Occurrence and Safety Evaluation of Some Pollutants in Some Canned Foods

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Summary
During the neonatal period where rapid changes in organ development and function occur, the central nervous system is in a rapid growth rate and highly vulnerable to toxic effects. Due to their low body weight and high food consumption per kg of body weight, the tissue levels of contaminants can reach higher levels in newborns than adults. We examined a total of 60 samples of canned baby foods randomly collected from Kalubia and Gharbia Governorates for their content of mycotoxins (Ochratoxin A, Aflatoxin B1 and Aflatoxin M1); heavy metals (cadmium, copper, lead and mercury). The samples were classified into 3 types each of 20, type (A) canned vegetable with beef, type (B) canned vegetable with chicken meat, and type (C) canned vegetable with turkey meat (20 of each). Our results revealed the presence of Ochratoxin A, Aflatoxin B1 and Aflatoxin M1 in all types of examined baby foods. Furthermore, various concentrations of heavy metals (Cd, Cu, Pb and Hg) have been recorded in the examined samples.

Introduction
Mycotoxicosis is diseases caused by mycotoxins, i.e., secondary metabolites of moulds. Ochratoxin A is a toxic compound produced by Penicillium viridicatum and Aspergillus ochraceus; it may play a role in the irreversible and fatal kidney disease known as Balkan endemic nephropathy. Also, it has potent carcinogenic effects and cause liver damage. Aflatoxins are produced by Aspergillus flavus and Aspergillus parasiticus, mainly they have hepatotoxic, hepatocarcinogenic, nephrotoxic and immuno-suppressive
effects (25). However, 376 samples of milk baby food were examined for aflatoxin M1 (AFM1), where they found that only two samples (0.5%) possessed higher concentration than 0.1 μg/L., which represents the tolerance limit for AFM1 in baby milk foods admitted in Czechoslovakia (12). Similarly, 33 (11%) out of 300 samples of milk powder consumed by infants in Brazil were positive for AFM1 at levels of 0.10-1.00 ng/ml with a mean of 0.27 ± 0.20 ng/ml (24). They also estimated the mean daily intake of 3.7 ng aflatoxin M1 / kg body weight/day. AFM1 was detected in 81 (84%) and 49 (53%) out of 97 and 92 samples of dry milk for infant formula in a range of 1-101.3 ng/kg and 1-79.6 ng/kg with a mean of 21.77 ng/kg and 32.2 ng/kg (13 and 14, respectively). On the other side, there was no contamination with AFM1 in infant formula in Kuwait (31). Meanwhile, AFB1 was found in 7 of the 8 newly opened packages of different brands of infant formula (2).

From six types of analyzed baby foods, 32%, 34% and 32% of examined samples of baby food type 1, type 2 and type 3 respectively were found to be contaminated with 88.88 ± 1.82, 90.24 ± 1.32 and 91.80 ± 1.24 μg Ochratoxin A (OTA) / kg respectively (9). Moreover, 48 samples of weaning food for children in Nigeria for mycotoxins. 12 samples (25%) were positive for aflatoxins (in a range of 2-19.71 pg/g), but only 4 (8%) were positive for OTA (in a range of 142 -6516 pg/g) (25). While in Norway, no OTA was detected in any of the examined 20 infant formula samples (30). Further, 119 batches (338 samples) of baby foods were analyzed for OTA, where they found that 20 batches (16.8%) contained detectable quantities of OTA and 4 of these (3.4% of the total) contained OTA above the Italian permitted value (0.5 μg/kg) (3).

