Sorbates and benzoates in meat and meat products: Importance, application and determination

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Sorbates and benzoates in meat and meat products: Importance, application and determination

A Bajcic[1], R B Petronijevic[1], M Sefer[1], D Trbovic[1], V Djordjevic[1], J Ciric[1] and A Nikolic[1]

[1] Institute of Meat Hygiene and Technology, Kacanskog 13, 11000 Belgrade, Republic of Serbia

E-mail: radivoj.petronijevic@inmes.rs

Abstract. Recent views on the use of preservatives sorbic and benzoic acids and their salts in meat products are presented from the point of accordance with current legislation in the Republic of Serbia and the EU, food safety and public health risks, and mainstreams in the methodology for their determination. These preservatives are permitted to be added individually or in combination, the maximum level is applicable to the sum and the levels are expressed as the free acid. Currently set values of the recommended daily intake of sorbate and benzoate are 25 mg/kg and 5 mg/kg, respectively. These values vary and depend on regulations in different countries. Considering control of the use of these additives, the most common methods for their determination are chromatographic methods based on high performance, or high pressure, liquid chromatography with diode array detectors.

1. Introduction

In order to prolong the shelf life of food in general, as well as meat products, several methods of their preservation have been developed in the food industry. The use of preservatives is a chemical method of preserving food [1]. Their application is versatile: to prevent reproduction of microorganisms, to reduce the chemical oxidation processes to a minimum and to reduce the darkening of products [2]. The harmfulness of the presence of microorganisms in meat products is multiple [3]. By reducing their number, a reduction is achieved of their metabolic products, which are directly related to faster food spoilage, and are also toxic to humans. Sorbic and benzoic acids, as well as their salts, have been widely used as antimicrobial preservatives in foods with a lower pH value.

2. Sorbic acid and sorbates

The food additive sorbic acid has a role of general food preservative and is known under the number E 200. Beside sorbic acid, its salts (potassium sorbate, E 202 and calcium sorbate, E 203) are also allowed to be used in meat products [4,8,9]. Sorbic acid is an unsaturated fatty acid, chemical name 2,4 hexadienoic acid, primarily extracted from plants [5,6]. Today, sorbic acid and its salts are produced synthetically and marketed in the form of powder or granules. They have a neutral taste and smell, which is a very important characteristic, because they do not affect the sensory properties of the products in which they are used. Due to their physical and chemical properties, sorbates can be used in various food categories such as aqueous solutions, fat emulsions, suspensions, gels and other products with a high water content [7]. Usually, sorbates in amounts of 0.1 - 0.2% are added to food.

The average recommended daily intake (RDI) for humans is up to 25 mg/kg, but these values vary and depend on regulations in different countries [10,11]. The mechanism of their antimicrobial effect is not fully explained. As a weak lipid-soluble acid, sorbic acid dissolves the membrane of microorganisms, penetrates and accumulates in the cell, affects the pH of the cell contents, which results in disruption of transport and metabolic functions, and ultimately causes cell death [12,13]. Sorbates are mostly used as inhibitors of mould and yeast growth, but they are effective in reducing the production of bacterial biofilm [14,15]. If the pH of the product is lower, the effects of sorbates are more efficient. The best effects are in the range of pH 3-6.5 [16]. For use in human nutrition, they show very low harmful effects, which have been shown by numerous studies conducted on laboratory animals [17,18].

3. Benzoic acid and benzoates

Benzoic acid was first described in the 16th century. It is an aromatic carboxylic acid found naturally in prunes, cinnamon and cloves [16]. It is known as a preservative under the number E 210, and its salts that are also widely used as preservatives are sodium benzoate E 211, potassium benzoate E 212 and calcium benzoate E 213 [4,8,9].

Benzoic acid has low toxicity, and its use within the permitted limits does not harm human health. However, the danger is its conversion to benzene, which is a carcinogenic and toxic compound, but studies have shown that there is little chance that this reaction will occur in food [16].

The use of benzoate in food has an antimicrobial effect. Benzoates primarily have an inhibitory effect on yeasts and moulds, but also, like sorbates, they have a bactericidal effect. As benzoates are weak acids, they are used in products with a pH value below 7. The pH range in which they show the best effects is pH 2.5-4 [19]. In the food industry, they are used as additives and are added to products in amounts of 0.05-0.1% [20]. They are widely used in carbonated drinks, where they provide long-term product safety despite the constant opening and closing of products. They are also used in jams, fruit salads, minced meat, ice cream, pickles and non-alcoholic beverages [21]. The RDI of benzoate is up to 5 mg/kg body weight [22]. Excessive use can lead to abdominal pain, enlargement of the liver and kidneys, as well as diarrhoea [21,23].

