

# ON THE USAGE OF TARTRAZINE (E102) IN CERTAIN FOOD PRODUCTS AND ESTIMATION OF POTENTIAL DAILY INTAKE

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## Abstract

The inclusion rate of the synthetic food dye Tartrazine E102 in 6 products from 2 categories of food products - "Fresh, non-alcoholic and flavored beverages - sodas," and "Snacks and nuts with salted crust" was studied using the photo-colorimetric method. The acquired data served to estimate the hypothetic daily intake of this additive, in relationship with the Romanians' consumption habits. The results revealed that: inclusion rate in "Multi-fruit soda" product was 87.2-88.5% lower than the maximum residual admitted level (20 mg/liter product); daily intake level through a portion of "Multi-fruit soda" (500 ml in adults and 200 ml in children) reached 1.28-1.42% of the maximum tolerated doze in children, respectively 0.96-1.39 % of it in adults; tartrazine inclusion rate in "Cheese snack" product was 34.0-47.2% lower than the maximum residual admitted level (100 mg/kg product); calculation of the daily intake through one portion of "Cheese snack" (120 g in adults and 50 g in children) reached 1.17-1.47% of the maximum tolerated doze in children and 1.06-1.47% in adults. Despite the fact that inclusion levels and intake values have not been exceeded, the cumulative effect should be considered when multiple food products containing tartrazine are consumed, knowing this additive is one of the most incriminated factors in the onset of allergenic and irritating conditions in adults, respectively of attention deficit and hyperactivity syndrome in children.

**Key words:** Tartrazine (E102), sodas, snacks

## INTRODUCTION

Under the behavioral conjuncture of the modern consumers' alimentary habits, dictated mostly by sensorial traits and by a poor interest in achieving right and true data on the food quality and possible risks of an unhealthy nutrition [11; 19; 20]. One of the ways used by food industry to influence the consumers' choice, appealing to their sensorial perception, is the usage of food colorings, either of natural or synthetic origin.

The azoic food dyes have one or more chromophore azoic groups (monoazo, diazo, triazo, poliazo). Their color ranges between the extremities of the visual spectrum (red to violet), covering the visual wavelengths for orange, yellow and blue. They could be, as well, black or brown [3]. The most relevant

for the food industry are the following additives: tartrazine, orange yellow, azorubine and amaranth blue [7, 17]. The chosen additive for this study was the tartrazine (coded E102) [7], a yellow dye – the trisodium salt of the hidroxil-5-p sulfonyl-1-(p-sulfonylazo)-4-pirazol carboxylic-3 (C<sub>18</sub>H<sub>9</sub>N<sub>4</sub>Na<sub>3</sub>O<sub>9</sub>S<sub>2</sub>) acid, usually available in its commercial form as a water soluble orange powder [3].

Tartrazine (E 102) could induce allergic reactions and asthma episodes [2] and is also incriminated among the initiating and maintaining factors of the Attention Deficit and Hyperactivity Disorder – ADHD – in children [18]. The consumers having a background of allergies, asthma, rhinitis and skin rashes could experience the intensifying of particular symptoms, consequently to tartrazine intake [14]. Tartrazine increases oxidative stress and generation of free radicals on the metabolic pathways, inducing subsequent associated

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morbidities [4]. Tartrazine also increases the incidence of thyroidal tumors, of colon cancer and induces allergic response and eczema on skin [16]. It seems that was also incriminated in the onset of digestive ulcerations [15] and of other carcinogenic processes, due to their associations with benzidine like compounds, most probably used as solvents or intermediary reagents during synthesis [13]. DNA alterations consequently to tartrazine consumption were suggested by multiple studies reviewed by the EFSA [6]. Experiments on laboratory animals also revealed the depressing effect of tartrazine onto the learning and memorizing mechanisms [10].

Other studies reported that the effects of food colorings consumption are exacerbated by an atopic or allergenic background in consumers, suggesting the existence of multiple synergies between the synthetic food dyes and other commonly occurring allergens [8].

Although straight and absolute correlations between artificial food colorings intake and certain pathogenesis were not reported by particular studies, certain state authorities imposed to decrease the usage rate of synthetic food dyes, in order to prevent certain undesired effects linked to multifactorial syndromes, such as ADHD [12, 18].

Within this conjuncture, the actual research aimed to study the occurrence and the concentration of an azoic synthetic food dye (tartrazine) in certain food categories consumed by both adults and children.

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.

