Nutrition Evaluation by Bioavailability: Study of Some Essential Trace Elements of Infant Foods

S. Kakker[1], A. C. Kappor[1], Golam Mowlah[2]

1. Department of Food and Nutrition, Haryana Agricultural University, India.
2. Insititute of Nutrition and Food Science, University of Dhaka

Introduction

The child health is determined to a great extent by the nature and quality of food provided in their first five years. Because it is observed that impaired physical and mental growth is common to malnourished children as a consequence of unbalanced food intake[1,2]. Breast milk, if available in sufficient quantity, is adequate as the sole source of food during first four to six months of age[3]. Under some special circumstances including lactational failure where breast feeding is not possible, artificial feeding is done. This situation renders the possibility of intaking of incorrect infat foods, specially true in the developing countries[4]. Also, in recent years large number of commercially available infant foods have been developed.

Trace elements because of their distinct biological roles, are the vitally important nutrients of the infant food[5,6]. Among the fourteen essential trace elements present in hormones, vitamins, enzymes and other proteins in the body, iron, zinc and copper are the main three essential trace elements[5]. The role of iron in child nutrition is well established[7]. Among many functions of iron in the body iron-deficiency anemia has long been considered as wide prevalent. Nutritional disorder of the children and the young children need enough iron for their continued increase of blood volumes, iron is needed for immunocompetence, oxidative phosphorylation, oxygen and carbondioxide transport and in phagocytosis, and iron is a component of cytochromes, nonheme iron protein and lysosomal enzyme myeloperoxidases[8]. Zinc as essnetial trace element has been established by a series of studies by feeding zinc containing diet to children recovering from malnutrition[9,11], and also anemia related to copper deficiency is often detectable in preterm infants and in protein energy malnutrition[12]. As utilization of nutrients in the body is the major concern for health and nourishment which brings the consideration of bioavailability reflecting to the efficiency of utilization of nutrients in the body. This bioavailability concept of essential trace elements of diet are widely discussed and considered as a practical approach for assessing and identifying the nutritionally and biologically effective level of nutrients[13,15]. Taking all these facts into accounts and apprehending the immense importance of the three essential trace elements e.g. iron, zinc and copper in infant health and nutrition, the bioavailability study of iron, zinc and copper was performed for infant foods of both commercially available and synthetic diet in the present study and the results obtained are reported in this paper.

Materials and Methods

Bioavailability of iron, zinc and copper was assessed in three commercial infant foods namely; Sapan, Infanto and Amulspray and

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a Synthetic Diet similar in composition to those of commercial products. The recipe of the synthetic diet is consisted of egg albumin. sucrose, ground nut oil, mineral mixture and vitamin mixture. Four groups of young male Wister rats were fed on infant foods and synthetic diets for 28 days. During the last five days of experiment, metabolic study was conducted. The diets including the commercial products were analysed for chemical composition using standard method of analysis[16], to know the actual position of the products and to escertain the information of the commercial products. Calorie values were obtained using Atwater factor technique of FAO/WHO[17]. Trace elements like iron, zinc and copper in urine, faeces and diet samples were determined by atomic Absorption Spectro photometer[18]. Iron was also estimated by in vitro technique for all the infant foods sample according to Miller et al (1981) using dialysing method[19].

Results

The results of chemical composition in infant foods are presented in Table 1. Iron, zinc and copper intakes, and their apparent absorption and retention in rats fed on different infant foods are shown in Table 2 and 3, respectively. The bioavailability of iron determined by in vitro procedure are shown in Fig. 1.

Discussion

Table 1 gave the chemical composition of the infant foods. Allthe foods indicated similar nutrient components except in sapan and infanto which gave higher contents of zinc 4.77 and 4.55%, respectively. The synthetic diet contained 1.45% of zinc. Although the synthetic diet contained less amount of zinc, compared to the commercial products, it remains in the proper level required for infant foods. The daily requirement of zinc varied widely ranging from 6-22 mg[5]. and the USA recommended intake of zinc for adult is 15 mg[12]. Also the zinc content in the US adult food was found to be 12.5 mg/capita/day[20]. The authors during formulation of synthetic diet considered the over-dose affect of zinc in infant health like gastrointestinal distress and vomiting[21].

