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Determination of Zinc Contents in Iranian Flat Breads

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Abstract: Zinc is an essential element for the maintenance of good health. It is necessary for the activity of several enzymes involved in energy changes and protein formation. Bread is one of the foods that have some zinc. Bread and other cereal products provide the most of calories and protein intakes of Iranian people in cities. Iranian flat breads such as lavash, taftoon, barbari and sangak generally are produced from soft white wheat flours of higher extraction levels compared to western type breads. The diet of Iranian people is more bread and other cereal products provide as much as 50-90 % of total caloric. For zinc monitoring in flat breads, 36 flat bread samples were collected from bakeries in Tehran city in 2004 and analyzed by flame atomic absorption spectrophotometry for zinc metal. The mean and standard deviation of zinc content in lavash, barbari, taftoon and sangak breads were 12.17±1.91, 10.75±2.64, 10.41±3.54 and 14.25±3.56 mg/kg, respectively. Estimated intake of zinc based on consumption of Iranian flat breads is 3.499 mg per person per day. Flat breads are good sources of zinc and they can supply some of zinc requirements of human body for preventing of zinc deficiency.

Key words: Zinc content, estimated intake, Iranian flat breads, heavy metals, trace elements

Introduction

Trace heavy metals are significant in nutrition, either for their essential nature or their toxicity. Zinc is the most abundant trace element in the cytoplasm of humans, but 90% of the mineral is located in the muscle, bone and liver. Zinc makes strong, exchangeable complexes with organic molecules, including proteins, nucleic acids and membranes. Zinc requirements are highest during periods of greatest growth such as pregnancy, infancy and early childhood. Therefore, zinc is known to be essential and may enter the food materials from soil through mineralization by crops, food processing or environmental contamination, as in the application of agricultural inputs. Zinc deficiency, resulting from poor diet, alcoholism and malabsorption, causes dwarfism, hypogonadism and dermatitis, while toxicity of zinc, due to excessive intake, may lead to electrolyte imbalance, nausea, anemia and lethargy (Fairweather-Tait, 1988; Prasad, 1984). Outbreaks of zinc poisoning have taken place when stewed apples or other acid fruits were prepared in galvanized iron pans. The low toxicity of zinc and efficient homeostatic control mechanisms make chronic zinc toxicity from drinking water and dietary sources and unlikely hazard in man. Nevertheless, if it happens then zinc certainly interferes with copper and iron metabolism, it being an antagonist of both these metals as well as of cadmium. Zinc toxicity may result from excessive ingestion of the element in food or drink, although the margin of safety is large (Mahindru, 2004). Wheat is the major crop and bread and other cereal products provide as much as 50-90% of total caloric and protein intakes of Iranian people (Faridi and Finney, 1980). Iranian breads such as lavash, taftoon, barbari and sangak generally are produced from soft white wheat flours of higher extraction levels compared to western type breads. Their traditional preparation methods and physical characteristics differ significantly (Faridi *et al*., 1982). These flat breads also differ considerably in the extent and type of fermentation given (yeast raised, sour starter and un leavened) and time and temperature at which are baked. Higher flour extraction rate and inadequate fermentation will produce breads that are relatively high in phytic acid and fiber. The bioavailability of zinc in cereal depends on the presence or absence of certain dietary factors such as fiber and phytate that adversely affect on the bioavailability of zinc (Franz *et al*., 1980). Human zinc deficiency is characterized by failure to undergo the sexual development and growth spurt associated with puberty. However, lack of available zinc may have other effects and may be one of the factors for lag of growth beginning in early childhood in Iran. The objective of this study was to investigate and measure the content of zinc in Iranian flat breads in order to improve of breads.

Materials and Methods

Sample collection: Tehran city is metropolitan of Iran and has high intensive population. There are many traditional bakeries which supply the bread needed by people. These bakeries produce flat breads such as lavash, barbari, taftoon, and sangak breads. Nine bread pieces of lavash, barbari, taftoon and sangak bread samples were collected from bakeries at different bakes in 2004. Bread samples were analyzed by flame atomic absorption spectrophotometry for zinc metal.

