ASESSMENT OF SODIUM BENZOATE (E 211) INCLUSION RATE AS ANTISEPTIC FOOD ADDITIVE IN SAUCES, FISH ROE AND MARINATED PRODUCTS

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Abstract

Six products belonging in two food categories (sauces and fish roe and marinated products) have been investigated in laboratory via spectrophotocolorimetry to identify and quantify the usage of sodium benzoate as food additive with antiseptic-preservative purpose. The inclusion level of E-211 in the first group (mayonnaise) was 68.2-72.7% less than the maximum admitted inclusion level (AIL) (100 mg additive/100g product, while the calculated daily intake through eating a portion (20g) reached 3.6-4.2% out of the maximal admitted daily intake (MADI) for children and 0.9-1.59% of the MADI for adults. The concentration detected in the fish roe and marinated products was 38.67-40.93% lower than the AIL for this food category (150 mg/100 g). Calculus of the daily intake for a serving portion of fish roe (env. 60 g) reached 35.44-39.36% of the MADI for children and 13.28-18.96% for adult consumers. Although the inclusion rates were below the maximal admitted limits, if we cumulate the potential intake of the sodium benzoate from this two food sources with other food preferred by children (sweet treats and sodas), the daily intake dose for this additive present becomes alarming and could endanger the health of young age consumers.

Key words: sodium benzoate, inclusion level, daily intake, mayonnaise, fish roe

INTRODUCTION

The most numerous group among additives that slow down food spoilage is represented by the antiseptic ones, commonly known as 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 [5]. In food products, preservatives change the permeability of cytoplasmic membranes or cell walls, damage the genetic system, and deactivate some enzymes [24]. Food is preserved using antiseptics or antibiotics [18]. The former ones 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, were also used in very small, yet effective, doses but they were eventually cancelled, due to antibioresistance installation in both foodborne pathogens and in consumers [8, 17, 30]. 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, mold, or yeast) [26]. 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 stabilization methods, such as drying, pickling, sterilizing, 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

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irradiation, packaging, and storing products in a modified atmosphere, using aseptic technology [32], along with newer biotechnological methods, as the usage of beneficial bacteria [13] or bacteriophage viruses capable to selectively destroy the foodborne pathogens only [4]. Products that are most commonly preserved include ready-made dishes and sauces, meat and fish products, fizzy drinks, and ready-made deserts [19, 21].

Other substances used as preservatives are acids and acidity regulators. These substances lower the pH level and slow down the growth of enzymes and yeasts, which hampers the development of fermentations and unwanted microbiota species [28]. They are used mainly in the production of marinades. Specific mixtures of acetic acid, salt and sugar are used to preserve and equally provide flavor to pickled vegetables [15]. However, 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% [5]. Acids and acidity regulators are also used to enhance flavor (usually in fruit or vegetable products, or beverages, to bring out their sour taste) or to facilitate gelatinization and frothing during food processing [22, 31].

A Report of European Food Safety Authority from 2015 [10] says 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).

Other studies [25] demonstrate that mayonnaises and mustards are the fourth most often preserved product group, with ready-made concentrates ranking seventh.

The food products investigated within this study belonged to two groups in whose composition the benzoic acid and its salts can be included. The additives in this group, coded by the E numbers E210-E213 in the Codex Alimentarius catalogue [12], are known for inducing some adverse effects in consumers' health. The oral and/or dermal exposure to benzoic acid [9] and to sodium benzoate could produce rush, asthma, rhinitis [16, 27] or even allergic reactions leading to sudden anaphylactic shock in certain highly sensitive consumers [1, 23].

Experimental data, issued from laboratory analysis on the investigated products, served to estimate the daily ingested intake for sodium benzoate, in relation with the food category, with the consumer type (age, gender, body weight). All the data was interpreted in relation with the on-force regulations on the usage of sodium benzoate as antiseptic (preservative) food additive [11, 12].

MATERIAL AND METHOD

There have been studied two groups of food, in whose composition the usage of sodium benzoate as antiseptic additive is allowed at certain legal levels: "Sauces" (maximum inclusion level of 100 mg/100 g edible portion) and "Fish roe and marinated" (maximum inclusion level 150 mg per 100 g edible portion). Out of the first category (sauces), three brands of mayonnaises, have been investigated (coded mayonnaises A, mayonnaises B, mayonnaises C). Out of the second category, three commercial products of "Fish roe and marinated" type have been investigated (coded Fish roe A, Fish roe B, Fish roe C).

The analytical method was derived from the A.O.A.C. 960.38 and 980.17 methods [2, 3] and has as principle the Beer's laws.

