Assiut Vet. Med. J. Vol. 45 No. 90. July 2001

Dept. of Food Hygiene,
Fac. Vet. Med., Assiut University, Assiut

ESTIMATION OF SOME METALLIC POLLUTANTS IN DRIED WEANING BABY FOODS

(With 1 Table and 2 Figures)

By

*ENAS EL-PRINCE and MANAL ABDEL-MOHSEN**

* Dept. of Forensic Med. and Toxicology, Fac. Vet. Med., Assiut Univ., Assiut

(Received at 27/6/2001)

قياس بعض الملوثات المعدنية في بعض أغذية الفطام الجافة للأطفال

ايناس البرنس محمد ، منال عبد اللطيف عبد المحسن

تم في هذه الدراسة تجميع خمسة وسبعون (٧٥) عينة عشوائية ممثلة لنوع واحد من الألبان الجافة كاملة الدسم والتي تعطى للأطفال من عمر سنة وبعض من أغذية الفطام الجافة المحتوية على خلاصة حبوب القمح والأرز والتي تستخدم كغذاء تكميلي للرضاعة من عمر أربعة أشهر. تم الحصول عليها من محلات وصيدليات مختلفة بمدينة أسيوط والتي تم إنتاجها خلال عامي ١٩٩٩ و ٢٠٠٠م بواقع خمسة عشر عينة لكل نوع. اشتملت عينات أغذية الفطام للأطفال على الأنواع التالية (لبن جاف كامل الدسم – خليط من اللبن كامل الدسم مع خلاصة القمح – خليط من اللبن كامل الدسم مع خلاصة الأرز – خلاصة القمح الخالي من اللبن – خلاصة الأرز الخالي من اللبن). تم تحليل هذه العينات لتقدير مستوى كل من الرصاص والكادميوم والحديد والزنك والنحاس باستخدام جهاز الامتصاص الذرى. أوضحت النتائج وجود ارتفاع في نسبة الرصاص عن الحد المسموح به في العينات المحتوية على خلاصة القمح بنوعيها. أما الكادميوم والنحاس فكانت نسبتها خلال الحد المسموح به دوليا. وكانت نسبة الحديد والزنك في العينات موضع الدراسة أعلى نسبيا من المسموح بها كجرعة يومية بالنسبة للأطفال أكثر من ستة أشهر. ناقش البحث الآثار المترتبة على زيادة نسبة هذه المعادن في غذاء الأطفال ومدي تأثيرها على صحتهم وعلى صحة الإنسان والحيوان بصفة عامة وقد أثبتت الدراسة سلامة هذه الأغذية على صحة الأطفال وأن الزيادة في نسبة بعض هذه الملوثات مع تعرض الأطفال المستهلكين لهذه المنتجات وكذلك التعرض لهذه الملوثات من البيئات الأخرى مثل الماء والهواء والأغذية الأخرى يهدد صحة الأطفال.

SUMMARY

Seventy five samples of some dried weaning infant foods were collected randomly from Assiut City supermarkets and pharmacies during 1999 to 2000. The samples (15 sample each) included full cream milk powder (for infants up to one year), wheat cereal with milk base, rice cereal with milk base, wheat cereal without milk base and rice cereal without milk base, which used for babies of four months age. Some heavy metal (lead & cadmium) levels and the related trace elements (iron, copper and zinc) were estimated using atomic absorption spectrophotometer. The obtained results revealed that the mean levels of lead in the examined samples of full cream milk powder, wheat cereal with milk base, rice cereal with milk base, wheat cereal without milk base and rice cereal without milk base were 0.00, 0.32 ± 0.34, 0.01 ± 0.02, 0.39 ± 0.44 and 0.00 ppm, respectively. These results were higher in both wheat cereals, with or without milk base than the permissible limits. The mean values of cadmium were 0.06 ± 0.04, 0.05 ± 0.04, 0.05 ± 0.03, 0.03 ± 0.03 and 0.02 ± 0.02 ppm, respectively. For iron, the mean levels were 9.89 ± 2.18, 28.78 ± 3.80, 14.42 ± 2.47, 40.60 ± 3.35 and 35.54 ± 4.85 ppm, for zinc, it is 11.46 ± 3.21, 9.78 ± 1.37, 13.83 ± 3.44, 5.86 ± 1.32 and 6.77 ± 1.16 ppm, while for copper it is 0.92 ± 0.23, 1.30 ± 0.33, 1.59 ± 0.26, 1.26 ± 0.30 and 1.27 ± 0.18 ppm, in full cream milk powder, wheat cereal with milk base, rice cereal with milk base, wheat cereal without milk base and rice cereal without milk base, respectively. Iron and zinc values were higher than the daily required for children more than six months while the copper values were within the permissible limits. The public health hazards of heavy metals residues and the suggestive measures for preventing pollution of baby foods were discussed.

