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Monitoring of Some Metals in Some Canned Foods

By

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ABSTRACT

The present study aimed to monitor some metals such as zinc (Zn), copper (Cu), iron (Fe), lead (Pb), cadmium (Cd), calcium (Ca) and magnesium (Mg) in canned foods to assess food quality. Samples of canned topping cream chantilly, condensed milk, mushroom, soft drinks, diet soft drinks, tuna, beef, processed cheese, chick pea dip, baked beans, salmon, fava beans, tomato juice, margarine and pineapple were evaluated. Canned foods were digested with HNO_3, H_2SO_4 and $HClO_4$ and metals were determined using atomic absorption spectrometry (AAS). Recoveries of Zn, Cu, Fe, Ca, Mg, Pb and Cd from 15 canned foods ranged from 88-107, 92-102, 88.5-101, 89-99.8, 89-98, 87-97 and 92-101%, respectively. Average means and ranges of concentrations (μ/g) found in canned foods were Zn, 1.547 (0.0-5.491); Cu, 0.353 (0.0-1.765); Fe, 9.76 (0.0-43.656); Pb, 0.325 (0.0-1.25); Cd, 0.027 (0.0-0.19); ; Ca, 34607 (85-330111) and Mg, 26692 (0.0-291180). It can be concluded that canned foods packed in metal cans may contain high level of metals because of the interaction between the container and contents and we recommend to use glass jars for food prescrvarion in order to minimize food contamination with metals from metal cans.

INTRODUCTION

Food sources probably represent the largest source of exposure to metals for consumers from the general population. In canned food packed in metal containers permits metals to dissolve into food because of the interaction between container and contents (Sumitani, *et al*, 1993). The actual concentration of metals in food and beverages from various countries varies widely depending upon the food product, the growing conditions (soil, use of fertilizers, water) and the type of processing used; in particular, pH levels and use of metal containers (Tanner *et al*, 1979, Muller *et al*, 1996). Even though some metals are necessary for human and have positive health effects (Dehne, 1979), the consumption of foodstuffs with high levels of metals can cause gastric irritation and diarrhea (WHO, 1982; Goyer, 1986) and affect multiple organ systems, and the target for toxicity are specific biochemical processes (enzymes) and/or membranes of cells and organelles (Goyer, 1986). Also, some useful metals such as calcium and magnesium are competitive with respect to their absorptive sites. On the other hand, excess of calcium may partially inhibit the absorption of magnesium (Goyer, 1986). To monitor the food supply for toxic and nutritionally important of chemicals, many organizations conducted a number of surveys in foods (Capar, 1990; Dabeka and McKenize, 1995).

The present study was designed to provide background information on the levels of some metals in various canned food stuffs collected from the local market of Alexandria.

MATERIALS AND METHOSýDS

1-Sampling

Fifteen categories of canned foods (5 samples per each) were collected form the local supermarkets of Alexandria. The fifteen categories are topping cream chantilly, condensed milk, mushroom, soft drinks, diet soft drinks, tuna, beef, processed cheese, chick pea dip, backed beans, salmon, fava beans, tomato juice, margarine and pineapple.

2-Sample Preparation

Sample preparation was performed according to the method of NIOSH (1994) with slight modifications. In this method, 1g of each sample was transferred to a beaker containing 10 ml of digestion acid (nitric acid, sulfuric acid & perchloric acid in ratios of 3:1:1, respectively). The mixture was heated overnight at 110 °C and then at 250 °C until ca 1 ml of mixture remained (2-3 hrs). The solution was left to cool and the contents of the beaker was transferred to a volumetric flask and diluted with 10% sulfuric acid to 5 ml. A blank was prepared in the same fashion. The absorbance was measured using Atomic absorption spectrometry.

3-Determination

a- Standard metal solution (500 or 1000 µg/ml). Specific weight of metal salt or pure metal was dissolved in either concentrated HCl or HNO_3 and diluted with deionized water to give 500 µg/ml in the case of calcium and magnesium or 1000 µg/ml in the case of remaining metals. Working solutions were prepared directly before determination.

b- Preparation of standard addition sample

Three standard concentrations, 0, .25; and 0.5 µg of metal stock solution (1000 µg/ml) were added to 0.1 g of sample in case of Ca and Mg and 1 g of sample in case of the remaining metals and then digested as described previously to calculate recoveries and reproducibility coefficient of variation (RCV).

c- Apparatus

Atomic Absorption Spectrophotometer, Perkin Elmer Model 2380 equipped with a hollow cathode lamp and a nitrous oxide-acetylene flame was used.