## MATERIAL AND METHOD

There were studied two categories of foods, in which tartrazine is allowed to be used [5, 7, 9], as following:

a. "Fresh, non-alcoholic and flavored beverages – sodas" (maximum admitted inclusion rate = 20 mg tartrazine/liter

product), with three commercially available brands of multi-fruits flavored sodas: Soda A, Soda B, Soda C.

b. "Snacks and nuts with salted crust" (maximum admitted inclusion rate = 100 mg tartrazine/kg product), with three commercially available brands of cheese flavored snacks: Snacks A, Snacks B, Snacks C.

The analytical method was adapted from the AOAC Official Method 988.13 FD&C Color Additives in Foods Rapid Cleanup for Spectrophotometric and Thin-Layer Chromatographic Identification [1].

*Method principle* states that a photons fascicle is absorbed during the transmission through a measurement camera containing the solution to be investigated, in straight proportionality with the concentration of chromophore particles, at appropriate wavelengths for each investigated food coloring (425 nm in the case of tartrazine).

*Equipment:* UV-VIS VWR UV-6300PC spectrophotometer, double beam, with a wavelength interval of 190-1100±0.3 nm, quartz cuvettes, Berzelius flasks of 150 ml, Glass balloons quoted at 100 ml, volumetric pipettes of 0.5; 1; 10 ml..

*Reagents:* etalon solutions of 1, 10, 40 and 100 ppm tartrazine, prepared as reconstitutions from commercial food additive powder and bi-distilled ultra purified water.

*Standard curves:* 6 successive dilutions are prepared from the etalon solutions, introducing 1; 2; 3; 4; 5; 6 ml in quoted balloons and completing till quoting with the appropriate volume of bi-distilled ultra purified water

Five ml are sampled from each prepared balloon and are introduced in the quartz cuvettes. Blank sample consists in a cuvette filled in with 5 ml ultra purified water.

The cuvettes with successive dilutions are read at spectrophotometer, within the 375 - 475 nm wavelength interval, knowing the maximum absorbance for tartrazine occurs at 425 nm. The blank value absorbance is subtracted from the values for the tartrazine samples and the appropriate values of concentrations are found, within the interval 1-240 ppm (mg/kg or mg/L) tartrazine;

*Analytical procedure:* 20 g thin grounded (homogenized) sample are introduced into a

quoted balloon with 100 ml capacity, then filled with ultra purified water till the quoted volume. The recipient is stirred env. 10 minutes for the complete extraction of the dye then the content is filtered in Berzelius flasks. From each resulted filtrate, 5 ml are pipetted into the quartz cuvettes. They are afterwards exposed to beam reading using the same wavelength interval like in the calibrating curve procedure and there are supervised the peaks corresponding to the maximal absorbance wavelength of tartrazine (425 nm).

The data acquired from the 10 replications per sample, read using the UV-Vis spectrophotometers were statistically processed to obtain the arithmetic mean, standard mean error and variation coefficient. The average values were expressed as percentage from the maximum inclusion levels approved by the EU and FAO regulations [5, 7, 9].

Using these data, the hypothetical daily intake of tartrazine was estimated and compared with the maximal admitted daily intake level, regulated by the en-force regulations for the three types of standard consumers (adults –

woman weighing 60 kg, man weighing 80 kg and child weighing 30 kg).

The daily size of the portions was considered in accordance with the consumptions habits, as following:

- product Multi-fruits soda:
  - \* adults: 2 portions of 250 ml = 500 ml;
  - \* children: one portion of 250 ml.
- product Cheese flavored snacks:
  - \* adults: one portion of 120 g;
  - \* children: one portion of 50 g.

## RESULTS AND DISCUSSIONS

The results on the quantity of tartrazine detected in the three multi-fruit acidulated beverages (sodas) are presented in table 1 and fig. 1, as averages of the 10 analytical replications per product and as relative deviation from the maximal admitted inclusion rate in the final product.

In product Soda A, the remnant dose of tartrazine varied between 8 and 17 mg/liter final product, with a mean of  $11.50 \pm 0.89$  mg tartrazine/liter, that represented 57.5% of the inclusion rate maximum allowed legally.