Concerning the occurrence of heavy metals in baby food, cadmium (Cd) levels in 131 infant foods, where mean levels were 3.3. ng / g for meats, 4.1 ng / g for vegetables, 0.5 ng/g for fruits and desserts; 0.33 ng/g for juices and drinks and 33.6 ng/g for dry infant cereals, respectively (4). The cadmium (Cd) content in weaning foods, milk free infant cereals and baby foods, where they found that Cd concentration were 1.10 - 23.5 μg/kg, 6.6-35.8 ng/g and 0.45 - 17.7 μg/kg, respectively (8, 27 & 33).
Cadmium content was investigated in infant formulas which distinguished as "beginner", "continuation" and "special infant formulas", the mean concentrations of Cd were 1.97 ± 0.84; 1.86 ± 0.65 and 2.98 ± 2.59 µg/kg, respectively (22). The mean values of milk products, where they noticed that, the mean values for Copper (Cu) in baby food ranged from 0.12 - 12.9 mg/kg (10). Similar results were recorded by (1), where it has been noted that Cu concentrations were 0.04 - 0.09 mg Vs 0.09 - 0.10 mg for milk base products and milk cereal blends. Moreover, higher concentrations were recorded in India in 1999 by (33), where, it has been noted that Cu concentration was higher than that of control (1106.3 - 3157.3 µg/kg).

The mean lead in 729 samples of baby food examined in Italy was above the maximum recommended limit 0.2 g/g. A national maximum limit of 0.2 g/g in baby foods is proposed (16).

Lead in infant foods where lead levels were 19.3 ng/g for meats, 8.4 ng/g for vegetables, 14.9 ng/g for fruits and desserts, 9.6 ng/g for juices and drinks and 32.8 ng/g for dry infant cereals (4). Lead mean concentration in special infant formula was 23.95 ± 13.76 µg/L (17).

The geometric mean concentration of lead in different baby foods in India, had values from 39.5 to 77.7 µg/kg. The daily intakes of lead (Pb) (1.1. µg/kg) for infants through baby foods are well below the recommended tolerable levels of 3.57 µg/kg (33) Similar concentrations were observed in Spain, where infant formulas contain lead in a concentrations of 25.7 ± 8.4; 36.9 ± 6.4 and 3.5 ± 16.3 µg/kg for beginner, continuation and special infant formula, respectively (22) A high concentrations of lead were also recorded in Spain where lead contents of milk -free infant cereals and milk added infant cereals range from 36.1 to 305.6 ng/g and from 53.5 to 598.3 ng/g, respectively (27).

The breast milk showed low mercury (Hg) concentrations 1.59 ±1.21 g/L), 8% of these samples marginally exceeded the screening level of 3.5 µg/L. Also mercury content of cow milk and infant formulas were far below respective guide line values (18).

Because mycotoxins and heavy metals are potentially toxic substances, especially for susceptible infant and exposure to them may result in various illness, so, in this work we aimed to make a survey dealing with
some mycotoxins (AFB1, M1 and OTA), and heavy metals (Cd, Cu, Pb and Hg) in three different types of baby foods in a trial to determine the amount of these toxic substances that consumed by some classes of Egyptian childrens.

**Material and Methods**

A total of 60 random samples of canned baby foods "Gerber " represented by canned vegetables with beef (A) canned vegetables with chicken meat (B) and canned vegetables with turkey meat (C) ( 20 of each) were collected from different supermarkets in Kalubia and Gharbia Governorates for determination of their content of toxic substances.

**Determination of mycotoxins:**

*Ochratoxin A* All samples were undergoing a quantitative determination by using Veratox ® quantitative OTA ELISA kits, Neogen TM Corporation. 520 Lecher Place, Lansing, M, 48912, 800-234-5333. The concentrations of OTA were determined using standard calibration curve.

*Aflatoxins determination* Aflatoxins were extracted from the examined samples, then the concentration were determined using ELISA reader and Veratox ® test kit from Neogen TM corporation (32).

**Determination of heavy metals:**

Heavy metals were determined in the samples using the wet weight method (15). Accurately, 1 g of examined samples was digested with 5 ml concentrated nitric acid overnight. The mixture was heated at 70°C for 2 hours and filtered through Ashless Whatman filter paper No. 42. The filtrate was completed to 50 ml with deionized water.