Key words: *Metalic pollutants, dried weaning body foods.*

INTRODUCTION

Mother's milk is an ideal food for babies, but after a period, the increase of infants requirements required an additional prepared weaning foods. The manufacture of weaning infant foods based on dried milk involving mixing of various ingredients as milk powder with addition of vegetable powder, fruits, cereals and pulses. Also, during preservation and processing of baby foods, different substances are employed to prevent spoilage, promote binding properties and enhance flavor and nutritive value, antioxidents, coloring agents and others (Gracey, 1986). However, serious health hazards may be resulted if good manufacturing and hygienic practices of baby foods are not applied (Anon, 1986).

Unfortunately, environmental pollutants play an important role in development of several diseases in human being especially in children, where they are more sensitive to pollution. Heavy metals are among the most dangerous forms of pollution that may contaminate a food source by a leaching process between food and its container (Hagstad and Hubbert, 1986). Moreover, they have a tendency to accumulate in living tissues and organs (Antoniou et al., 1989).

Furthermore, heavy metals as a chemical residues in food have a role in animal and human health, so it is important and interesting to distinguish between the harmful effects on health due to trace amounts present in food and nutritional requirements of these elements known to be essential to human and animal life (Crosby, 1977). The toxic metals which considered of major interest in food safety are lead and cadmium. These metals are of recognized toxicity and their presence in foods at significant concentration is a potential health hazard. Iron, zinc and copper are considered as nutrients and are essential in biological value as activator of certain enzymes or indirectly as essential components of vitamins or hormones, and when they are given in excess amount , they become toxic (Cantharow and Schsport, 1977)

Lead is recognized as a known neuro-toxicant and of a major public health concern which causes both acute and chronic intoxication (Gossel and Bricker, 1990). It is known to cause encephalopathy in young children (Carl, 1991). Chronic exposure of children to low lead levels shows a variety of problems that link environmental lead exposure in early childhood with delayed neuropsychological development, intelligence, and academic achievement including attention deficits, impaired school performance, slowed psychomotor performance (Baghurst et al., 1992, Bellinger et al., 1992, Pocock et al., 1994, Howard 1995, Guidi et al., 1996 and Srianujata, 1998).

Laurence and Baure (2000) stated that children are particularly susceptable to lead toxicity because in increased hand-to-mouth activity, increased gut absorption, decreased sequestration in bone, and relatively less functional blood-brain barrier.

Cadmium and its salts are widely employed in numerous industrial processing. It is a component of many commercial products and found in nature in close association with lead and zinc (Klaassen, 1985). Moreover, it is virtually absent from the human body at birth and it is accumulated with age in body tissues and cause kidney failure (Gracey and Collins, 1992). Cadmium is toxic to all systems in the animal body, wherever ingested, injected or inhald. Anemia is a common manifestation of chronic cadmium toxicity in all species (Underwood, 1977). It also known to induce chronic renal disease due to the fact that urinary elimination is a main route of excretion and the proximal tubules are especially sensitive as a result of their high reabsorptive activity (Madden and Foweler, 2000).

The main sources of food contamination by cadmium are phosphate fertilizers and sewage sludge used on agriculture lands, using cadmium plated utensils and galvanized equipment in food processing and preparation. It is a metal with an extremely long biological half life in man. Even low exposure level may cause accumulation in the tissue by time leading to hypertension, testicular atrophy, may induce prostate cancer, renal dysfunction, bone changes and slight anemia (WHO, 1977 and WHO, 1980). Lee and White (1983) mentioned that food represents the second major source of exposure to cadmium.