Equipment: UV-VIS VWR UV-6300PC (double beam, reading wavelength spectrum: 190-1100±0.3 nm); quartz cuvettes; laboratory glassware (flasks of 150 ml, 100 ml balloons, 0.5, 1 and 10 ml pipettes).

Reagents: sodium benzoate 0.2% solution; bi-distilled and ultra-purified water.

Calibration curves: 6 successive diluted solutions of sodium benzoate are prepared (1; 2; 3; 4; 5; 6 ml sodium benzoate 0.2% solution added in 100 ml bi-distilled and ultra-purified water). Out of each dilution, there were taken 5 ml and were added to the measuring cuvettes. The blank sample cuvette is filled with 5 ml bi-distilled and ultra-purified water only. The successively

diluted solutions, as well as the blank sample, were read in spectrophotometer between 200-300 nm wavelengths. The values read at 225 nm (wavelength at which the sodium benzoate exerts absorbance of the photonic beam) were subtracted from the value read for the blank sample, resulting the quantitative values corresponding to 0.1-0.6 mg sodium benzoate.

Working procedure: 20g (mashed) or 20 ml for each food product have been sampled and introduced into a 100ml balloon. There were added 80ml bi-distilled and ultra-purified water to reach the whole balloon capacity. The balloons were steered then quantitatively filtered in 150 ml flasks. From the filtrate, 5ml have been taken and pipetted into the measuring cuvettes. Those were scanned at 200-300 nm wavelengths, observing the peak readings for 225 nm. The readings were expressed as deviations from blank sample reading. Hence every cuvette contains a dilution equivalent of 1 g or 1 ml sample, each point of 0.1 mg on the calibration curve represents 0.01% sodium benzoate. Ten reading replicates have been run for each analyzed product.

The acquired data have been statistically interpreted, computing the main statistical descriptors (mean, standard mean error and variation coefficient). The means have been compared with the maximum tolerated limits of sodium benzoate inclusion in food and relative differences were also calculated. Starting from the average obtained values, the ADI (average daily intake) of E-211 were calculated, in relation with the legal allowance and with the type of consumer (child - 30 kg body weight, adult woman - 60 kg body weight, adult man - 80 kg body weight). When ADI was calculated, the size of consumed portions was considered in accordance with every product specificity and consumption habits: 20 g for mayonnaise, 60 g of fish roe.

RESULTS AND DISCUSSIONS

The data on the occurrence and concentration of sodium benzoate in the analyzed mayonnaise are presented in table 1. In the situation of Mayonnaise A samples, the analytical values varied within the 24 - 32 mg sodium benzoate /100g, resulting a mean of 27.3 mg/100g, which represented 27.3 % of the maximal inclusion level (100 mg E-211/100 g product). In the other analyzed products, there were identified levels of 28-34 mg/100g Mayonnaise B, resulting an average content of 31.8 mg sodium benzoate/100 g, respectively values of 27-38 mg/100g Mayonnaise C, with an average of 31.6 mg sodium benzoate /100 g.

In order to estimate the daily intake of sodium benzoate, the eatable mayonnaise portion was considered of 20 g. The results are presented in table 2. It resulted that compared with the maximal allowed intake level (5 mg E-211/kg body weight), a child eating such a mayonnaise portion will ingest a daily dose of 0.182 mg/kg BW – 0.211 mg/kg BW, which means 3.6-4.2% of the maximal allowed daily intake. If such a product would be eaten by adults, we estimated a daily intake of 0.091 mg/kg BW – 0.106 mg/BW in women, respectively of 0.068-0.08 mg/kg BW in men, resulting proportions of 1.82-2.12% of the maximal allowed daily intake in women and 1.37-1.59% in men.

$\bar{x}$

Table 1 – Average values of the sodium benzoate contents in the three food products in the ”sauces” category

Analyzed product	Analytical value (mg/100 g) $\bar{X}$	Mean standard error $\pm s_{\bar{x}}$	Variation coefficient v%	Legal Inclusion threshold (mg/100 g)	% vs. legal threshold
Mayonnaise A	27.30	1.06	12.26	100	27.30
Mayonnaise B	31.80	0.69	6.89	100	31.80
Mayonnaise C	31.60	0.61	6.09	100	31.60

Table 2 – Estimation of the sodium benzoate (E-211) daily intake (mg/kg body weight) from the three products belonging to "Sauces" foods category

Consumer category	Analyzed product		
	Mayonnaise A	Mayonnaise B	Mayonnaise C
Maximal allowed intake	5	5	5
Child, 30 kg body weight	0.182	0.212	0.211
% of daily maximum allowed intake	*3.6*	*4.2*	*4.2*
Adult woman, 60 kg body weight	0.091	0.106	0.105
% of daily maximum allowed intake	*1.82*	*2.12*	*2.11*
Adult man, 80 kg body weight	0.068	0.080	0.079
% of daily maximum allowed intake	*1,37*	*1.59*	*1.58*

Results of the analytical trials related to the fish marinated with vegetables are presented in table 3. Results of the analysis on the fish roe content are presented in table 3.