The concentrations of heavy metals in the solutions were estimated by Atomic Absorption Spectrophotometer ( Perkin Elmer, 2380, U.S.A.) which was adjusted at 228.8 nm for cadmium, 324.8 nm for copper, 217.0 nm for lead and 253.7 nm for mercury.
Absorption and concentration were recorded on the digital scale of Atomic Absorption Spectrophotometer. The obtained results were recorded as ppm on wet weight of the examined samples.

**Results**

**Table (1): Concentrations of some mycotoxins in examined samples of**

**baby foods (n=20):**

<table>
<thead>
<tr>
<th>Mycotoxins</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTA (ug/kg):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Minimum</td>
<td>62</td>
<td>71</td>
<td>80</td>
</tr>
<tr>
<td>- Maximum</td>
<td>98</td>
<td>100</td>
<td>102</td>
</tr>
<tr>
<td>- Mean ± S.E.</td>
<td>77.35 ± 2.58</td>
<td>85.85 ± 2.27</td>
<td>89.30 ± 1.62</td>
</tr>
<tr>
<td>AFB1(ug/kg):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Minimum</td>
<td>3.33</td>
<td>3.33</td>
<td>6.66</td>
</tr>
<tr>
<td>- Maximum</td>
<td>5.66</td>
<td>8.00</td>
<td>10.00</td>
</tr>
<tr>
<td>- Mean ± S.E.</td>
<td>4.56 ± 1.02</td>
<td>5.55 ± 0.04</td>
<td>9.01 ± 0.24</td>
</tr>
<tr>
<td>AFM1(ug/kg):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Minimum</td>
<td>2.50</td>
<td>2.50</td>
<td>5.46</td>
</tr>
<tr>
<td>- Maximum</td>
<td>5.44</td>
<td>6.06</td>
<td>9.48</td>
</tr>
<tr>
<td>- Mean ± S.E.</td>
<td>3.87 ± 0.22</td>
<td>5.61 ± 0.36</td>
<td>6.91 ± 0.45</td>
</tr>
</tbody>
</table>

A: canned vegetable with beef; B: canned vegetable with chicken; C: canned vegetable with turkey

**Table (2) Heavy metal levels (ppm) in examined samples of canned vegetable with beef (A), chicken (B) and turkey (C) (n=20).**

<table>
<thead>
<tr>
<th>Heavy metal</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium (mg/kg):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Minimum</td>
<td>0.06</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>- Maximum</td>
<td>0.15</td>
<td>0.12</td>
<td>0.09</td>
</tr>
<tr>
<td>- Mean ± S.E.</td>
<td>0.09 ± 0.01</td>
<td>0.08 ± 0.01</td>
<td>0.04 ± 0.01</td>
</tr>
<tr>
<td>Copper (mg/kg):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Minimum</td>
<td>0.89</td>
<td>0.45</td>
<td>0.31</td>
</tr>
<tr>
<td>- Maximum</td>
<td>2.27</td>
<td>1.63</td>
<td>1.22</td>
</tr>
<tr>
<td>- Mean ± S.E.</td>
<td>1.58 ± 0.29</td>
<td>1.12 ± 0.14</td>
<td>0.83 ± 0.07</td>
</tr>
<tr>
<td>Lead (mg/kg):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Minimum</td>
<td>0.07</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>- Maximum</td>
<td>0.54</td>
<td>0.36</td>
<td>0.19</td>
</tr>
<tr>
<td>- Mean ± S.E.</td>
<td>0.21 ± 0.02</td>
<td>0.11 ± 0.02</td>
<td>0.06 ± 0.01</td>
</tr>
<tr>
<td>Mercury (mg/kg):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Minimum</td>
<td>0.13</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td>- Maximum</td>
<td>0.79</td>
<td>0.41</td>
<td>0.30</td>
</tr>
<tr>
<td>- Mean ± S.E.</td>
<td>0.38 ± 0.05</td>
<td>0.28 ± 0.03</td>
<td>0.16 ± 0.02</td>
</tr>
</tbody>
</table>
Table (3): Evaluation of heavy metal levels (ppm) in examined samples of canned vegetable with beef(A), chicken(B) and turkey (C) in comparison to the standard permissible limits (1993).

