Study of EDTA intake of children for potential use of FeNaEDTA for breakfast cereal fortification

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SUMMARY. EDTA is used as disodium salt or disodium-calcium in foods, to prevent lipid oxidation or as color and flavor stabilizer. In some countries, FeNaEDTA is also used as a source of iron for fortification. However, EDTA has an Acceptable Daily Intake (ADI) of 2.5 mg / kg/day. The aim of this study was to estimate the intake of EDTA in children of school age and the potential use of FeNaEDTA as iron source for breakfast cereal fortification. A qualitative-quantitative food frequency questionnaire was conducted on 225 schoolchildren of both sexes, aged between 4 and 13, from school canteens, public and private schools, from the city of Santa Fe (Argentina). Only those foods which EDTA addition is allowed in Argentina: packaged ice cream, soda, soft drinks and powdered soft drinks (upper limit of Na₂EDTA o Na₂CaEDTA: 35 mg/kg) and dressings and margarines (upper limit of Na₂CaEDTA: 75 mg/kg) were considered. EDTA Average Daily Consumption (ADC) was 0.06 mg/kg/day with a median of 0.011 mg/kg/day, representing 2.4% of the ADI. In the hypothetical case that FeNaEDTA would be used as iron source for breakfast cereal fortification at level of 11 mg Fe%, the potential EDTA ADC would be 0.46 ± 0.32 mg/kg/day, representing 18.4% of the ADI (2.5 mg/kg/day). Results indicate that children from Santa Fe city have an EDTA ADC currently well below the maximum ADI of EDTA, which would remain low even if FeNaEDTA is used for breakfast cereal fortification.

Key words: EDTA consumption, iron fortification, FeNaEDTA, breakfast cereals, food frequency questionnaire.

INTRODUCTION

Iron-deficiency anemia is the most prevalent disease in developed and undeveloped countries, affecting two million people worldwide (1, 2). Risk groups are young children and women of childbearing age. During periods of rapid growth, blood volume expands and more iron for red blood cells is needed. Iron deficiency can result in neurological and muscular diseases in pregnant women, prema-

ture birth and diseases of the fetus (3).

International organizations such as UNICEF and the World Health Organization (WHO) have been actively working to eradicate malnutrition, recommending four strategies: education, dietary diversification, supplementation and fortification (2).

Fortification of foods, namely micronutrients addition to staple foods, has been done in many industrialized countries for many years with considerable success,
proving to be effective in correcting nutritional deficiencies of the population or specific groups at risk. Foods from all major groups such as flour, bread, cereals, dairy, oils, sugar, sweets and non-alcoholic beverages, can be fortified without altering the taste and appearance of food (4).

Dietary micronutrients are found in different chemical forms, which absorption depends not only on the content and chemical form of the mineral, but also on other occurring food components, interactions between elements and individual physiological factors (4).

Consequently, to estimate the effectiveness of the micronutrient contribution from the diet, it is not enough to determine the content in the food, but also the absorption and utilization by the body’s cells, i.e. the bioavailability (5, 6).

Several organizations promote the use of sodium iron EDTA salt (FeNa EDTA) as iron source in developing countries. The main advantage of using FeNa EDTA in food fortification is that Fe is protected in gastrointestinal tract from iron absorption inhibitors, such as phytates and polyphenols. Another proposed strategy is the use of the disodium salt of EDTA (Na₂EDTA) as an enhancer of iron absorption when it is added as ferrous sulfate (7).

Cereal-based foods are found among the most commonly suggested vehicles for iron fortification (4). It has been reported that iron from FeNaEDTA is 2 to 4 times better absorbed than iron from ferrous sulfate in a variety of cereals and legumes based foods. It does not promote lipid oxidation and is stable during food processing and storage (8).

Iron is better absorbed when the ratio EDTA: Fe is 0.25 to 1. The protective action of EDTA is independent of whether it is added as FeNaEDTA or Na₂EDTA (9).

EDTA is also used as disodium salt or disodium calcium in foods such as heavy metal scavenger to prevent lipid oxidation or as a color and flavor stabilizer. Many countries permit EDTA addition to foods. The European Union allows the addition of EDTA in a very small number of foods and prohibits it use intended for infant food. In Latin America there are different policies. In Argentina, the Argentine Food Code (CAA) allows the addition of Na₂EDTA or Na₂CaEDTA to packaged ice cream, soda, soft drinks and powdered soft drink with a limit of 35 mg/kg and in dressings (mayonnaise and mustard) and margarines, Na₂CaEDTA is allowed with a limit of 75 mg/kg. In other countries, including Brazil, Chile and Colombia the addition of these additives is allowed in a greater number of foods (10).

It should be noted that EDTA has an ADI of 2.5 mg/kg/day. Therefore, it should be considered the potential daily intake of this additive not only for controlling the levels of addition, but also for the possibility of using FeNaEDTA for food fortification. According to a report by the Organization of the United Nations Food and Agriculture Organization and WHO (2) there are three groups of additives on which it is important to evaluate the intake: the additives permitted in high concentrations in many foods, the additives in foods that are highly consumed and those with an ADI of 0 to 5 mg/kg.

There are two types of groups where EDTA intake should be carefully controlled, the population of higher economic strata because of their greater access to industrialized food and children (11).

The aims of this work were estimate EDTA consumption by children and adolescents in order to determine EDTA employment levels and evaluate the potential consumption of EDTA in the hypothetical case of using FeNaEDTA as fortification iron source in breakfast cereals.