Table 1 Tartrazine content in the three commercial products belonging to the “Fresh, non-alcoholic and flavored beverages – sodas” category

Analyzed product	Analytical value (mg/L) $\bar{X}$	Mean standard error $\pm S_{\bar{x}}$	Variation coefficient v%	Legal inclusion threshold (mg/L)	% vs. legal inclusion threshold
Soda A	11.50	0.89	24.34	20	57.50
Soda B	12.50	1.08	27.26	20	62.50
Soda C	12.80	1.09	27.01	20	64.00

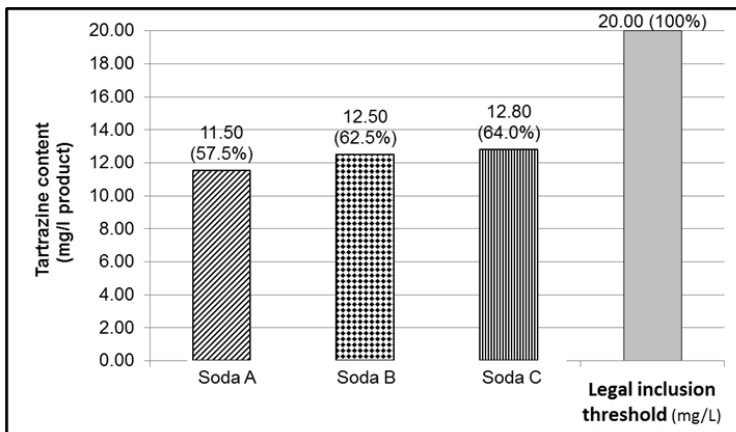


Fig. 1 - Tartrazine content in “Fresh, non-alcoholic and flavored beverages” – sodas (mg/l product) and percentage of the maximum admitted inclusion rate

In the 2<sup>nd</sup> analyzed product – Soda B -, the analytical values oscillated within the 7-18 mg tartrazine/liter, hence a mean value of  $12.50 \pm 1.08$  mg/liter, that meant 62.5% of maximal allowed inclusion rate.

The analytical findings on the 3<sup>rd</sup> product Soda C – indicated 7-18 mg E102 food additive/liter product, while most of the values passed above the 10 mg/liter threshold. The calculated mean value was  $12.80 \pm 0.9$  mg tartrazine/liter), that meant 64% of the maximal regulated inclusion rate (20 mg tartrazine/soda liter).

Hypothetical daily intake (HDI) of tartrazine was calculated using a theoretical consumption dose of 500 ml in adults and of 250 ml in children consumers. The estimated results are presented in table 2.

Thus, in comparison with the allowed daily intake, regulated by J.E.C.F.A. and

published by the competent authorities (7.5 mg tartrazine/kg body weight), the results obtained for adult women weighing 60 kg oscillated between 0.096-0.107 mg tartrazine/kg body weight, converted into a percentage level of 1.28-1.42% of the maximal allowed daily intake.

In adult men, weighing 80 kg, the hypothetical daily intake of tartrazine varied between 0.072 and 0.080 mg/kg body weight, representing thus 0.96-1.07 of the daily allowed intake.

In children weighing 30 kg, the values of the daily hypothetical tartrazine intake were found between the 0.096-0.107 mg/kg body weight limits, representing 1.28-1.42% of the maximum legally admitted daily intake: 7.5 mg tartrazine/kg body weight.

Table 2 – Estimated tartrazine daily intake(mg/kg body weight) via products in food group “Fresh, non-alcoholic and flavored beverages – sodas”

Consumer category	Analyzed product		
	SodaA	SodaB	Soda C
Maximal allowed intake	7.5	7.5	7.5
Adult woman, 60 kg body weight	0.096	0.104	0.107
<i>% of daily maximum allowed intake</i>	<i>1.28</i>	<i>1.39</i>	<i>1.42</i>
Adult man, 80 kg body weight	0.072	0.078	0.080
<i>% of daily maximum allowed intake</i>	<i>0.96</i>	<i>1.04</i>	<i>1.07</i>
Child, 30 kg body weight	0.096	0.104	0.107
<i>% of daily maximum allowed intake</i>	<i>1.28</i>	<i>1.39</i>	<i>1.42</i>

Knowing this additive is often incriminated as the most favoring factors of the allergies and irritative syndrome in adults, as well as of the attention deficit and hyperactivity disorder in children [18], the effect of cumulative consumption from multiple food categories that might contain tartrazine should be taken into consideration.

The analytical findings related to the tartrazine content of the products Cheese flavored snacks are displayed in table 3 and fig. 2. Thus, the E-102 food additive was identified in product Snacks A and quantified within the de 38-65 mg/kg analytical range, resulting a mean of  $52.8 \pm 2.59$  mg tartrazine / kg product (52.80% of the maximal residual

dose, regulated at 100 mg tartrazine/kg final product).

In product Snacks B, the remnant average content of tartrazine, calculated on the basis of the extreme analytical findings of 51 and 63 mg/kg was of  $57.10 \pm 1.20$  mg tartrazine/kg (57.1 % of the residual dose legally regulated).