<table>
<thead>
<tr>
<th></th>
<th>SPL</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.1</td>
<td>2</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Copper</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Lead</td>
<td>0.1</td>
<td>5</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.5</td>
<td>3</td>
<td>15</td>
<td>—</td>
</tr>
</tbody>
</table>

SPL: Standard permissible limit
No. number of examined samples exceeding the permissible limits.

**Discussion**

Mycotoxins and heavy metals are of public health concern due to their toxic effects on fetuses, persistence in pregnant and breast feeding mothers, and also their widespread in the environment.

Data in Table (1) showed that the average concentrations of OTA on the examined baby foods are $77.35 \pm 2.58$ ; $85.85 \pm 2.27$ and $89.3 \pm 1.62$, respectively. These concentrations were slightly lower than that recorded by (9) in Egypt, but significantly higher than that noted in Nigeria by (25) (0.12 - 6.516 µg/kg). On the opposite view, OTA was not detected in Norway (30). Owing to my best knowledge, there is no permissible limit or guide line for OTA in baby food in Egypt, but according to the Italian permitted values (0.5 µg/kg) the examined samples of baby foods have 15.7 : 171.6 and 178.6 times as that permitted in Italy !!! The OTA levels found in this work are sufficient to cause a higher intake of OTA than the suggested total daily intake (TDI) of 5 ng/kg b.w./daily, especially in childrens whom consume large quantities of milk.

This table also show us the concentration of AFB1 and AFM1 in the examined baby foods which are $4.56 \pm 1.05$ & $3.87 \pm 0.22$ ; $5.55 \pm 0.35$; & $5.61 \pm 0.86$ and ; $9.01 \pm 0.24$ & $6.91 \pm 0.45$, respectively. There are only two samples in the type "C" exceeding the permissible limit for AFB1, in case of milk, all examined samples exceeds the permissible limit for AFM1 (0.5 µg/L). The mean of AFM1 in our investigation was much higher than that recorded in Czechoslovakia in 1991 by (12) In Brazil in 1997 by (24).
and in Italy in 1998 and 2001 by (14). Contrawisely, in Kuwait, there was no contamination with AFM1 in infant formulas (31). Also the mean concentrations of AFB1 in this survey was higher than that recorded in Nigerian weaning of foods by (25). From data of this table we can conclude that all examined samples (100%) were positive for OTA, AFB1 and AFM1, the type "C" which have turkey meat possessed the highest concentrations followed by type "B" which contain chicken meat, then type "A" which contain beef, this may be related to that turkey meat may contain higher residues of mycotoxins than other types of meat.

Cadmium is a non essential element that progressively accumulates inside the body particularly kidneys. Thus, the incidence of kidney stones was increased in people affected with cadmium poisoning (11). Chronically, toxic cadmium intake causes a microcytotic hypochromic anaemia in young rats at lower exposure levels and after shorter exposure periods than in adult animals (28). Moreover, cadmium poisoning may result in a case called Itai-Itai or Ouch-Ouch disease which characterized by sever pain, soft bones and death may occur due to renal failure (26). Concerning the mean concentrations of heavy metals in the examined baby foods, table (2) and Fig. (2) showed that Cd concentrations were 0.09 ± 0; 0.080 ± 0.01 and 0.040 ± 0.01 μg Cd/kg, respectively. These results were higher than that recorded previously by many authors in another types of baby foods as (8, 23, 27 & 33).

The damage of the central nervous system is a marked and common feature particularly in children due to their low lead tolerance and its low rate of elimination resulting in accumulation inside the body (20 & 21). The occurrence of excessively high Cd and Pb contents was due to contamination of the raw material with these metals (19).

Ingestion of an excessive dose of Cu may lead to Wilson’s disease which manifested by destruction of nerve cells, liver cirrhosis, ascitis, edema and hepatic failure. Moreover, Cu poisoning is characterized by Kayser-Fleischer ring which is a golden brown ring of accumulated Cu on the cornea of the eye (15).

