FLUORIDE CONTENT OF SELECTED INFANT FOODS CONTAINING POULTRY OR FISH MARKETED IN POLAND

Justyna Opydo-Szymaczek,a Jadwiga Opydo b
Poznan, Poland

SUMMARY: The aim of this study was to determine the fluoride (F) content of 19 kinds of ready-to-eat infant foods containing fish or poultry sold in Poland under three different brand names. Analyses of samples were performed by the perchloric acid digestion-diffusion procedure of Taves followed by determination of F by use of an ion-selective F electrode (09–37 type) and a RAE 111 chloride-silver reference electrode (MARAT). The F concentration in foods containing chicken, turkey, and fish ranged from 0.12 to 1.06 mg/kg, 0.15 to 0.74 mg/kg, and 0.16 to 0.44 mg/kg, respectively. If infants are fed according to current dietary recommendations in Poland, consumption of these foods should not increase the risk of dental fluorosis.

Keywords: Dental fluorosis; Fluoride intake; Infant foods in Poland.

INTRODUCTION

In the earliest days of dental F research, investigators believed that F worked pre-eruptively by incorporation into developing tooth enamel to shield against tooth decay. Modern research, however, indicates that the predominant caries preventive effect of F, to the extent it occurs, is posteruptive and topical, which means that F works primarily after teeth have erupted, when small amounts are maintained constantly in dental plaque and saliva.1,2 As noted by many researchers, excessive F ingestion bringing negligible dental benefits should be avoided to minimize the risk of adverse health effects.2,3

Dental fluorosis is the first overt sign of chronic F toxicity, and its occurrence is reported to be most strongly associated with cumulative F intake during enamel development.1

The critical period for development of fluorosis in permanent maxillary central incisors is from 4 months to 4 years of age. Thus, excessive F intake must occur during early childhood, to affect the most aesthetically important teeth.1,3,4

Among various infant foods, milk formulas,5,6 chicken meat,7-9 and fish (especially small, dried fish eaten whole),10,11 along with certain bottled waters and beverages,5,12-14 have been identified as significant sources of ingested fluoride. Previous studies of foods intended for infants and young children available in Poland revealed that all examined bottled waters had low concentrations of F (0.3 mg/L) and can be safely consumed by infants,15 but consumption of some infant tea beverages,13 as well as reconstitution of infant formulas with water containing more than 0.5 mg F/L may increase the risk of dental fluorosis.6

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aFor correspondence: Department of Pediatric Dentistry, Poznan University of Medical Sciences, Bukowska 70, 60-812 Poznan, Poland. E-mail: jopydo@am.poznan.pl. bInstitute of Chemistry and Technical Electrochemistry, Poznan University of Technology, Piotrowo 3, 60-965 Poznan, Poland.
The aim of this study was to determine the concentrations of F in three brands of ready-to-eat Polish infant foods containing chicken, turkey, or fish and to estimate the extent to which these foods can contribute to total F intake of young children.

**MATERIALS AND METHODS**

A total of 19 ready-to-eat foods in jars, either as homogeneous purees for young infants or as preparations with larger particles for older infants and toddlers, labeled as containing fish or poultry, were obtained from supermarkets of the city of Poznan in 2011. Two jars of each type of food were examined. All examined products are classified as foodstuffs intended for particular nutritional uses.

Analyses were performed in the laboratory of the Technical University of Poznan. A silicone facilitated diffusion, a modification of the procedure described by Taves for F in biological samples, was used to isolate F from the perchloric acid treatment of the samples.\(^6,16\)

Pureed infant food was sampled without further modification. Other foods were processed by homogenization prior to analysis. A 2-g sample of the food was placed in a polypropylene Conway dish to which 2 mL of 70% perchloric acid was added, and the diffused F was trapped in 1 mL of 1 M NaOH placed in the center well. Then 0.2 mL of 4% hexamethyldisiloxane (HMDS) was added to the sample and perchloric acid to initiate the diffusion. Two mL of 80% sulfuric acid was added to the outer closing chamber of the Conway dish, and a liquid trap was formed by dipping the lid into this chamber. The F in the sample was isolated after overnight diffusion. The lid was then removed; the final solution from the center well was quantitatively transferred to a volumetric flask by washing the well thoroughly with 1–2 mL portions of distilled water. The solution in the flask was diluted with distilled water to 15 mL, and 10 mL of TISAB buffer was added to maintain an appropriate ionic strength and pH.