One of the essential elements is iron, where it is necessary to all living cells and body fluids and play an important role in regulation of vital cell processes (WHO, 1972). Administration of large dose of iron for longe time lead to some liver damage (Doyle et al., 1993). Although, relatively high concentration is present in most grains, nuts and meat (Yeshajahu, 1994).

Zinc is essential for biological functions of all living matter. It is necessary for growth, appetite, testicular maturation, skin integrity, mental activity, wound healing and immunocompetence. Zinc is required for the metabolic activities of over 70 metalloenzymes (Abdel-Mageed and Oehme, 1990). Miranda et al. (2000) reported that copper and zinc are essential elements whose deficiency result in impairment of biological functions. Nevertheless, when present in excess, essential metals may also become toxic.

Copper occurs in foods in many chemical forms and combinations which affect its availability to the animal. Repeated copper exposures have been associated with haemolytic anemia (Manzler and Schreiner, 1970). The dairy products, white sugar and honey are considered the poorest sources of copper, which rarely contain more than 0.5 ppm (Underwood, 1977).

Chemical estimation of the trace element levels in human diets and their components provide the best indication of levels intake in relation to minimum needs and toxic potential. Because of greater sensitivity of young children to toxic substances in the diet and their primary dependence on this item in their diets, this study was undertaken to throw light on the level of some heavy metals and essential elements in baby food and to evaluate their hygienic condition.

MATERIALS and METHODS

Collection of samples:

Seventy five samples of some dried weaning infant foods were collected randomly from Assiut City supermarkets and pharmacies during 1999 to 2000 and transferred to the laboratory in their packages. The samples (15 sample each) included full cream milk powder (for infants up to one year), wheat cereal with milk base, rice cereal with milk base, wheat cereal without milk base and rice cereal without milk base, which used for babies of four months of age.

Estimation of metals:

- The level of lead and cadmium (non essential and toxic elements) and iron, copper, and zinc (essential elements) were estimated by using the atomic absorption spectrophotometer AAS (Buck Model 210 VGP, USA). The absorption and concentration were recorded directly from the digital scale of AAS in ppm. Standard procedures were used to estimate lead, cadmium, iron, copper and zinc in the examined samples (Agemain et al., 1980).
- Iron, copper and zinc were measured by using AAS according to Parker et al. (1968).

The calculation was carried according to the formula:

$$\frac{\text{Dilution x reading}}{\text{Weight}} = \text{ppm}$$

RESULTS

The obtained results were summarized in Table 1 and Figures 1 and 2.

DISCUSSION

Contamination of food and milk by heavy metals is one of the major problems that affecting human health. The main source of these heavy metals is the over using of fertilizers and increase industrial activity. Industrial and agricultural use of heavy metals and their compounds resulted in environmental pollution and presence of metal residues in food chain (Tork, 1996).

Lead is a cumulative poison that causes both acute and chronic intoxication. Although acute poisoning is rare, chronic poisoning is more common and serious (Gossel and Bricker, 1990). The obtained results revealed that the mean values of lead in full cream milk powder base, wheat cereal with milk base, rice cereal with milk base, wheat cereal without milk base and rice cereal without milk base were 0.00, 0.32 ± 0.34, 0.01 ± 0.02, 0.39 ± 0.44 and 0.00 ppm, respectively as shown in Table 1 and Fig. 1. These result in comparison with the permissible limit in milk and cereals (0.02 and 0.2, respectively, as stated by Panariti, 1998) are within the normal levels except an elevation in case of both types of wheat cereals. Fathi et al. (1995) recorded that milk powder contain 0.8260 µg/g which is higher than the obtained results in this period of year.

Lisk (1972) found that the lead content by mg/kg fresh weight basis in cereals and grains was 0.0 – 7.5. On the other hand, in Italy, Guidi et al. (1996) found that the mean concentration of lead in milk-based formula used in infants feeding was 73 ± 39.11 µg/L.