4. Domestic and EU regulations on preservatives in meat products

Legislation [4,8,9] relating to the use of sorbic acid and benzoic acid and their salts in meat products in various ways regulate their addition in particular categories of products.

4.1. Fresh meat, meat preparations and non-heat-treated processed meat

In accordance with the regulations, sorbic acid and sorbates and benzoic acid and benzoates are not allowed at all in fresh meat and meat preparations. Also, in the non-heat-treated processed meat category, the use of these compounds is allowed only for surface treatment of dried products in the *quantum satis* amount [4,9].

4.2. Heat-treated processed meat

The regulations for heat-treated processed meat are rather different, so the use of sorbic acid and sorbates is allowed up to 1000 mg per kg only in pâtés and in the same quantity only in aspic, and benzoic acid and benzoate only in aspic up to 500 mg per kg. These preservatives are permitted to be added individually or in combination, the maximum level is applicable to the sum and the levels are expressed as the free acid [4,9]. In local Serbian regulation [4], in the same category of processed meat, sorbic acid and sorbates and benzoic acid and benzoates are allowed in the *quantum satis* amount for surface treatment of heat-treated, dried products.

4.3. Casings, coatings and decorations for meat

In this category, the regulation allows the use of sorbic acid and sorbates in the *quantum satis* amount only in collagen-based casings with water activity greater than 0.6, and up to 1000 mg per kg only in jelly coatings for meat products (cooked, cured or dried) [4,9]. As in the previous category, sorbic acid

and sorbates are permitted to be added individually or in combination, and the maximum level is applicable to the sum and the levels are expressed as the free acid. Benzoic acid and benzoates are not allowed in these products.

5. Determination of sorbates and benzoates in meat products

Several analytical techniques have been used for determination of sorbic and benzoic acids and their salts in meat products. The two main classes of methods for determination of these additives are ones based on spectrophotometry and chromatography [24].

Spectrophotometric analytical methods have been seldom used to determine sorbates and benzoates in meat products in recent times [24]. The reason for this is the complex techniques of sample preparation for analysis and the possibility that other compounds present in the sample interfere with the determination.

Today, the most common chromatographic methods are based on the technique of high pressure liquid chromatography (HPLC) or ultra-high pressure liquid chromatography (UHPLC, UPLC). After relatively simple extraction procedure from meat product sample and purification of extract, sorbates and benzoates have been determined by HPLC with various detection techniques. The most common detection techniques for HPLC determination of sorbates/benzoates use photodiode array (PDA) or diode array (DAD) detectors. Also, methods involving mass spectrometer detection were used [25].

In most cases, the same method can be used to determine sorbates and benzoates along with some other additives [26]. The variety of analytes that can be determined by these methods along with sorbates and benzoates, especially when it comes to additives added to meat products, gives them special importance for controlling the use of additives in accordance with legislation, food safety and public health control.

6. Conclusion

Sorbates and benzoates are of great importance for preventing spoilage and prolonging the shelf life of food, including meat products. Despite the fact that there is no clear evidence of their potential harmful effects on the health of consumers, studies are periodically conducted to re-evaluate their use in food and meat products. In order to increase food safety and reduce consumer health risks, RDI values of these additives have been set.

In order to maintain a satisfactory level of food safety and to ensure the achievement of the conditions of health recommendations as required by RDI, legislation has been adopted regarding the use of these additives in food. The use of sorbates and benzoates is very strictly regulated in meat products and is allowed mainly for external use, on surfaces of non-heat-treated processed meat and casings, coatings and decorations for meat. In fresh meat and meat preparations their use is not permitted. The exception is their use in heat-treated processed meat, which is limited to the addition of sorbic acid and sorbates and benzoic acid and benzoates only in aspic, as well as sorbic acid and sorbates only in pâtés. The local Serbian regulation allows the external use of sorbates and benzoates in heat-treated processed meat for use on the surface of smoked products.

Today, HPLC chromatographic methods with diode-array detectors are mostly used to determine the content of sorbates and benzoates because such systems are low-cost and available, analyte extraction is simple, and sample preparation does not require complicated purifications and time-consuming sample manipulation. These methods can usually be used at the same time to determine other additives, such as added colours, which increases the methods' usability for controlling the use of additives in meat products.

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