In the 3<sup>rd</sup> analyzed product, the analytical calculated average was of  $66.00 \pm 2.05$  mg/kg product, obtained on the basis of an analytical results variation between 56 and 75 mg tartrazine/kg. Therefore, the residual tartrazine in the Snacks C finished product represented 66% of the maximal allowed inclusion level.

Table 3 Tartrazine content in the three commercial products belonging to the "Snacks and nuts with salted crust" category

Analyzed product	Analytical value (mg/kg product) $\bar{X}$	Mean standard error $\pm s_x$	Variation coefficient v%	Legal Inclusion threshold (mg/kg)	% vs. legal inclusion threshold
Snacks A	52.8	2.59	15.51	100	52.8
Snacks B	57.1	1.20	6.63	100	57.1
Snacks C	66.1	2.05	9.82	100	66.1

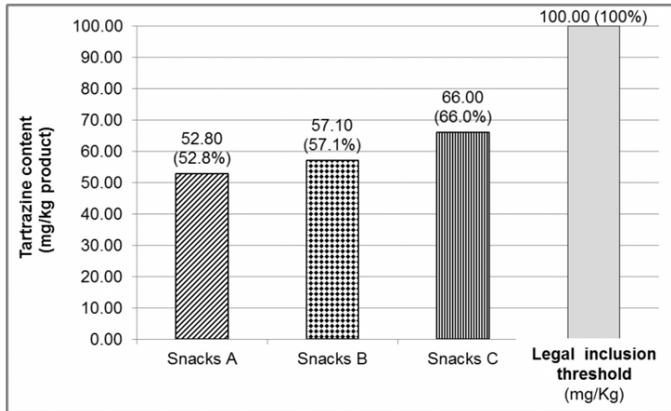


Fig. 2 Tartrazine content in "Snacks and nuts with salted crust" – sodas (mg/l product) and percentage of the maximum admitted inclusion rate

It is interesting that, in comparison with the first food category (sodas), in snacks, the residual amounts of tartrazine were quite 4 times higher, however filling in within the maximal admitted inclusion rate, varying between 52.8 mg E102/kg and 66.0 mg

E102/kg, in comparison with the legal inclusion threshold (100 mg tartrazine/kg product).

The daily hypothetical intake was estimated using different portion sizes in adults (120 g), and children (50 g). the resulted values are presented in table4.

Table 4 Estimated tartrazine daily intake (mg/kg body weight) via products in food group "Snacks and nuts with salted crust"

Consumer category	Analyzed product		
	Snacks A	Snacks B	Snacks C
Maximal allowed intake	7.5	7.5	7.5
Adult woman, 60 kg body weight	0.106	0.114	0.132
<i>% of daily maximum allowed intake</i>	1.41	1.52	1.76
Adult man, 80 kg body weight	0.079	0.086	0.099
<i>% of daily maximum allowed intake</i>	1.06	1.14	1.32
Child, 30 kg body weight	0.088	0.095	0.110
<i>% of daily maximum allowed intake</i>	1.17	1.27	1.47

In adult women, weighing 60 kg, the daily hypothetical intake oscillated between 0.106-0.132 mg tartrazine/kg body weight which represented 1.41-1.76% of the maximal allowed daily intake (7.5 mg tartrazine/kg body weight).

In adult men, weighing 80 kg, the daily intake, hypothetically estimated through the

consumption of 120 g cheese flavored snacks, would reach 0.079-0.099 mg tartrazine/kg body weight, meaning a level of 1.06-1.32 % of the maximal dose admitted for ingestion per day.

Finally, in children weighing 30 kg that would consume daily a portion of 50 g snacks, it was calculated a hypothetical intake of 0.088-0.110 mg tartrazine/kg body

weight, respectively 1.17-1.47% of the maximal allowed intake per day (7.5 mg/kg body weight).

## CONCLUSIONS

A cumulative computation for daily intake of tartrazine, due to the consumption of both products (soda and snacks) indicates proportional values of 2.02-2.39% from the maximal admitted daily intake in adult men; 2.69-3.18% in adult women and 2.45-2.87% in children.

Therefore, despite the fact that the daily intake is quite low compared with the maximum admitted one, it should proceed with caution when adults and children nutritional habits are considered, due to the cumulative intake of food colorings and of other potential harmful additives (such as antiseptic agents) because most of them are used in sensorial appealing products, such as sodas and other beverages, many sweet confectioneries, all parts of the daily modern human diet.

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