The level of isolated F was determined with the use of an ion-selective F electrode (09-37 type) and a RAE 111 chloride-silver reference electrode (MARAT). Measurements were performed using the addition of a known concentration of F method.\(^17,18\) Two samples of each food taken from different jars, were analyzed. The determinations were repeated three times for each sample, and means ±SD were reported as the final results.

**RESULTS**

As seen in the table, F concentrations in the samples of chicken, turkey, and fish ranged from 0.12 to 1.06 mg/kg, 0.15 to 0.74 mg/kg, and 0.16 to 0.44 mg/kg, respectively.
DISCUSSION

F accumulates in bones and skin of animals,\textsuperscript{7,11} and processed foods containing fish or chicken bones and skin may contain high amounts of F.\textsuperscript{7,8,10,11} In their study, Malde et al. found that whole fish and bone samples had a high F concentration, while fillet samples were low in F. The highest F concentrations in fish were found in marine species that are eaten whole.\textsuperscript{11} Similarly, in the study of Tomori et al. the F content of commercial porridge prepared with “dried young

Table. F content of infant foods sold in Poland according to manufacturer, content of chicken, turkey, or fish

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product name</th>
<th>Quantity per jar/ content of meat</th>
<th>F content (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jar 1</td>
</tr>
<tr>
<td>Nestle Polska S.A.</td>
<td>Vegetable soup with chicken and semolina</td>
<td>130 g/chicken 8%</td>
<td>0.37±0.07</td>
</tr>
<tr>
<td></td>
<td>Delicate vegetables with chicken</td>
<td>190 g/chicken 8%</td>
<td>0.36±0.05</td>
</tr>
<tr>
<td></td>
<td>Vegetable cream soup with turkey</td>
<td>130 g/ turkey 8%</td>
<td>0.35±0.05</td>
</tr>
<tr>
<td></td>
<td>Chicken</td>
<td>80 g/chicken 55%</td>
<td>1.06±0.10</td>
</tr>
<tr>
<td></td>
<td>Turkey</td>
<td>80 g/turkey 55%</td>
<td>0.74±0.07</td>
</tr>
<tr>
<td></td>
<td>Chicken ragout with vegetables</td>
<td>190 g/ chicken 16%</td>
<td>0.56±0.07</td>
</tr>
<tr>
<td></td>
<td>Chicken-veal sausages</td>
<td>70 g/chicken 43%, veal 23%</td>
<td>0.37±0.06</td>
</tr>
<tr>
<td>HiPP Polska Sp. z o.o</td>
<td>Chicken broth with semolina</td>
<td>190 g/chicken 10%</td>
<td>0.23±0.05</td>
</tr>
<tr>
<td></td>
<td>Cream of rice and vegetable with chicken</td>
<td>125 g/chicken 8%</td>
<td>0.20±0.04</td>
</tr>
<tr>
<td></td>
<td>Tagiatelle with fish and broccoli</td>
<td>220 g/fish 12%</td>
<td>0.16±0.04</td>
</tr>
<tr>
<td></td>
<td>Noodles with fish and vegetables</td>
<td>220 g/fish 12%</td>
<td>0.16±0.05</td>
</tr>
<tr>
<td></td>
<td>Vegetables with chicken and noodles</td>
<td>220 g/chicken 8.4%</td>
<td>0.28±0.02</td>
</tr>
<tr>
<td>Nutricia Polska Sp. z o.o</td>
<td>Vegetables with chicken and semolina</td>
<td>125 g/chicken 9%</td>
<td>0.30±0.09</td>
</tr>
<tr>
<td></td>
<td>Vegetables with chicken and apple puree</td>
<td>125 g/chicken 10%</td>
<td>0.57±0.06</td>
</tr>
<tr>
<td></td>
<td>Vegetables with aromatic turkey</td>
<td>125 g/turkey 10%</td>
<td>0.19±0.03</td>
</tr>
<tr>
<td></td>
<td>Tomato soup with mild chicken and rice</td>
<td>190 g/chicken 10%</td>
<td>0.12±0.02</td>
</tr>
<tr>
<td></td>
<td>Assorted vegetables with gold chicken</td>
<td>190 g/chicken 10.9%</td>
<td>0.33±0.05</td>
</tr>
<tr>
<td></td>
<td>Vegetables with delicate fish</td>
<td>190 g/fish 11%</td>
<td>0.44±0.07</td>
</tr>
<tr>
<td></td>
<td>Vegetables with chicken in tomatoes</td>
<td>250 g/chicken 10.8%</td>
<td>0.34±0.04</td>
</tr>
</tbody>
</table>

Mean   0.38 0.30
SD     0.23 0.13
sardines” was 2.91 mg/kg. Polish baby foods examined here are prepared with fish fillet without bones and skin, which results in low F content (0.16 to 0.44 mg/kg).