Cadmium levels were estimated in baby food samples, including milk-base, cereal and milk-based and soy-based formulas recommended from 0 to 18 months of age by Eklund and Oskarsson, (1999). They found that the mean cadmium levels ranged from 1.10 to 23.5 µg/kg fresh weight of concentrated formulas. They also found that the formulas based on cow's milk had the lowest concentrations. Soy formulas contained approximately six times more cadmium than cow's milk formulas, and diet with a cereal content had 4 – 20 times higher mean levels. Fathi et al. (1995) recorded that the mean level of cadmium in milk powder sample was 0.0704 µg/g wet weight. Our study revealed lower concentration of cadmium either in full cream milk powder or in various cereal foods with or without milk. The mean levels of cadmium were 0.06 ± 0.04, 0.05 ± 0.04, 0.05 ± 0.03, 0.03 ± 0.03 and 0.02 ± 0.02 ppm in full milk powder, wheat cereal with milk base, rice cereal with milk base, wheat cereal without milk base and rice cereal without milk base, respectively which were lower than those obtained by the aforementioned authors.

As well as, iron is present in relatively high concentrations in most grains and grain products (Yeshajahu, 1994). Chronic iron overload in humans results in hepatocellular damage and fibrosis (Doyle et al., 1993). The maximum permissible limits of iron in food for daily intake is 0.8 mg/kg body weight according to Egyptian Organization for Standardization (1993). Underwood (1977) recorded that most cereal grains contain 30 – 60 ppm of iron and cereal species differences appear to be small. These records were agree with our results, where the mean values of iron in the examined cereal samples were 28.78 ± 3.80, 14.42 ±

2.47, 40.60 ± 3.35 and 35.54 ± 4.85 ppm which recorded within the same levels (Table 1 and Figure 2).

Zinc is an essential trace element, necessary for enzyme reactions, protein synthesis and carbohydrate metabolism. As in case of many elements, food provide the largest source of zinc and cadmium intake for human being. Abdel-Mageed and Oehme (1990) reported that the recommended daily zinc requirement is 3 mg for infants less than six months of age, 5 mg for older infants, 10 mg for preadolescent children, 15 mg for adolescents and adults, 20 mg during pregnancy and 25 mg during lactation. They also postulated that wheat germ bran and oysters are among the richest sources of zinc. The zinc content of cow's milk varies from 3 to 8 µg/g. As regarding from the obtained results (Table 1 and Figure 2), the mean values of zinc in full cream milk powder was 11.46 ± 3.21 ppm which is higher than those present in cow's milk as previously recorded. Also, the mean values of zinc in other cereal foods were 9.78 ± 1.37, 13.83 ± 3.44, 5.86 ± 1.32 and 6.77 ± 1.16 ppm, respectively, which are higher than the daily requirements for infants older than six months.

Copper is considered an essential mineral for the functioning of certain enzymes, and a daily dietary intake of 2 to 3 mg is recommended for adult (Grandjean, 1986). Copper appears to be present in meat and cereals in large amounts than in other types of food being as high as 2.5 mg/kg (Gracey, 1986). Saad et al. (2001) measured the level of copper in farm bulk milk collected from Ismailia and El-Sharkia Governorates, they found that the levels decrease as the lead levels increase. These findings are similar to those reported by Evans (1971) and El-Hoshy et al. (1994). It has been recorded that some of toxic effects of cadmium were related to its copper-depleting effects, where the decreasing in copper levels are associated with high cadmium concentration in human and animal organs and tissues (Lamphere et al., 1984). Higher levels of copper in raw, pasteurized and UHT milk were detected by Fayed (1997). Our results which recorded in Table 1 and Fig.1 revealed that the mean values of copper in examined samples were 0.92 ± 0.23, 1.30 ± 0.33, 1.59 ± 0.26, 1.26 ± 0.30 and 1.27 ± 0.18 ppm, respectively, which had lower level if compared with the daily intake of adults (2 – 3 mg).

From the achieved results, it is conclude that industry should pay more attention both in supplying and in technological management to avoid the exposure of babies to low levels of these metallic pollutants which may be with other sources induce health hazards for children.

REFERENCES

Abdel-Mageed, A.B. and Oehme, F.W. (1990): A review of the biochemical roles, toxicity and interactions of zinc, copper and iron: I. Zinc. Vet. Hum. Toxicol. 32 (1): 34 – 39.