Compared to the legal limit of E-211 inclusion for the food category "Fish roe and marinated" (150 mg/100 g), the analytical values oscillated between 80-92 mg/100 g in Fish roe A samples, between 82-96 mg/100 g in Fish roe B and between 96-104 mg/100 g in Fish roe C samples. Detection of such concentrations led to various proportions of persistence in the three products, respectively of 59.07%, 61.33% and 65.60%, compared with the maximal admitted level (150 mg/100 g) (table 3).

Table 3 – Average values of the sodium benzoate contents in the three food products in the "Fish roe and marinated products" category

Analyzed product	Analytical value (mg/100 g) $\overline{X}$	Mean standard error $\pm s_{\bar{x}}$	Variation coefficient v%	Legal Inclusion threshold (mg/100 g)	% vs. legal threshold
Fish roe A	88.60	2.02	7.21	150	59.07
Fish roe B	92.00	1.73	5.95	150	61.33
Fish roe C	98.40	1.00	3.21	150	65.60

Starting from these values and considering the size of an eaten portions of fish roe of 60 g per day, the daily intake of sodium benzoate has been calculated (table 4).

If such products would be consumed by children weighing 30 kg, the daily intake would reach 1.772-1.968 mg sodium benzoate per kg body weight (35.44-39.36% of the maximal allowed daily intake dosage, i.e. 5 mg preservative E-211/kg body weight). In adult consumers, the daily intake varied between 1.579-1.983 mg sodium benzoate/kg body weight in women (60 kg) or between 0.664-0.738 mg sodium benzoate/kg body weight in men (80 kg), resulting levels of 13.28-14.76% and 13.28-18.96% of the maximal allowed daily intake level in both analyzed genders (table 4).

Table 4 – Estimation of the sodium benzoate (E-211) daily intake (mg/kg body weight) from the three products belonging to "Fish roe and marinated" foods category

Consumer category	Analyzed product		
	Fish roe A	Fish roe B	Fish roe C
Maximal allowed intake	5	5	5
Child, 30 kg body weight	1.772	1.84	1.968
% of daily maximum allowed intake	*35.44*	*36.8*	*39.36*
Adult woman, 60 kg body weight	0.886	0.920	0.984
% of daily maximum allowed intake	*17.72*	*18.4*	*18.96*
Adult man, 80 kg body weight	0.664	0.690	0.738
% of daily maximum allowed intake	*13.28*	*13.80*	*14.76*

Although in the investigated foods, the intake proportions, compared to the maximal allowed daily intake were lower, if one child would consume a portion from both products in the same day, the real daily intake would reach 5.3-6.2%. In adult consumer, the daily cumulative intake of sodium benzoate from the two food categories would reach 2-4% of the daily maximal admitted intake level.

In both consumption scenarios, there must be proceeded with caution when children nutritional habits are considered, due to the cumulative intake of such food additives and, in particular, of sodium benzoate, from many other food categories [14]. It is known that E-211 is also used in sweet treats and fizzy drinks, frequently consumed by toddlers, school pupils and teenagers [29]. It is known that there are common food consumption patterns and preferences in children of such ages for products rich in antiseptic-preserving additives (fast-food products, sweets, snacks and sodas) [6, 7, 20].

CONCLUSIONS

The inclusion rate of sodium benzoate in the products from the "Sauces" category was 69.4-72.7% lower than the Maximal allowed inclusion level (100 mg/100g). The daily intake due to the consumption of 20 g mayonnaise represents 3.6-4.2% of the maximal allowed daily intake in children and 1.37-2.12% in adult consumers.

The E 211 concentration in Fish roe de samples was 40.93-44.4% below the maximum inclusion rate for such food (150 mg/100 g). Estimation of daily intake through a portion of fish roe (75 g) indicated a level of 35.44-39.36.7% of the maximal tolerated intake in children and 13.28-18.96% in adults.

Based on the achieved results, may we recommend increased caution in the nutritional choices that are made for children in order to avoid cumulative intake of food additives that could induce side effects on their health status.

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