All reagents were of analytical-reagents grade and deionized water was used throughout the study.

4- Calculations

The solution concentration for each elements in the sample C_s (µg/ml), and the average blank, C_b (µg/ml) were obtained from the measurement data. The final solution volumes of samples V_s (ml) and blank, V_b (ml) were used. The concentration, C (μg/g) of each sample in the mass of sample taken , M (g) was calculated as followis:-

$C\ (\mu g/g) = (C_sV_s - C_bV_b) / M$

RESULTS AND DISCUSSION

Analyses and Quality Control

Most methods now rely on wet digestion to destroy organic matter, because dry ashing leaves some metals as insoluble oxides. The wet digestion used in this study was a modification of the NIOSH Manual of Analytical Method (1994).

Recoveries of metals from 15 canned food types were 88 to 107%, 92 to 102%, 85.5 to 101%, , 87 to 97%, 92 to 101%, 89 to 99.8% and 89 to 98% for Zn, Cu, Fe, , Pb, and Cd, Ca and Mg, respectively.

Reproducibility coefficients of variation (RCV) ranged from 2.5 to 9%, 1.7 to 7.8%, 2.2 to 2.16 to 8.5% and 3.8 to 13%, 6.6%, 2.11 to 11% and 2.1 to 7%, for Zn, Cu, Fe, Pb, and Cd, Ca and Mg, respectively.

Zinc Survey Results

The range of zinc concentration in all samples was 0.0-5.491 μg/g. For the individual samples, the highest mean levels of zinc were in processed cheese (5.491 μg/g), beef (4.519 μg/g), salmon (2.412 μg/g), topping cream chantilly (2.005 μg/g), tuna (1.905 μg/g), tomato juice (1.545 μg/g), condensed milk (1.455 μg/g), chick pea dip (1.410 μg/g), backed beans (1.389 μg/g), mushroom (0.575 μg/g) and fava beans (0.497 μg/g). On the other hand, margarine and pineapple were zinc free.

Zinc is a nutritionally essential metal, and its deficiency result in severe health consequences. On the other hand, the ingestion of beverage standing in galvanized cans or using of galvanized utensils results in gastrointestinal distress and diarrhea (Goyer, 1986).

Table (1): Recovery of metals from canned foods by standard addtition method

Sample	Zn		Cu		Fe	
	Recovery %	RCV %	Recovery %	RCV %	Recovery %	RCV %
Topping cream chantilly	94	2.5	92	2.11	93	2.8
Condensed milk	100	9	93	3.6	85.5	3.1
Mushroom	103.4	3.8	97.2	2.2	92.2	3.5
Soft drinks	88	2.5	90	2.3	94	3.55
Diet soft drinks	93.9	4.7	101	4.4	90	3.8
Tuna	92.3	3.2	96.6	4.5	94	2.6
Beef	95	5	94	7.8	90	6.2
Processed Cheese	93	3	92	2.8	94	4.4
Chick pea dip	101	3.7	97	4.3	98	3.7

Backed beans	98	4	102	3.1	92	4.2
Salmon	107	3.42	102	1.7	97.6	6.6
Fava beans	101	3.6	97	4.2	86	3.3
Tomato juice	100.3	6	94	5.5	101	2.52
Margarine	89	4.2	91.6	7.5	90	5.2
Pineapple	105	9	98	4.5	90	2.2

Table (2): Recovery of metals from canned foods by standard addtition method

Sample	Ca		Mg		Pb		Cd	
	Recovery %	RCV %	Recovery %	RCV %	Recovery %	RCV %	Recovery %	RCV %
Topping cream chantilly	99.8	4.4	90.5	3.3	96	8	95	6
Condensed milk	96.5	2.11	97.5	2.5	95	6	101	13
Mushroom	93	11	95.2	3.5	92	3.4	93	7
Soft drinks	95	6	89	2.1	94	3.1	96	6
Diet soft drinks	94	4.6	97.7	3.2	89	2.2	92	8
Tuna	90	3.2	98	6.6	89	2.8	91	4.4
Beef	97	4.6	91	3.7	88	4.2	93	5.2
Processed Cheese	92	6.6	93	2.9	97	7.3	96	5.9
Chick pea dip	89	3.8	97	3.5	93	2.5	92	4.5

