report Series, No. 947).