Table 2 revealed that iron and copper intake in synthetic diet groups were significantly higher as compared with other food groups. Zinc intake in synthetic diet groups was the lowest and highest in sapan. Differences in trace elements intake of vrious groups may be due to variations in dietary trace elements concentration. It is reported that trace elements intake is directly proportional to their contents and availability in the supplied diet[5].

Absorption of iron in infanto group was the highest and differed from other groups except sapan (Table 3). Retention of iron was minimum in synthetic diet group which differed from sapan and infanto groups. Lower absorption and retention of iron in amulspray and synthetic diet than those of other foods may be due to higher levels of copper present in amulspray and synthetic diet. Studies with experimental animals indicated that excess dietary copper may hinder the absorption and retention of iron[22]. Similarly, it was observed in another study that dietary copper affected the absorption of iron adversely[23].

Copper absorption in synthetic diet group was significantly lower than those of other infant foods which indicated that high copper intake resulted in decrease in apparent absorption. Also, apparent absorption of copper was lower in sapan and infanto foods having lower dietary copper levels as compared with amulspray, indicating a decrease in apparent absorption of copper by lowering the dietary copper levels. The similar result was also observed previously[23]. Apparent retention of copper in sapan was lower as compared to amulspray having low zinc concentration, indicating that higher retention of copper in amulspray may be due to high dietary copper and low levels of zinc in diet. Klevay (1981) has shown data indicating that copper and zinc are inversely related and decrease in dietary zinc level will increase copper availability[24]. The findings of the present study exhibit similar pattern to those of Klevay [24].

The absorption and retention of zinc in sapan group was maximum and differed significantly from amulspray and synthetic diet group. Apparent absorption of zinc in sapan and infanto group was more because of their lower copper concentration as compared with amulspray showing that at lower level of copper intake, the apparent absorption of zinc was more. These observations comply with the studies reported by other author [24]. Also it is reported elsewhere that excess intake of either copper or zinc interferes with the absorption of others [8].

Results of bioavailability of iron in infant foods estimated by in vitro procedure showed that sapan, infanto, amulspray and synthetic diet contained 13.47, 14.43, 10.36 and 13.20% of dialysable iron, respectively. It can be mentioned that there exists a positive and significant (P=0.05) agreement between in vitro and in vivo analysis (r=+0.578).

There are other chemical substances and factors that effect the absorption and retention of iron, zinc and copper in the body. The detail discussion on them may be beyond the scope of this paper because the presence of these chemical substances and factors are not analysed or ascertained in the infant food under the present study. But for general interest and to cover some related aspect of the present study, it can be briefly mentioned, that iron absorption is inhibited or hindered by the presence of tannin[25], both by egg yolk and white[26,27], phosphate salts in presence of calcium[28], by phosphorprotein present in egg yolk[26], phosphate-rich component of meat[29] and by strong chelating agent like Disodium EDTA[30].

The bioavailability of both iron and zinc is adversely affected by phytate containing foods[31,32]. On the other hand, the addition of animal foods improves the absorption of iron and the other food substances like sugar, citric acids, and amines improves the iron bioavailability, and the most important dietary promotor of iron absorption is ascorbic acid[33, 34].