Flame conditions for the AAS measurements of Zn: The atomic absorption spectrometric analysis of Zn was performed using at least two standard solutions for each metal. Flame conditions are summarized for Zn in Table 1. (Flame Atomic Absorption Spectrophotometer- ALPHA 4, Chem. Tech. Analytical Co. England)

Table 1: Flame conditions for the AAS measurements of Zn

Wave Length (nm)	213.9
Slit	2
Lamp current (mA)	4
Gain	8
Oxidant A= air	A
Acetylene flow	13.5
Berner Height	7
Sensitivity µg/ml	0.009
Detection limit µg/ml	0.006
Calibration range at 1 scale Exp. µg/ml	0.002-2

Sample examination: For Zn analysis bread samples were left to air dry before sub samples of 50 g each were taken from each group. Sub- samples were ground in Titanium knives and stored in high density polyethylene bottles, 100 ml capacity, with screw caps. Bottles were pre washed with nitric acid, rinsed with de-ionized water, dried and tested for contamination by leaching with 5% nitric acid. The bottles contained no metal liners that can contaminate the samples.

Sample extraction: About 1 g finely ground samples were precisely weighed in test tubes and 3 ml of nitric acid were added to each tube, and tubes were allowed to remain over night at room temperature, protected from dusts. Tubes were heated up to 130°C for 4 h using a metal block thermostat unit. Tubes were left to cool down before 2 ml of nitric acid and 0.7 of perchloric acid and 43 ml distilled water were added to each tube. A programmable circuit was used to raise temperature up to 230°C within 33.5 h. The clear wet ash in each tube was dissolved in 2 ml of distilled water and tubes were stored until the flame atomic absorption spectrophotometry was performed. The samples were analyzed by atomic absorption spectrophotometer (ALPHA 4, Chem Tech Analytical Co. England) using an air - acetylene flame. The certified standard reference material (Alpha- Line, Chem Tech Analytical, Ltd, England) was used to check the accuracy, and the analytical values were within the range of certified values. All the recoveries of the metals studied were over 95%. All the concentration of the metals is expressed in µg/g or mg/ kg in dry weight.

Calculation of Zinc content in sample: The mean absorbance produced by the standards (corrected for the standard blank) was plotted vs the concentration of the analyte in the sample to produce an external calibration curve. The concentration of the analyte in the sample was calculated from the following equation: $[M] = (C \times V)/SW$; where [M] is the concentration (µg/ml) of in original sample, C is the concentration of zinc in the analytical sample as calculated from standard curve in units of µg/ml, V is the volume of the analytical sample in units of ml and SW is the weight of the sample employed in units of grams.

Statistical analysis: The index was used for correlations between the specimens and metal levels. ANOVA analysis was made between kinds of consumption bread and spatial distribution, and a multiple regression between kinds of consumption bread and the amount of the zinc metal. All the statistical methods were done using the software SPSS, version 11.5. Analysis of variance ANOVA was employed after logarithmic conversion when necessary to detect significant differences among means.