Agemain, H., Sturtevant, D.P., Epivatianos, P. and Nathanael, B. (1980): Stimultanco-extraction of six trace metals from fish tissue by Hot Digestion and determination by atomic absorption spectrophotometer. Analst, 105: 125.

Anon (1986): Sampling plans for milk and milk products. In: Microorganisms in Foods. Vol.2, 2nd. Ed. Roberts, T. A., Bryan, F.L., Christian, J.H.B., Kilsby, D., Olson Jr., J.C., Silliker, J.H. pp. 161 – 174. Oxford: Blackwell Scientific Publications.

Antoniou, H. Tsoukali, P., Epivatianos, P. and Nathanael, B. (1989): Cadmium concentrations in beef consumable tissues in relation to age of animals and area of their breeding. Bull. Ern. Contam. Toxicol., 41: 915 – 919.

Baghurst, P., McMichael, A. and Wigg, N. (1992): Environmental exposure to lead and children's intelligence at the age of 7 years. N. Engl. J. Med., 327: 1279 – 1284.

Bellinger, D., Stiles, K. and Needleman H. (1992): Low-level lead exposure, intelligence, and academic achievement: A long-term follow-up study. Pediatrics, 90: 855 – 861.

Cantharow, A. and Schsport, Z.B. (1977): Biochemistry. 6th Ed., Saunder B. W. Co., Philadelphia, USA.

Carl, M. (1991): Heavy metals and other trace elements. Monograph on residues and contamination in milk and milk products. Chapter 6, Int. Dairy Federation Belgium.

Crosby, N.T. (1977): Determination of metals in foods. A review. J. The Analyst., 102 (12): 1213.

Doyle, M.E., Steinhart, C.E. and Cochrane, B.A. (1993): Food Saftey 1993. pp. 324 – 329. Food Research Institute, Marcel Dekker, Inc., New York.

Egyptian Organization for Standardization (1993): Egyptian Standard, maximum levels for heavy metal contaminants in food. ES: 2360, UDC: 546.19:815. Arab Republic of Egypt.

Eklund, G. and Oskarsson, A. (1999): Exposure of cadmium from infant formulas and weaning foods. Food Addit. Contam., 16 (12): 509 – 519.

El-Hoshy, S.M., Draz, A.A. and Samaha, H.A. (1994): Influence of lead and copper as water pollutantson their level in produced milk. 6th Sci. Cong. Fac. Vet. Med., Assiut University, Egypt.. pp. 371-377.

Evans, C.W. (1971): Biological function of copper. Chemistry. 44: 10 – 13.

Fathi, Sh.M., Nagah, M.S. and Nagwa, M. El-Sawi (1995): Trace metal levels in some selected food items. Assiut Vet. Med. J., 33 (65): 123 - 129.

Fayed, A.H. (1997): Pollution of raw milk with some heavy metals. M.V.Sc. Thesis, Fac. Vet. Med., Alex. Univ., Egypt.

Gossel, A.T. and Bricker, J.D. (1990): Metals. In: Principles of Clinical Toxicology. 2nd Ed., pp. 162 -192. Raven press, New York.

Gracey, J.F. (1986): Chemical Residues in Meat. In: Meat Hygiene. 8th Ed., English Language Book Society/Bailliere Tindall. Pp. 191-210.

Gracey, J.F. and Collins, D.S. (1992): Meat Hygiene. 9th Ed., Bailliere Tindall, pp. 24-28, Oval Road, London.

Grandjean, P. (1986): Diseases associated with metabolism. In Last, J. M. (ed.) Publi:c Health and Preventive Medicine. In: Public Health and Preventive Medicine, Last, J.M. (ed.) 23rd Ed., Norwalk, Conn., Appleton Century-Crofts, 1986, pp. 587 – 661.

Guidi, B., Ronchi, S., Matti, F., Tripodi, A. and Ori, E. (1996): The lead concentration in the converted and special-formula milks used in infant feeding. Pediatr. Med. Chri., 18 (3): 275 – 277.

Hagstad, H.V. and Hubbert, W.T. (1986): Food Quality Control. In: Foods of Animal Origin. Pp. 86-87, The Iowa State University Press Ames.