Backed beans	99	4.3	91	2.5	87	2.6	93	6
Salmon	94	6	94	3.2	88	4.7	94	4.7
Fava beans	89	4.5	98	4.6	98	3.2	92	3.8
Tomato juice	89	6.2	94	5.5	93	6.8	91	4.7
Margarine	97	10.5	92	3.1	97	4.9	95	7.7
Pineapple	97	4.6	89	7	91	8.5	96	10.5

Copper Survey Results

Individual samples with the highest levels were tomato juice (1.765 μg/g), margarine (1.206 μg/g), backed beans (0.917 μg/g), salmon (0.496 μg/g), fava beans (0.326 μg/g) and tuna (0.225 μg/g), mushroom (0.18 μg/g), pineapple (0.113μg/g) and processed cheese (0.061 μg/g), whereas topping cream chantilly, condensed milk, soft drink, beef and chick pea dip were copper free (Table 2). The present results are parallel to the investigations of WHO (1998) who reported that seafood have the high concentration, while dairy products have relatively low levels. Also, high levels of copper have been identified in wheat bran, beans and seeds (Jorhm and Sundstrom, 1993).

Iron Survey Results

The food categories with the highest levels of iron were baked beans (43.956 μg/g), tomato juice (40.935 μg/g), and salmon (28.6 μg/g), whereas beef, tuna, chick pea dip, topping cream chantilly, pineapple, proceed cheese and fava beans having 8.748, 7.08, 4.59, 4.48, 4.005, 3.855 and 0.152 μg/g, respectively. On the contrary, condensed milk, mushroom, soft drinks and margarine were iron free. Arvanitoyannis (1990b) found a considerable increase in iron content with time for strongly corrosive acidic vegetables (pickles) than weakly corrosive vegetable (peas, green, haricot beans, mushrooms). Also, a gradual increase in iron levels in canned meat with storage time was reported (Arvanitoyannis, 1990a). Chronic iron toxicity or iron overload in adult is a more common problem. The African Bantu who prepares his daily food and brews fermented beverages in iron pots is the classic example of this form of iron overload (Muller-Eberhard *et al*, 1977).

Lead Survey Results

Lead is the most ubiquitous metal which is detectable in practically all phases of the inert environment and in all biological systems (Goyer, 1986). The major source of daily intake of lead in adult and children is food and beverage. Data in Table (2) illustrate that the highest mean level of lead was found in tomato juice, baked beans, tuna, processed cheese, beef and chick pea dip, where the level values were 1.25, 0.965, 0.85, 0.746, 0.467 and 0.30 μg/g, respectively. The present results are paralleled with the results of Capar (1990) and Dabeka and McKenzie (1995) who reported that foods preserved by a commercial canning process and packed in metal containers contained high levels of lead. Moreover, lead levels in foods packed in lead-soldered cans were about 5 times as high as those foods packaged in nonlead-soldered cans (Capar, 1990). Also, data in Table (2) show that lead was not detected in condensed milk, mushroom, soft drinks, salmon, fava beans, margarine and pineapple. The estimated dietary intake of lead by Canadians varied with age and sex from 15μg/day for 1-4 year old children to 33 μg/day for 20-39 year old males with average of 24 μg/day for all ages and sexes (Dabeka and McKenzie, 1995).

Cadmium Survey Results

Cadmium is a modern toxic metal. its main use is electroplating or galvanizing, as a color pigment for paint and plastic and cathode material for nickel-cadmium which are sources of pollution. Table (2) lists the mean cadmium finding for all products. The highest cadmium levels were in tomato juice (0.19 μg/g), then processed cheese (0.145 μg/g), backed beans (0.039 μg/g), and beef (0.033 μg/g). Meat, fish and fruit contained 1 to 50 μg/kg, grains contained 50μg/kg, and the greatest concentrations were in liver and kidney of animals (Goyer, 1986). Dabeka and McKenzie (1995) reported that the food categories with the highest mean concentrations of cadmium were bakery goods, cereals, vegetable, fats and oils. The estimated dietary intakes of cadmium by Canadians varied from 8μg/day for 1-4 year old children to 18 μg/day for 20-39 years old males with beverages of 13 μg/day for all ages and sexes.