Results and Discussion

Zinc concentrations obtained from this study are summarized in Tables 2. Present study shows that the zinc contents in Iranian flat breads are 12.17-14.25 mg/kg and they are less than the maximum limit allowed of Zn for bread and bake products (15 mg/kg) (Banu *et al*., 1985). Sangak bread had the highest concentrations of zinc in the four groups of bread samples, followed lavash, barbari and taftoon bread. All bread samples produced by natural gas. Since fuel used in bread production has one origin, it affects very low in zinc levels. While, since wheat flour in bread production has various origins, it is rather likely that variation in zinc concentrations is due to cereal growth or storage or mill in wheat and wheat flour before baking. Also, zinc contamination during processing of primary and subsequently desired products due to corrosion of metallic equipment in the food industry or storage of foods in containers fabricated out of galvanized iron (zinc is the surface coating metal) which gets leached out by some foods. Also, the concentration of zinc in surface water owing to the leaching of zinc from galvanized pipes, brass and zinc-coating fittings (Mahindru, 2004). The mean concentration of Zn in lavash, barbari, taftoon and sangak were found to be 12.7 mg/kg, 10.75 mg/kg, 10.42 mg/kg and 14.25 mg/kg, respectively. The zinc levels of Iranian flat breads at this study were less than the reported by Faridi *et al*., 1983. They reported that the zinc levels in lavash bread, barbari bread, taftoon bread and sangak bread are 9.44 mg/kg, 7.32 mg/kg mg/kg, 10.47 mg/kg and 12.17 mg/kg, respectively. Also, they found that the zinc levels at the doughs of these breads are 9.93 mg/kg, 7.55 mg/kg, 11.41 mg/kg and 12.93 mg/kg, respectively. According to zinc levels in bread samples and dough samples can find that baking reduces the zinc levels in Iranian flat breads.

Table 2: Content of Zinc element in Iranian flat breads

Kind of flat bread	Zn (mg/kg dry wt.) Mean±SD
Lavash	12.17±1.91
Barbari	10.75±2.64
Taftoon	10.42±3.54
Sangak	14.25±1.97

According to statistical analysis of data at present study, the results showed that the mean difference is not significant at the $P<0.05$ level.

Faridi *et al*., 1983 reported that extraction rate of flour for barbari, lavash, taftoon and sangak bread are 78, 82, 84 and 87% and the zinc values are 7.32, 9.44, 10.47 and 12.17 ppm, respectively. Reinholdt *et al*., 1981 suggested that access to mills providing flour of lower extraction rate would largely eliminate zinc deficiency. But other study such as Sandstrom *et al*., 1980 reported that comparable Zn absorption from bread made of whole wheat flour containing 22 ppm and from white bread made of 72% extraction flour having a Zn content of 7 ppm.

The zinc level of Iranian flat breads has been compared with other countries (Table 3). Table 3 shows that Zn level in present study is higher than other countries. Also, the results generally indicate that the levels of zinc in Iranian flat breads compare favourably with zinc levels in bread from other parts of the world.

Table 3: Comparison of Zn levels (mg/kg) in bread in other countries

Country	Zn levels (mg/kg)	References
Egypt	8.2	Hussein & Brauggeman, 1997
Iran	7.32-12.17	Faridi *et al*., 1983
Romania	13.97	Nicoleta *et al*., 1996
Nigeria	2.93	Onianwa *et al*., 2001
USA	7.2	Pennington *et al*., 1995
Present study	10.42-14.25	

The estimated daily intake of Zn based on flat bread consumption with using of market basket has done and it has shown in Table 4. The highest value was observed for Zn in sangak bread.

In attention to Table 4, Iranian flat breads can supply 3.499 mg per person per day of zinc requirement in diet. Hussein and Brauggeman (1997) have reported which bread can supply 36% of total dietary Zn among an Egyptian urban population group. Nutritional deficiencies of Zn may arise from inadequate intakes (Waslien, 1976) and / or poor availability of dietary Zn (Kirksey *et al*., 1992). Good sources of available dietary Zn are dairy

Table 4: Estimated intake (mg per person per day) of zinc based on consumption of Iranian flat breads

