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DIETARY REQUIRMENTS OF ZINC FOR BREAST - FED INFANTS DURING THE FIRST YEAR OF AGE

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ABSTRACT

The present work aimed to study the zinc content of human and cow milk as well as some plant products which are used for preparing some natural foods and juices for feeding infant as food supplement. Also, the present study calculated the dietary zinc intake to ensure normal growth and good health for infants. Ten lactating mothers supplied monthly samples of human milk allover the year (2003). Milk samples from cows were taken from 5 governorates allover the same year. Samples of eggs, vegetables (potatoes and green peas), fruits (apple, banana and orange), cereals (wheat and rice) and legumes (lentil) were collected from the same 5 governorates. Skim milk was prepared from cows. Belila, boiled rice, lentil, potatoes, green peas and eggs were prepared. Orange juice was prepared. Zinc concentration was determined in all the above mentioned products.

Results showed that zinc concentration in human milk ranged from 0.63 to 3.8 µg / ml, while, cow's milk contained the lowest zinc concentration ranged from 0.007 to 0.017 µg / ml. on the contrary, zinc concentration was relatively high in whole boiled eggs ranged from 1 to 1.5 mg. Zinc concentration was 5 mg/100g in lentil, 3 mg / 100 gm in belila, , 0.4 mg / 100 g in boiled rice, 4 mg / 100g in green peas, 0.3 mg / 100g in potatoes and 0.2 mg / 100g in banana. Orange juice has the lowest recorded value of 0.02 mg / 100 g.

Since the recommended dietary allowances set by the Food and Nutrition Board (1980) was 3-5 mg / day of zinc as intake for infants during the first year of age, five regimes were suggested. The calculation of these regimes based on the age of infants and the requirements of k cal / day and protein (g/ day) and calculation of zinc concentration of each regime to supply the infants with the satisfied nutrients and recommended zinc concentration.

Keywords : zinc, milk , egg, cereals, legumes, vegetables, fruits.

INTRODUCTION

The most sensitive index of nutritional health during infancy is growth. Virtually all nutrients, when severely limited can retard growth, of which is Zinc. For this reason monitoring of growth is the most important indicator of nutritional status in pediatric practice (Solomons and Molina, 1988). The assessment of growth is a mean by which normal growth and good health in a child is ensured. Human milk serves as a single food source of nutrients during the growth (Nancy *et al.*, 1992). The American Academy of Pediatrics (1976) recommended that breast milk be the sole source of nutrients for infants aged ≤ 4-6 month, therefore, it is important to understand factors that affect breast milk composition. One of the nutrients that may play a role in the etiology of stunting is Zinc which has an essential role in growth and development (Golden, 1988). It was evident that mild Zinc deficiency is one reason why some children grow poorly. The recommended Zinc allowance for adult men is set at 15 mg / day. The allowance for adult women, because of their lower body weight, is set at 12 mg / day. (Recommended Dietary Allowances (RDAs), 1989). (Swanson *et al.*, 1983)

pointed out that a dietary Zinc intake of 15 mg / day is recommended during pregnancy. Food and Nutrition Board (1980) recommended a value of 20 mg / day as a daily dietary allowances for pregnant women and 3 – 5 mg/ day for infants during the first year of age. The increased Zinc requirement of lactating women can be calculated from the amount of Zinc lost each day in the different phases of lactation. The mean Zinc content of human milk in the USA is 1.5 and 1.0 mg / L during the first and second half year, respectively (Krebs *et al.*, 1985 and Moser & Reynolds, 1983). The Food and Nutrition Board (1980) recommended a value of 25 mg / day as a daily allowance for lactating women throughout lactation. Approximately 30 µg of Zinc is required for each gram of weight gain in infants. For infants consuming only human milk do not show any sings of Zinc depletion (Hambidge *et al.*, 1979). The Zinc requirements vary from 1.0 - 3.1 mg / day for 2 month – old male infants, this level corresponds to both the recommended dietary allowances (RDAs, 1989) and the recommendation of the committee of nutrition of the American Academy of Pediatrics (1976). Beyond the age of 6 months, infants would receive from 700 ml of breast milk only 0.7 mg of Zinc / day which can be augmented by the use of solid foods (RDAs, 1989). The dietary Zinc requirements of infants consuming formula is higher than that of breast- fed infants because of lower Zinc availability of the formulae (Casey *et al.*, 1981 and Lonnerdal 1987). RDAs (1980) recommends 5 mg / day of Zinc as intake for formulated infants. For preadolescent children, the linear growth was improved as a result of supplementation to a total Zinc intake of approximately 10 mg / day.