Calcium Survey Results

Data in Table (3) show that topping cream chantilly having the highest concentration (330111 μg/g), while the levels of this element in condensed milk, processed cheese, salmon, tomato juice, chick pea dip, backed beans and tuna were 29.261, 25.76, 23.75, 22.811, 21.011, 19.79 and 18.51 mg/g, respectively. On the other hand the remaining food categories had lower concentrations of calcium.

Table (3): Levels (µ/g) of metals found in canned foods

Sample	Zn	Cu	Fe	Pb	Cd
Topping cream chantilly	2.005± 0.22	0.00	4 48± 0 18	0.30±0.005	0.00
Condensed milk	1.455± 0.08	0.00	0 00	0.00	0 00
Mushroom	0.575±0.10	0 18± 0.01	0.00	0.00	0.00
Soft drinks	0.00	0.00	0.00	0.00	0 00
Diet soft drinks	0.00	0.00	0.00	0.00	0.00
Tuna	1.905± 0.35	0.225± 0.03	7 08± 0.35	0.85± 0.08	0.00
Beef	4.519± 0.22	0.00	8 748± 0.42	0 467± 0.12	0.033± 0.01
Processed Cheese	5.491± 0.88	0.061±0.001	3.855± 0.33	0.746± 0.35	0 145± 0.06
Chick pea dip	1.410± 0.17	0.00	4 59± 0.90	0.30± 0.09	0.00
Backed beans	1 389± 0.04	0.917±0.009	43 956±2 45	0 965± 0.08	0.039±0.002
Salmon	2.412± 0.31	0.496± 0.10	28.60± 2.05	0.00	0.00
Fava beans	0.497± 0.06	0.326± 0.06	0 152± 0.09	0.00	0.00
Tomato juice	1 545± 0.21	1 765± 0.22	40 935±5 55	1 25± 0 06	0 19± 0.01
Margarine	0.00	1 206± 0.05	0 00	0.00	0.00
Pineapple	0.00	0.113±0.002	4.005± 0.29	0.00	0 00

Data are expresses as mean ± SD (n=5)

Magnesium Survey Results

Magnesium levels in canned food were determined (Table 3). The highest magnesium levels were in condensed milk (291.18 mg/g), topping cream chantilly (53.88 mg/g), tomato juice (13.18 mg/g), baked beans (9.06 mg/g), salmon (7.42 mg/g), tuna (5.03 mg/g), chick pea dip (4.83 mg/g), processed cheese (4.81 mg/g), whereas the levels of magnesium in beef, mushroom, fava beans and pineapple ranging from 0.487 to 1.56 µg/g. Moreover, the results showed that normal soft drinks and margarine were magnesium free. Cichon (1995) studied the migration phenomena of iron, tin, calcium and magnesium in canned fruits during long storage and he found increasing dependence of storage time on concentration of iron and tin in cans, while contents of calcium and magnesium decreased in cans due to adsorption process on internal coating.

Means and ranges of metal concentrations (µ/g) found in canned foods were: Zn, 1.547 (0.0-5.491); Cu, 0.353 (0.0-1.765); Fe, 9.76 (0.0-43.656); Pb, 0.325 (0.0-1.25); Cd, 0.027 (0.0-0.19); Ca, 34607 (85-330111) and Mg, 26692 (0.0-291180) (Table 5).

In conclusion, in canned food packed in metal cans, metal cations dissolve into the food because of the interaction between the container and content. Therefore, the estimation of metals in various canned foods is important in assessing food quality. It is necessary to recommend that human exposure to metals from food-contact materials be restricted to the lowest levels technologically attainable. One way to achieve this is to implement strict specifications limiting the quantities in the food materials. Also, the present study recommend to use glass jars for food canning in order to minimize food contamination with metals from metal cans.