Howard, Hu. (1995): Revision de los efectos de la exposicion a plomo sobre la salud. In: Intoxicacion por Plomo en Mexico: Prevencion y Control. Instituto Nacional de Salud publica. Hernandez M, Palazuelos E eds. Mexico.

Klaassen, C.D. (1985): Heavy metals and heavy metal antagonists in the pharmacological basis of therapeutics. 7th Ed., A J. Gilman, L. S. Goodman, T. W. Rall and F. Murad (eds.), pp. 1605 – 1627, Macmillan, New York.

Lamphere, D.N., Dorn C.R., Reddy, C.S. and Meyer, A.W. (1984): Reduced cadmium body burden in cadmium exposed calves fed supplement zinc. Environ. Res., 33: 119 – 122.

Laurence, F.M.D. and Baure, E.M.S. (2000): Lead contamination of imported candy wrapper. Vet. Hum. Toxicol., 42 (1): 41-42.

Lee, J.S. and White, K.L. (1983): Cadmium. In: Environmental and Occupational Medicine. Rom, W. N. (ed.), pp. 465-472, Boston, Little, Brown.

Lisk, D.J. (1972): Trace metals in soils, plants and animals. In: Advances in Agronomy.Brady NC (ed.): Academic press INC, pp. 267-325, New York.

Madden, E.F. and Foweler, B.A. (2000): Mechanisms on nephrotoxicity from metal combinations: a review Drug Chem. Toxicol., 23(1): 1-12.

Manzler, A.D. and Schreiner, A.W. (1970): Copper-induced acute hemolytic anemia. A new complication of hemodialysis. Ann. Intern. Med., 73: 409- 412.

Miranda, M., Alonso, M.L., Castillo, C., Hernandez, J. and Benedito, J.L. (2000): Effect of sex on arsenic, cadmium, lead, copper and zinc accumulation in calves. Vet. Human Toxicol., 42 (5): 265 – 268.

Parker, M.M., Hummoler, F.L. and Mahler, D.J. (1968): Determination of copper and zinc in biological materials. Anal. Chem., 13: 40-48.

Pocock, S., Smith, M., and Baghurst, P. (1994): Environmental lead and children's intelligence: A systematic review of the epidemiological evidence. B.M.J, 309: 1189-1196.

Saad, A.H., El-Kosi, O.H.R. and Abdel-Hakiem, E.H. (2001): Surveillance of some heavy metals in raw milk. 1st Cong. of Food Hygiene & Human Health, 6 – 8 February, Assiut, Egypt, pp. 258-270.

Srianujata, S. (1998): Lead-the toxic metal to stay with human. J. Toxicol. Sci. (23 Suppl), 2: 237 – 240.

Tork, I.Y. (1996): Environmental heavy metal hazard in relation to animal health. Project Proposal, Fac. of Vet. Med., Zagazig University, Egypt.

Underwood, E.J. (1977): Trace Elements in Human and Animal Nutrition. 4th Ed. Academic Press, New York, San Francisco, London.

WHO (1972): Evaluation of certain food additives and the contaminants. Mercury, lead and cadmium. 16th Rep. J. FAO/WHO Expert Committee on Food Additives. Geneva, 4-12 April.

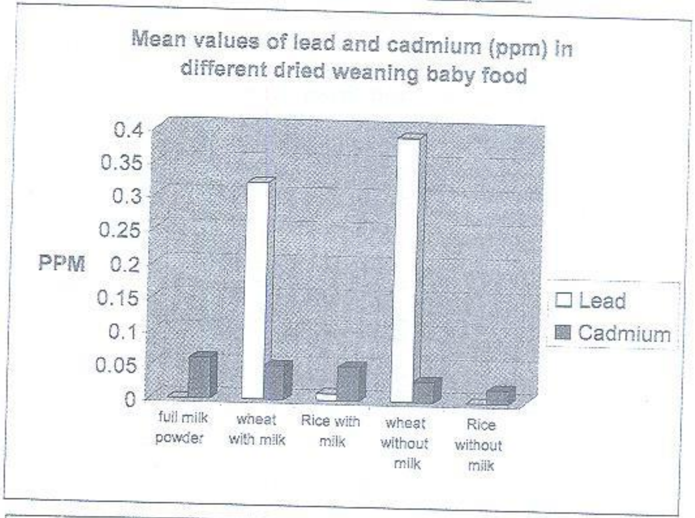
WHO (1977): Environmental Health Criteria No. 3. Lead. World Health Organization, WHO, Geneva. pp. 160.