The present work will focus on the Zinc content of human milk as well as some natural foods and juices for feeding infants as food supplement.

MATERIAL AND METHODS

I- Sampling

I.1- Human Milk (Breast milk)

Samples of (10 – 20 ml) human milk were collected from each of 10 lactating mothers monthly all over the year 2003, starting from January till December (120 samples). The selected mothers who participated in the present work, were attached to family regulation center, Shoubra El- Kheima, Cairo. They met the following criteria:

- Healthy, free from any debilitating diseases.
- Have no history of smoking, chronic disease, toxemia of pregnancy, hypertension or any infection.
- Have the intention to breast feed their infants.
- Have delivered single infant at the term.
- Have received no oral contraceptives.

Samples were collected in small plastic bottles, transported in ice bags immediately to the laboratory for analysis.

I.2- Cow milk

Samples of 500 ml – 1000 ml of cows milk were taken from 5 govenorates (Giza, El-Fayoum, Kaliobia, Beny – sweif and Menia) allover the year 2003.

I.3- Eggs

One sample was collected from each of the same five governorates every other month. One sample is composed of 9 eggs collected randomly from3 farms, i.e. 3 eggs from each farm (30 composite samples / years)

I.4- Vegetables and fruits

Composite samples of potatoes, green peas, apple, banana and orange of 1 kg were collected from 3 different locations of each studied governorates during the months of their production (15 composite samples each).

I.5- Cereals and legumes.

Composite samples of wheat, rice and lentil of 1 kg were collected from 5 different locations of each studied governorates (15 composite samples each).

II. Preparation of Samples

II.a. Lentil

Lentil was prepared by taking 100 g of washed lentil, brought to boiling using 700 ml tap water, then stewed for 1/2 hour, the final product weight was 453 g. One hundred grams calculated to contain 73 kcal and 5.5 g protein (Food composition table, 1982).

b. Boiled rice

100 g of washed polished rice were boiled in a volume of tap water for 1 hr with continuous addition of water to a final volume of 1000 ml. The final product weight was 545 g and calculated to contain 66 k cal and 1.4 g protein per 100 g (Food Composition Table, 1982).

c. Potatoes, green peas and apple

100 g from potatoes, green peas and apple were boiled for 30 min. in 500 ml tap water. The nutritive value / 100 g were as follow 80 k cal and 1.4 g protein, 52 k cal and 5.1 g protein and 46 k cal and 0.3 g protein, respectively, as described by Michael (1986).

d. Skim milk preparation

Skim milk was prepared from fresh milk warmed to 45°C using stainless steel separator. The nutritive value was 41 kcal and 4.3 g protein (Food composition table, 1982).

e. Eggs

Eggs were boiled for 5 min. The nutritive value was 150 kcal and 12.5 g protein as described by FAO (1982) and Michael (1986).

f. Orange juice

To 500 ml orange juice, 50 g sugar and 500 ml tap water were added. One hundred grams of the prepared juice was calculated to contain 41 kcal and 0.33 g protein (Jean, 1994).

g. Belila

100g of washed wheat grains were sooked for 24 hr in 200 ml tap water, brought to boiling and continued boiling for 1 hr, with continuous addition of water to have a final added volume of 1200 ml. The resulted product, 776 g, is called in Egypt " Belila" , and calculated to contain 44 kcal and 1.6 g protein per 100g (Food Composition Table, 1982).

h. Banana.

Fresh sample was cleaned to get rid of any dust and washed by spraying with water and blenched
(Food composition table, 1982).

III. Estimation of Zinc

Zinc in milk, vegetable, fruits, cereals and legumes were determined using atomic absorption spectrophotometer, Pye Unicam SPgo A series 2. Varian hallow- cathode lamps were used as radiation sources for the zinc studied metal. The instrument settings for the atomic absorption measurement of zinc was 213.9 nm and slif width of 1 nm.