Summary

Bioavailability of trace elements (iron, copper and zinc) in three commercially available infant foods and a synthetic diet were assessed by feeding four groups of young male Wistar rats. The results revealed that rats in all the groups were on positive iron, copper and zinc balance. Iron absorption and retention was maximum in rats fed on infanto food and it was lowest in rats fed on synthetic diet. Absorption of copper ranged from 14.2% (synthetic diet) to 37.7% (amulspray). Retention of copper was the highest (23.1%) in rats fed on

amulspray. Zinc absorption was maximum in rats fed on synthetic diet, whereas its retention was highest in sapan formula fed rats. Bioavailability of iron by in vitro procedure revealed that sapan, infanto and amulspray and synthetic diet were found to contain 13.57, 14.43, 10.36 and 13.20% of available iron, respectively. Comparison of results from in vitro and in vivo methods shows a good agreement between these two methods.

Table 1. *Chemical Composition of different diets (per 100g of dried powder)*

Food Component	Dietary Group			
	Sapan	Infant	Amulspray	Synthetic Diet
Moisture (g)	3'35	1.69	1.72	6.11
Protein (g)	21.66	21.32	22.33	21.43
Fat (g)	18.61	18.24	18.28	18.00
Ash (g)	5.94	5.55	4.86	4.96
Energy (Kcal)	455	455	450	466
Iron (mg)	4.20	4.19	4.07	4.30
Copper (mg)	0.350	4.350	0.550	0.530
Zinc (mg)	4.77	4.50	2.90	1.45

Table 2. *Trace elements intake of rats fed on different infant feeds and synthetic diet for five days*

Dietary Group	Iron (µg)	Copper (mg)	Zinc (mg)
Sapan	2.01	111.5	2.291
Infanto	1.97	109.6	2.149
Amulspray	1.95	263.3	1.388
Synthetic Diet	2.75	397.7	0.928

Table 3. *Apparent absorption and retention of trace elements in rats fed on different infant foods for five days (average of six rats)*

	Absorption(%)			Retention (%)		
Dietary Group	Iron	Copper	Zinc	Iron	Copper	zinc
Sapan	16.91	35.6	21.7	12.23	15.9	16.9
Infanto	17.26	36.5	21.2	12.84	16.1	16.8
Amulspray	14.87	37.7	17.5	10.11	23.1	12.9
Synthetic Diet	11.63	14.2	23.8	9.35	8.9	12.2

Sa: Sapan; Am: Amulspray In : Infanto; Sy: Synthetic diet

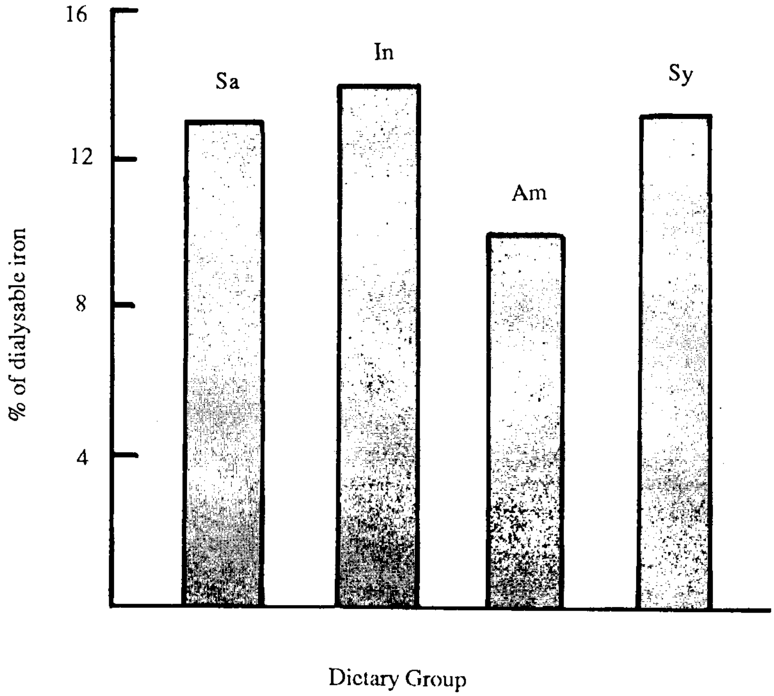

Fig. The bioavailability of iron in different dietary groups

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