Table (4): Levels (mg/g) of calcium nad magnesium found in canned foods

Sample	Ca	Mg
Topping cream chantilly	330.111 ± 0.22	53.880 ± 0.34
Condensed milk	29.261 ± 0.25	291.180 ± 0.28
Mushroom	3.420 ± 0.07	1.000 ± 0.027
Soft drinks	0.085 ± 0.02	0.00
Diet soft drinks	2.001 ± 0.03	0.050 ± 0.005
Tuna	18.510 ± 0.024.	5.030 ± 0.077
Beef	17.350 ± 0.101	1.560 ± 0.02
Processed Cheese	25.76 0± 0.056	4.810 ± 0.03
Chick pea dip	21.011 ± 0.033	4.830 ± 0.020

Backed beans	19.790 ± 0.175	9.060 ± 0.078
Salmon	23.750 ± 0.115	7.420 ± 0.013
Fava beans	1.572 ± 0.019	7.890 ± 0.070
Tomato juice	22.811 ± 0.077	13.180 ± 0.056
Margarine	0.917 ± 0.013	0.00
Pineapple	2.402 ± 0.023	0.487 ± 0.016

Data are expresses as mean ± SD (n=5).

Table (5): Summary of metals concentration (µg/g) in all canned foods

	Zn	Cu	Fe	Pb	Cd	Ca	Mg
Mean	1.547	0.353	9.76	0.325	0.027	34607	26692
Minimum	0.0	0.0	0.0	0.0	0.0	85	0.0
Maximum	5.491	1.765	43.656	1.25	0.19	330111	291180

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الملخص العربى

رصد بعض العناصر فى بعض الاغذية المعلبة

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تهدف الدراسة الحالية الى رصد بعض العناصر مثل الزنك ، النحاس ، الحديد ، الرصاص ، الكادميوم ، الكالسيوم والماغنسيوم فى الأغذية المعلبة لتقدير جودة هذه الأغذية. وقد تم جمع عينات من الأغذية المعلبة مثل كريم شانتيه ، لبن محلى ، عش الغراب ، مشروبات غازيةعادية ، مشروبات غازية خفيفه ، تونة ، بلوبيف ، جبنه مطبوخة ، حمص بالطحينة ، فاصوليا مطبوخة ، سلمون ، فول مدمس ، صلصة طماطم ، سمن وأناناس. وقد تم هضم هذه الأغذية المعلبة بإستخدام حمض النتريك ، حمض الكبريتيك و حمض فوق الهيدروكلوريك ثم تقدير هذه المعادن بإستخدام جهاز الامتصاص الذرى (AAS). وقد بلغت متوسط نسبة الاستعادة لكل من الزنك ، النحاس ، الحديد ، الرصاص ، الكادميوم ، الكالسيوم والماغنسيوم من المواد الغذائية المعلبة بما قيمته ٨٨-١٠٧% ، ٩٢-١٠٢% ، ٥ر٨٨-١٠١% ، ٨٧-٩٧% ، ٩٢-١٠١% ، ٨٩-٨ر٩٩% و ٨٩-٩٨% على التوالى .

كما أوضحت النتائج ان متوسطات ومدى التركيزات (ميكروجرام/جرام) كما يلى : الزنك ٤٧٥ر١ (صفر-٤٩١ر٥) والنحاس ٣٥٣ر٠ (صفر-٧٦٥ر١) والحديد ٧٦ر٩(صفر-٦٥٦ر٤٣) والرصاص ٣٢٥ر٠ (صفر-٢٥ر١) والكادميوم ٠٢٧ر٠(صفر-١٩ر) والكالسيوم ٣٤٦٠٧ (٨٥-٣٣٠١١١) والماغنسيوم ٢٦٦٩٢ (صفر-٢٩١١٨٠) .

ويمكن القول بأن الأغذية المعلبة فى أوعية معدنية قد تحتوى على مستويات عالية من المعادن نتيجة حدوث تفاعل بين الاوعية المعدنية ومحتوياتها

، ولذا توصى الدراسة الحالية بإستخدم الأوعية الزجاجية لحفظ المواد الغذائيـــــة لتقليل التلوث الغذائى بالمعادن ٠