RESULTS AND DISCUSSION

I. Zinc concentration in Milk

I.A. Human milk

Table (1) presents the monthly average concentration of Zinc in human milk allover a year taken from 10 lactating women. Zinc ranged from 0.63 to 3.8 µg / ml. A descending trend in zinc concentration towards the progress of lactation is apparent, such trend was noticed with all the 10 subjects used in the present work.

In this respect, the values reported in literature for the milk zinc level (µg / ml) was 3.22 at 1st month, 1.14 at 4th month and 0.94 at 6th month post partum (Disilvestro and cousins, 1983). Rohr and Lothian (1984) found that zinc content of breast milk vary from 5.59 to 1.18 µg / ml.

I.B. Animal milk

Cow's milk is used to substitute or to complement the amount of milk sucked by the infant in some rural areas in Egypt. Therefore, the present work included cow's milk as the most used milk in that respect. Table (1) presents the monthly values of zinc concentration in cow's milk µg / ml allover the year 2003 and cow's milk samples contained the lowest zinc concentration ranging from 0.007 to 0.017 µg / ml. Cow's milk was studied by Rohr and Lothian (1984) who reported that zinc concentration ranged from 0.005 to 0.016 µg/ ml.

II. Zinc content of some animal food sources, some cereals, legumes, vegetables, fruits and fruit juice

II.1.Eggs

Data presented in Table (2)revealed that zinc concentration in eggs vary from 1-1.5 mg. Zimmermann (2001) found that zinc content per one medium egg is 1.5 mg.

II.2.Prepared cereals and legumes

The zinc content in prepared cereals, i.e. belila, boiled rice and cooked legumes, i.e. lentil are presented in Table(2). Lentil gave the highest value of 5 mg / 100 g. Belila has intermediate zinc content of 3 mg / 100 g and rice has the lowest zinc content of 0.4 mg / 100g. These results are in accordance with zimmermann (2001).

II.3.Vegetables, fruits and fruits juice

From the previous study of prepared vegetables and fruits, green peas has the highest zinc content (4 mg / 100 g), followed by potatoes (0.3

mg / 100 g), banana (0.2 mg / 100 g) and finally the lowest value was recorded for orange juice (0.02 mg / 100 g).

III. Supplemental foods to breast feed infants

During the first 3 months of age, breast milk production can suffice the requirements of infants for maintenance and normal growth (Oski *et al.*, 1994). After 3 months of age, infants require added foods in addition to breast milk to cover their nutritional requirements (Table 3), Pamela (1994) and Oski *et al.* (1994). Not all foods could be given, but it is recommended to give special suitable foods according to age of infants (Whiting Mary and L. Tim, 1992).

III.1. Zinc dietary intake

5 regimes were suggested according to the recommendation of American Academy of Pediatrics (1985) and are illustrated in (Table 4 and 5).

III.2. Supplemental foods to infants 3 – 6 months old.

During the period 3 – 6 months, infants require more food in addition to breast milk. This could be provided (gradually) by boiled rice, cooked lentil, boiled vegetables, apples and banana. Table (4) presents 5 alternative regimes as food supplement to cover the infant nutrition requirements. The 5 regimes supply energy and protein ranging from 132 – 134 kcal and 5.80 – 6.40 g protein / day. The supplemental requirements has been calculated to be 130 kcal and 5.28 g protein / day. On the other hand, the 5 regimes will provide infants with zinc ranging from 4.29 to 4.83 mg / day. To cover the recommended level of zinc, it is required to provide the infants with 3-5 mg / day.

III.3. Supplemental foods to infants 7-9 months old.

Five regiments of supplement foods for 7-9 months old infants are shown in (Table 5). All regimes satisfy the supplemental energy and protein requirements , i.e. energy values ranged from 255 - 274 kcal and protein from 6.0 up to 7.1 g/ day. Zinc supplied by the 5 regimes ranged from 4.07 to 5.7 mg/day. Many foods are available for infants during the period 7-9 months of age. Skim milk and egg represent sources of animal protein. Legumes as a source of plant protein is presented by lentil, carbohydrate sources are belila and boiled rice. Potatoes, green peas, apple, orange juice and banana are the most common vegetables and fruits used to compose the 5 regimes.

III.4. Supplemental foods to infants 10 – 12 months old.