Data in table (2) showed the copper concentrations in the examined baby food samples which are 1.58 ± 0.29; 1.12 ± 0.14 and 0.6 ± 0.15.
Cu/kg, respectively. These results were lower than that recorded in baby food (10), but higher than Cu limits in milk base baby formula and milk-cereal blends (1), but nearly similar to that recorded in India by (33).

Dealing with contamination of baby foods with Pb, table (2) and Fig. (2) show that the examined baby food samples contain $0.21 \pm 0.02 ; 0.11 \pm 0.02$ and $0.06 \pm 0.01 \mu g/kg$ respectively. These concentrations of Pb were much higher than that previously recorded by many authors (17, 22, 27 & 33). Toxic Pb concentrations can lead to Pb encephalopathia. A high percentage of surviving children have seizures and show signs of mental retardation. Anemia and reduced intelligence scores were recently observed in children after exposure to very low level of Pb (28). The occurrence of excessively high Cd and Pb contents was due to contamination of the raw material with these materials (19).

Mercury and methyl-mercury can cause Hg encephalopathia and frequently cause mental retardation in adults correspondingly. Hg accumulation in the brains of suckling rats is approximately 10 times higher than in grown animals (28). Exposure to Hg and Pb may result in neurotoxic and nephrotoxic impairment and in anemia (18). Also, Hg and Pb possess similar adverse effects on central nervous system, but they have environmental and metabolic differences that modulate their toxicity and neurobehavioral outcome in infant exposure during fetal development (5).

Table (2) show the mean concentration of Hg in the examined baby food samples which contain $0.38 \pm 0.05 ; 0.28 \pm 0.03$ and $0.16 \pm 0.02 \mu g Hg/kg$, respectively. These limits were much higher than that recorded in breast milk in Austrian population by (18).

Concentrations of all these metals are approximately one order of magnitude higher in baby food products than those observed in different types of milk owing to higher fat content (33). Also from table (2) it could be noticed that baby food type "A" (which contain beef) have the highest concentrations of Cd,Cu,Pb and Hg, while type "C" (which contain turkey meat) have the lowest concentrations. Table (3) show the standard permissible limits for some heavy metals in baby foods according to (6).
where it equal to 0.1 mg/kg for Cd ; 2 mg/kg for Cu; 0.1 mg/kg for Pb and 0.5 mg/kg for Hg. In 1983, the national maximum limit for Pb in baby foods was 0.2g/g, (16) but in 1988 FAO/WHO Provisional Tolerable Daily Intake (PTWI) of Pb by children was 3.5 μg/kg while for Cd by adults of 0.96 - 1.2 μg/kg (4). Moreover, in 1999, the (PIWI) for Cd established by a WHO/FAO expert group was 7 μg/kg body weight, while in India, the recommended tolerable levels for Pb and Cd was 3.57 μg/kg and 0.8 - 1.0 μg/kg, respectively (8). Meanwhile, the screening level for Hg according to (18) was 3.5 μg/L. From the above mentioned limits it has been noticed that the Egyptian limits in 1993 for Pb, Cd and Hg was 28.01 ; 100 and 28.57 respectively times higher than that in other countries as India and Austria. Also, it has been noticed that the average heavy metal uptake from baby foods exceeds the provisional tolerable weekly intake levels set by the WHO for adults, calculated on the basis of an average food intake and a downscaled body weight. These concentrations do not even provide for differences in absorption and distribution or for the increased sensitivity of children to heavy metal exposure. However, dilution effect for essential heavy metals were observed in fast-growing young children; this effect might be extrapolated to toxic metals (28).

Concerning the percentage of positive samples exceeding the Egyptian Standard (1993), table (3) show that for Cd, 10%; 5% and 5% of baby food type A,B and C, respectively exceeded the limits while for Cu, it was 5% for type A only. In case of Pb, 29%; 10% and 5% of type A,B and C exceeding the limits, but for Hg , it was 15% for type A only. Also, from this table, it has been noticed that baby food type A which contain beef have higher percentage of samples exceeding the limits, this may be due to the raw material may contain high concentrations of these heavy metals.