MATERIALS AND METHODS

Participants:
A population of 225 children and adolescents of both sexes (97 female and 128 male) from the city of Santa Fe (placed in the center of Argentina), aged between 4 and 13 years old, who attend schools canteens (20.9 %), public and private schools (36% and 43.1% respectively), were classified as belonging to low (L), middle (M) and upper middle (UM) social class, respectively. The survey was carried out between October 2009 and April 2010. The sample was drawn randomly and parent consensus was asked. Surveys corresponding to children between 4 and 10 years were answered by their parents and those made for people over 10 years old were answered by themselves.

Data collection instrument and study procedures:
A qualitative-quantitative food frequency questionnaire considering only foods where EDTA as additive
is allowed by the CAA was performed. The food groups used for the preparation of this survey were: dressings (mayonnaise and mustard), soda, soft drink, powdered soft drink, packaged ice cream, and margarine. For each food group the frequency of consumption (how often the food is consumed at day, week or month), the number of servings consumed each time and the brand most frequently consumed were asked. The survey suggested different serving sizes depending on the food, for example: cups, soup spoons, teaspoons, etc.

The weight of each individual was measured in order to calculate the EDTA ADC, expressed as mg/kg/day.

The survey also requested details about the age and sex of the subject.

In the same survey, the consumption of breakfast cereals was assessed.

Analysis of the questionnaires:

The ADC of each food was recorded. The presence of EDTA in a product was considered from the label of each food. If the food contained EDTA, the maximum concentration allowed by the CAA was taken.

Serving sizes were considered according those established in the MERCOSUR Technical Resolution 47/03 (Spoonful of soup: 10 g, spoonful of tea: 5 g, glass: 200 ml, can: 354 ml, bottle: 250 ml) (12).

To study the potential use of FeNaEDTA as fortificant in breakfast cereal, a level of 11mg Fe/100 g product was considered. This is the amount stated in the majority of commercially available breakfast cereals. This value corresponds to 57.4 mg EDTA, because molar ratio iron: EDTA of 1:1 (11).

Statistical analysis:

Data were processed using the Statgraphic Plus 5.1 for Windows. In order to determine if the sample belonged to a normal population the determination of kurtosis was made. As samples were from a non-normal distribution, data were compared using Kruskal-Wallis Test. When p value was less than 0.05, the difference was considered significant.

RESULTS

Food Average Daily Consumption:

Table 1 shows food ADC for each one of the foods evaluated and the percentage of participants who consumed them. The Multifactor ANOVA shows that there were no statistically significant differences in the consumption of these foods by gender and social class.

<table>
<thead>
<tr>
<th>Food</th>
<th>%</th>
<th>ADC (g or mL/day)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayonnaise</td>
<td>79.1</td>
<td>7.2 ± 10.9</td>
</tr>
<tr>
<td>Mustard</td>
<td>24.0</td>
<td>1.0 ± 2.5</td>
</tr>
<tr>
<td>Margarine</td>
<td>16.0</td>
<td>3.1 ± 29.4</td>
</tr>
<tr>
<td>Soda</td>
<td>98.2</td>
<td>343.5 ± 395.0</td>
</tr>
<tr>
<td>Soft drinks</td>
<td>63.5</td>
<td>110.0 ± 235.0</td>
</tr>
<tr>
<td>Powdered soft drink</td>
<td>89.8</td>
<td>335.7 ± 479.0</td>
</tr>
<tr>
<td>Packaged ice-cream</td>
<td>62.7</td>
<td>14.0 ± 28.1</td>
</tr>
</tbody>
</table>

*Median value ± SD

These foods supply about 1226.2 KJ/day (293.3 Kcal/day), considering the ADC values showed in Table 1 and average energy values of 1676.2 Kj for mayonnaise, 200.6 Kj for soda and 54.3 Kj for powdered soft drinks (13), which would represent from 15 to 17% of the energy needs of this age group (7213-8175 Kj/día) (14).

EDTA Average Daily Consumption:

Considering the foods that actually use EDTA and the maximum EDTA supply that each type of food could do according CAA, an EDTA ADC of 0.0603 ± 0.0145 mg/kg/day was obtained. This represents a 2.4% of the ADI (2.5 mg / kg / day; ADI). The range of EDTA consumption was 0.001 - 1.26 mg/kg/day, with a median of 0.011 mg/kg/day.

Factors affecting EDTA Average Daily Consumption:

When EDTA ADC was analyzed by sex and age, no statistically significant differences were found. However, when the factor was the social class, middle-class children consumed more EDTA and upper middle class had the lower EDTA consumption (Table 2).

When EDTA ADC was analyzed by kind of consumed food, it could be observed that soda and mayonnaise were the foods which did the major contribution. Soft drinks, powder soft drinks and packaged ice cream consumed did not contain EDTA (Table 3).
STUDY OF EDTA INTAKE OF CHILDREN

Potential EDTA Daily Consumption:

In the unlikely event that all brands of food where EDTA addition is permitted would use it, the potential EDTA daily consumption would increase to 0.6 mg/kg/day, which represents 24.12% of the ADI.

Potential EDTA consumption in case of using FeNaEDTA as fortificant in breakfast cereals:

The ADC of breakfast cereals was 27 g/day, with a standard deviation of 61.58 g/day. No statistically significant differences were found when these data were evaluated according to sex and social class.

The hypothetical EDTA consumption from breakfast cereals, in the case of iron fortification with 11 mg Fe/100g using FeNaEDTA as iron source, would be 0.4 mg/kg/day.

If this value adds to EDTA ADC calculated from the intake of food which EDTA addition is allowed, the potential EDTA ADC would be 0.46 ± 0.32 mg/kg/day.

DISCUSSION

The children population under study belongs to L (20.9%), M (36%) and UM social class (43.1%).
Breakfast cereals would be an important vehicle for fortification using FeNaEDTA, particularly because cereals have high phytate content and other iron sources have low bioavailability in this matrix.

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REFERENCES


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