Infants at the age of 10 – 12 months can use a variety of food and food preparation. They may use variety of milk products preferably , skim milk. Boiled eggs are very nutritive food, either whole egg or youlk. They can use legumes, carbohydrate source e.g. belila and boiled rice. Vegetables are good sources of vitamins and minerals in addition to their content of protein and energy, (Table 5) suggests 5 different regimes with which a breast feed infants at that age can complete its nutrition requirements. Energy values of those regimes ranged between 326 – 350 kcal /day. Protein content ranged from 8.4 to 11.4 g/day. The protein quality provided by these regimes is of good quality. The five regimes suggested provide the infants with zinc ranging from 5.22- 6.13 mg / day.

Table 1. Zinc content of human breast milk and cow's milk in µg /ml during the months of the year 2003.

Kinds of milk \ Months		Jan.	Feb.	March	April	May	June	July	August	Sep.	Oct.	Nov.	Dec.
Human	Average	3.22	3.25	2.85	1.12	1.00	0.95	0.95	0.95	0.945	0.945	0.945	0.93
	Ranges	2.6-3.8	2.7-3.8	2.6-3.0	0.84-1.4	0.7-1.3	0.67-1.23	0.68-1.22	0.69-1.21	0.67-1.22	0.68-1.21	0.69 - 1.20	0.63-1.23
Cow's	Average	0.016	0.012	0.011	0.015	0.010	0.014	0.013	0.009	0.014	0.016	0.015	0.008
	Ranges	0.015-0.017	0.011-0.013	0.009-0.013	0.013-0.017	0.008-0.012	0.012-0.016	0.011-0.015	0.007-0.011	0.013-0.015	0.015-0.017	0.014-0.016	0.007- 0.009

Table (2): Zinc content of common foods used for feeding infants 3 – 12 months old in Egypt and their nutritive values.

Food	Serving size (gm)	Zinc (mg)		Nutritive value	
		Range	Average	K cal	Protein
Skim Milk	100	0.3-0.5	0.4	39	3.6
Lentil	100	4-6	5	73	5.5
Rice	100	0.3-0.5	0.4	66	1.6
Potatoes	100	0.2-0.4	0.3	80	1.4
Green Peas	100	3-5	4	52	5.1
Apple	100	0.04-0.06	0.05	46	0.3
Eggs	30	1-1.5	1. 25	100	8.3
Orange juice	100	0.01-0.03	0.02	41	0.3
Belila	100	2-4	3	44	1.4
Banana	100	0.1-0.3	0.2	79	1.1

II.2.Apple-

Table (3) : Requirements and daily required amounts of breast milk to be supplemented to satisfy infant nutrition*.

Age	Requirements		Breast milk production			Amounts Required to be supplemented to satisfy infant nutrition	
	Kcal / day	Protein g / day	Daily production ml	Daily kcal intake	Daily protein intake (g)	Kcal / day	Protein (g) / day
3 – 6m	690	12.7	700	560	7.42	130	5.28
7 – 9 m	825	13.7	700	560	7.42	265	6.28
10 – 12 m	920	14.7	700	560	7.42	360	7.48

*American Academy of pediatrics (1985)

Table (4): Alternative regiments of supplemented foods for infants of 3-6 months old with respect to their nutrition values and zinc Concentration per day.

Regim	Legume	Carbohydrate	Vitamins and minerals sources				Nutritive value of Supplemented Foods		Zinc	
	Lentil Boiled (g)	Rice boiled (g)	Vegetables		Fruits		Kcal /Day	Protein g/day	Supplem-ented foods mg / day	Supp. Foods g / day
			Potatoes Boiled (g)	Green peas Boiled (g)	Apple Boiled (g)	Banana (g)				
1	60	40	-	40	50	25	134	6.4	4.83	215
2	50	-	40	40	50	25	132	5.8	4.29	205
3	50	50	-	40	50	25	133	6	4.37	215
4	50	50	25	40	50	-	133	6.1	4.40	215
5	50	50	-	40	60	50	133	6.0	4.43	215

Table (5) : Alternative regiments of supplemented food for infants of 7 -9 and 10 – 12 months of age with respect to their nutritive values and zinc concentration per day.