Conclusions and Recommendations

From the present results, it has been noticed that all examined samples have a various concentrations of OTA, AFB1 and AFM1, baby food type C which contain turkey meat have higher concentration from the three mycotoxins. Also, the examined samples have different concentrations of heavy metals (Cd, Cu, Pb and Hg), baby food type A which contain beef
have higher concentrations of heavy metals and also have higher percentage of samples that exceeds those of the Egyptian standards (1993). Therefore, it was again concluded that environmental pollution seems to be the main reason for the high toxic content in baby foods, so breast milk may be safer than commercial formulas. Thus, the following recommendations should be adopted:

The quality of raw material used in the production of baby foods should be strictly controlled to be kept within the safe limits.

Although AFBI concentration were found to be acceptable limits, still its existence must be carefully evaluated because future influences of very small amounts of aflatoxin on the growing organisms have not been fully elucidated.

Commercial formulas must be regularly examined by authorities for the possible risk of aflatoxin contamination.

Nevertheless, a continuous surveillance programme may be warranted to monitor regularly the occurrence of mycotoxins in the animal feeds responsible for current limited contamination and to note rapidly and worsening in the situation that may depend on market changes or on unfavourable climatic developments.

However, stricter control has to be applied to reject the batches containing irregular concentration of OTA.

In order to avoid possible toxic injuries in little infants, industry should certainly pay more attention both in supplying and technological management of baby food.

The results of this study must lead to a revision of views on the production and packaging technologies for baby foods.

References


6- Egyptian Organization for Standardization and Quality Control (EOSQC)(1990): Aflatoxins

7- Egyptian Organization for Standardization and Quality Control (EOSQC) (1993): Maximum levels for heavy metal contaminants in food. Egyptian standard N. 2360.


دراسة مدى تواجد وتكرار الأمان لبعض الملوثات في معلقات الأغذية

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حنان مصطفى طه اللوندي ٣ ، محمد أحمد حسن ٤
قسم مراقبة الأغذية ١ ، قسم الطب الشرعي والسموم ٢ ، كلية الطب البيطري بشهر
جامعة الزقازيق - فرع بها ، معهد بحوث صحية الحيوان بالزقازيق ٣

خلال فترة الأشهر الأولى بعد الولادة يحدث تغيرات سريعة في تطور الأعضاء
ووظائفها مثل الجهاز العصبي المركزي الذي ينمو سريعا ويصبح أكثر عرضة للتأثيرات السمية.
كذلك نتيجة لصغر وزنهم وزيادة استهلاكم للطعام فإنه من الممكن أن يكون مستوى الملوثات في
الأسمدة في الأطفال بعد الولادة أكبر من في الكبار.

وقد تم فحص عدد ١٠٠ عينة من أغذية الأطفال المعلبة تم جمعها اعتقلاً من محافظات الفيومية
والغربية لدراسة مدى تواجد بعض السموم الفطرية (أوكتوكسين أ ، أفالتوكسين ب) وبعض
المعلاجات الطبية (إكا فاتوم ، النحس ، الرصاص ، الزئبق) ، وقد تم تقسم
العينات إلى ثلاثة مجموعات كل منهم ١٠ عينة : النوع (أ) : خضار معلب مع اللحم ، النوع (ب) :
خضار معلب مع الفراخ ، والنوع (ج) خضار معلب من الرومي.

ومن هذه الدراسة اختلفنا تواجد الأوكتوكسين (أ) ، الأفالتوكسين (ب) والأفالتوكسين (م) في
كل العينات التي تم فحصها ، علاوة على ذلك سجلت تركيزات مختلفة من المعادن الثقيلة (الكاديميوم
، النحاس , الرصاص , الزئبق ) في الأغذية تحت الفحص.