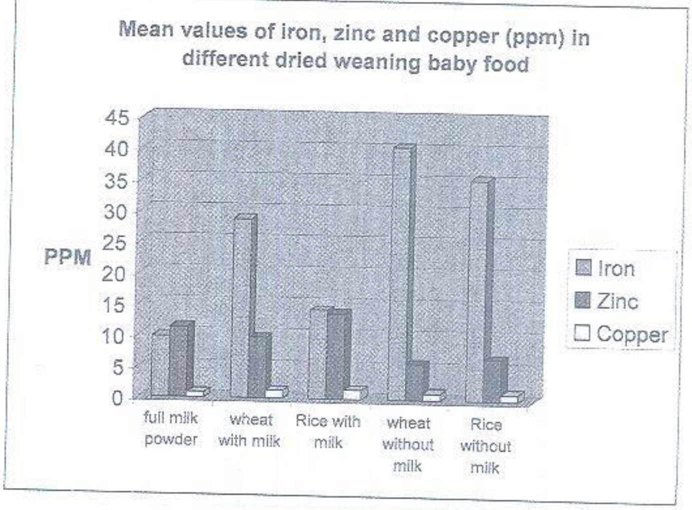
WHO (1980): Technical Report Series. Recommended Health_ Based Limits in Occupational Exposure to Heavy Metals. Report of WHO Study Group. Technical Report. Series No. 647.

Yeshajahu, P.C.E. (1994): Ash and minerals. In: Food Analysis, Theory and Practice. 3rd Ed. pp. 602. Chapman & Hall, New York, London.

Table 1: Range and mean values (ppm) of lead, cadmium, iron, zinc and copper in different dried weaning baby foods (mean ± SE)

Sample	Values	Lead	Cadmium	Iron	Zinc	Copper
Full cream milk powder	Min.-Max.	Not	0.01 – 0.12	6.84 – 15.84	7.85 – 20.84	0.59 – 1.54
	Mean	detected	0.06 ± 0.04	9.89 ± 2.18	11.46 ± 3.21	0.92 ± 0.23
Wheat cereal with milk base	Min.-Max.	0.0 – 0.94	0.0 – 0.11	23.80 – 37.94	7.12 – 12.07	0.72 – 1.91
	Mean	0.32 ± 0.34	0.05 ± 0.04	28.78 ± 3.80	9.78 ± 1.37	1.30 ± 0.33
Rice cereal with milk base	Min.-Max.	0.0 – 0.09	0.0 – 1.11	9.14 – 19.65	9.16 – 21.94	1.11 – 2.05
	Mean	0.01 ± 0.02	0.05 ± 0.03	14.42 ± 2.47	13.83 ± 3.44	1.59 ± 0.26
Wheat cereal without milk base	Min.-Max.	0.0 – 1.04	0.00 – 1.10	34.23 – 44.72	3.74 – 8.24	0.86 – 1.82
	Mean	0.39 ± 0.44	0.03 ± 0.03	40.60 ± 3.35	5.86 ± 1.32	1.26 ± 0.30
Rice cereal without milk base	Min.-Max.	Not	0.00 – 0.06	28.54 – 42.33	5.00 – 8.87	1.02 – 1.58
	Mean	detected	0.02 ± 0.02	35.54 ± 4.85	6.77 ± 1.16	1.27 ± 0.18


Mean values of lead and cadmium (ppm) in different dried weaning baby food
0.4
0.35
0.3
0.25
PPM
0.2
0.15
0.1
0.05
0
full milk powder
wheat with milk
Rice with milk
wheat without milk
Rice without milk
Lead
Cadmium


Mean values of iron, zinc and copper (ppm) in different dried weaning baby food
45
40
35
30
25
PPM
20
15
10
5
0
full milk powder
wheat with milk
Rice with milk
wheat without milk
Rice without milk
Iron
Zinc
Copper