REGIM	Protein Sources			Carbohydrate Source		Vitamins and Minerals sources					Nut. Value of Sup. food		Zinc	
	Animal Sources		Legumes			Vegetables		Fruits						
	Skim milk g	Eggs Whole g	Lentil g	Belila g	R.b. g	Potatoes boiled g	Green Peas g	Apple boiled g	Banana g	Orange juice g	K cal /Day	Protein g/ day	Supplemented Foods mg/day	Supp. Foods g/day
Infants of 7-9 months old														
1	50	-	-	100	50	100	25	75	50	-	263	7	4.83	450
2	-	-	40	-	100	-	25	100	100	100	274	6.75	4.07	465
3	50	-	-	100	-	50	50	100	100	-	255	6	5.4	450
4	50	-	25	-	100	50	25	100	100	-	263	6.3	4.15	450
5	-	-	-	100	100	50	50	100	50	-	262	7.1	5.7	450
Infants of 10 - 12 months old														
1	-	-	50	-	100	50	50	100	50	100	350	8.7	5.22	500
2	50	-	50	50	-	100	25	100	100	100	337	9.6	5.44	575
3	-	-	-	80	100	100	50	100	100	-	326	8.1	5.35	530
4	-	15	50	50	-	80	25	100	100	100	334	11.4	6.13	520
5	-	-	-	100	100	100	50	100	100	-	341	8.4	5.9	550

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احتياج الأطفال اليومى من الزنك خلال العام الأول من العمر

زينب خليل العوامرى

المعمل المركزى للأغذية والأعلاف – مركز البحوث الزراعية – جيزة – مصر

استهدفت هذه الدراسة دراسةمحتوى الزنك فى لبن بعض الأمهات وألبان الأبقار وكذا محتوى بعض النباتات التى تستخدم فى تحضير أغذية طبيعية وعصائر لتغذية الأطفال، كذلك حساب الأحتياج اليومى لعنصر الزنك للأطفال لضمان النمو الطبيعى والصحة الجيدة. لذلك تم أخذ عينات من لبن عشرة أمهات خلال عام ٢٠٠٣. وعينات من ألبان الأبقار تم أخذها أيضا من خمس محافظات فى مصر خلال نفس العام. تم تجميع عينات من البيض، الخضراوات (البطاطس والبسلة) ، الفاكهة (تفاح ، موز وبرتقال) ، الحبوب (القمح والأرز) و البقوليات (العدس) من نفس الخمس محافظات. تم تحضير اللبن الفرز من ألبان الأبقار كما تم تحضير بليلة، أرز مسلوق ، عدس ، بطاطس ، بسلة، بيض وعصير برتقال وتم تقدير عنصر الزنك فى كل من الأغذية السابقة الذكر . أظهرت النتائج أن تركيز عنصر الزنك فى لبن الأمهات يتراوح من ٠,٦٣ – ٣,٨ ميكروجرام / مللى، فى حين أن لبن الأبقار يحتوى على تركيز منخفض من الزنك يتراوح من ٠,٠٠٧ – ٠,٠١٧ ميكروجرام / مللى. وعلى العكس من ذلك فقد كان تركيز عنصر الزنك مرتفع نسبيا فى البيض المسلوق بقيمة تتراوح من ١ – ١,٥ مللجم . كان تركيز عنصر الزنك ٥ مللجم / ١٠٠ جرام فى العدس ، ٣ مللجم / ١٠٠ جرام فى البليلة ، ٠,٤ مللجم / ١٠٠ جرام فى الأرز المسلوق ، ٤ مللجم / ١٠٠ جرام فى البسلة ، ٠,٣ مللجم / ١٠٠ جرام فى البطاطس و ٠,٢ مللجم / ١٠٠جرام فى الموز. وقد سجل عصير البرتقال أقل قيمة للزنك وهى ٠,٠٢ مللجم / ١٠٠ جرام وحيث أن المأخوذ اليومى المطلوب والموصى به من Food and Nutrition Board (1989) يكون من ٣-٥ مللجم / يوم من الزنك للأطفال أثناء السنة الأولى من العمرفقد تم اقتراح خمس نظم تغذية. وهذه النظم تم حسابها لثلاث مجموعات من الأطفال تتراوح أعمارهم بين ٣ – ٦ ، ٧- ٩ ، ١٠ – ١٢ أشهر ومتطلباتهم من الأغذية على أساس كيلو كالورى / يوم ، بروتين جرام / يوم وحساب المطلوب من عنصر الزنك فى كل نظام لإمداد الأطفال بإحتياجاتهم اليومية من الغذاء وعنصر الزنك.