The common manufacturing process involving mechanical deboning leaves skin and bone particles in the food. Thus foods containing mechanically separated chicken meat have been found to be high in F, and their regular consumption by infants has been recognized as a risk factor for dental fluorosis. In contrast, foods made with mechanically separated turkey contain significantly less F than their chicken counterparts, probably because turkey bones are more difficult to crush and powder in the mechanical separation process than are chicken bones.

Analyses by Heilman et al. revealed a wide range of F concentrations in infant foods (0.01 to 8.38 mg/kg). Chicken had the highest F concentrations (1.05 to 8.38 mg/kg), with other meats ranging from 0.01 mg/kg (veal) to 0.66 mg/kg (turkey). Similarly, results in the study of Fein and Cerklewski indicate that foods labeled as containing mechanically separated chicken contain high concentrations of F (0.08 to 8.63 mg/kg). Foods made with mechanically separated turkey contained significantly less F (0.78, 1.37, and 1.07 mg/kg, for pureed type, meat sticks, and luncheon meat, respectively). In a study by Poureslami et al., the F content of chicken was lower (0.13–0.25 mg/kg), as compared to the results of other studies, which may be due to the fact that authors used raw chicken without the skin.

In our study, the highest F content was determined in a sample of ground chicken meat (1.06 mg/kg). Samples of turkey meat had a lower F content. F levels in other foods, which mix poultry meat and fish with other components, ranged from 0.12 to 0.57 mg/kg and were thus similar to those reported by Heilman et al. (0.01–0.63 mg/kg).

All Polish infant food products examined here are classified as foodstuffs intended for particular nutritional uses to satisfy the nutritional requirements of infants and young children. Restrictions on pesticides residues and requirement for the use of high quality ingredients may result in low levels of F found in these products. Although mechanically deboned poultry meat is a common ingredient of sausages, hot dogs, and meat nuggets, it is no longer found in Polish foodstuffs for particular nutritional uses intended for children.

The present study is the next step toward evaluating how much consumption of Polish products intended for particular nutritional uses might affect F exposure of this age group. The recent study by Rankin et al. showed that solid foods can be important contributors to dietary F intake, and possibly the risk of developing fluorosis, for some subjects. According to the Polish New Feeding Plan for Infants since 2007, 6–12 month-old infants should consume 10–20 g of cooked meat daily. A maximum daily total F intake of 0.10 mg/kg body weight from birth to age 8 has been proposed to avoid the risk of disfiguring dental fluorosis. In 1997 the Institute of Medicine (IOM) proposed the following upper limits: 0.7 mg/day for children from birth through 6 months of age, 0.9 mg/day for 7 through 12 months of
age, 1.3 mg/day for 1 through 3 years of age, and 2.2 mg/day for 4 through 8 years of age, based on average weights for children of those ages.\textsuperscript{25} The IOM also released recommendations for adequate intakes (AIs) of F. The AI is based on estimated intakes that have been reported to reduce the occurrence of dental caries maximally in a population without causing unwanted side effects including moderate dental fluorosis. The IOM AIs for F are: 0.01 mg F/day from birth through 6 months (corresponding to the F intake of human milk-fed infants), 0.5 mg F/day for 7 through 12 months, and 0.7 mg F/day for 1 through 3 years of age.\textsuperscript{25} However, some aspects of this IOM report are outdated in the light of more recent research. Especially the term adequate (or optimal) F intake should be dropped from common usage, since there is no physiological requirement for fluoride in the human body.\textsuperscript{2} As recently noted by Ismail and Hasson “dentists should dismiss the misconception that there is a balance between dental caries and fluorosis, because patients can accrue the benefits of topical fluorides without developing fluorosis and without systemic intake.”\textsuperscript{26}

Although the term of adequate (or optimal) F intake is now widely regarded as obsolete, it is still used in the estimation of daily F exposure.\textsuperscript{8,10,22} Consequently, we decided to compare F intake from our examined foods with IOM AIs and upper tolerable limits for F. Consumption of 20 g of meat containing 1.06 mg/kg by a 12-months old child would result in F intake equal 0.02 mg, which corresponds to 4\% of the AI. Consumption of one 125-g jar of mixed food containing 0.57 mg/kg by children up to the age of 6 months, would result in a consumption of 0.07 mg, which corresponds to 700\% of the AI. Although AIs for younger infants may be significantly exceeded, infant foods examined here do not increase F intake above the recommended upper level based on current dietary recommendations that may differ from real feeding habits in Poland.

**ACKNOWLEDGEMENTS**

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