Type of bread	Daily intake of Zn (mg/person/day)
Lavash	1.651
Barbari	0.828
Taftoon	0.570
Sangak	0.450
Total	3.499

products, meat, liver, eggs and sea foods. The sufficiency of zinc level of dietary intake can not be properly determined without a knowledge of the phytic acid contents of the food items. This is because high phytic acid contents in foods (particularly those of vegetable origin) inhibit the availability of dietary zinc (Bindra *et al*., 1986; Ellis *et al*., 1987; Gibson, 1994). A major proportion (50-80%) of the minerals in wheat is found in the aleurone, however, this fraction also contains nearly 90% of the phytate present in the whole krenel (O'Dell *et al*., 1972). Phytic acid reduces Zn availability by combining with soluble Zn in the intestinal lumen to form an unabsorbable complex (Fairweather-Tait, 1988). When the phytate content of bread is reduced by fermentation, Zn absorption has been reported to increase (Navert *et al*., 1985). Recent analyses of national food supplies suggest that the diets of 20% of the global population contain inadequate amounts of zinc in relation to theoretical requirements (Brown *et al*., 2001). Zinc deficiency has been associated with poor growth (Brown *et al*., 2002), depressed immune function (Fraker *et al*., 1986), increased susceptibility to and severity of infection (Bhutta *et al*., 1999; Bhutta *et al*., 2000), adverse outcomes of pregnancy (Caulfield *et al*., 1998) and neurobehavioral abnormalities (Black, 1998). There is a strategy for controlling zinc deficiency and it is fortification of an appropriate food vehicle with an absorbable zinc salt. Five zinc compounds are currently listed as generally recognized as safe (GRAS) by the US Food and Drug Administration: zinc sulfate, zinc chloride, zinc gluconate, zinc oxide, and zinc stearate.

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References

Banu, C., N. Preda and S.S. Vasu, 1985. Food products and their toxicity. Technical Publishing House, Bucharest.

Bhutta, Z.A., R.E. Black and K.H. Brown, 1999. Prevention of diarrhea and pneumonia by zinc supplementation in children in developing countries: a pooled analysis of randomized controlled trials. J. Pediatr, 135: 689-97.

Bhutta, Z.A., R.E. Black and K.H. Brown, 2000. Therapeutic effects of oral zinc in acute and persistent diarrhea in children in developing countries: pooled analysis of randomized controlled trials. Am. J. Clin. Nutr., 72: 1516-22.

Bindra, G.S., R.S. Gibson and U.L. Thompson, 1986. [phytate] [calcium] / [Zn] ratios in Asian immigrant lacto-ovo vegetarian diets and their relationship to zinc nutriture. Nutr. Res., 6: 475-483.

Black, M.M., 1998. Zinc deficiency and child development. Am. J. Clin. Nutr., 68(Suppl): 464S–9S.

Brown, K.H., S.E. Wuehler and J.M. Peerson, 2001. The importance of zinc in human nutrition and estimation of the global prevalence of zinc deficiency. Food Nutr. Bull., 22: 113-25.

Brown, K.H., J.M., J. Peerson, L.H. Rivera and Allen, 2002. Effect of supplemental zinc on the growth and serum zinc concentrations of prepubertal children: a meta-analysis of randomized controlled trials. Am. J. Clin. Nutr., 75: 1062-71.

Caulfield, L.E., N. Zavaleta, A.H. Shankar and M. Merialdi, 1998. Potential contribution of maternal zinc supplementation during pregnancy to maternal and child survival. Am. J. Clin. Nutr., 68: 499-508.

Ellis, R.,J.L, Kelsay, R.D, Reynolds, E.R, Morris, , P.B, Moser, and C.W, Frazier, 1987. Phytate: zinc and phytate×calcium: zinc millimolar ratios in self-selected diets of Americans, Asian Indians and Nepalese. J. Am. Dietary Assoc., 87: 1043-1047.

Fairweather-Tait, S.J., 1988. Zinc in human nutrition. Nutr. Res., Rev., 1: 23-37.

Faridi, H.A., P.L. Finney and G.L. Rubenthaler, 1983. Iranian flat breads: relative bioavailability of Zinc. J. Food Sci., 48: 107-110.

Faridi, H.A., P.L. Finney, G.L. Rubenthaler and J.D. Hubbard, 1982. Functunal (Bread making) and Compositional Charactristics of Iranian Flat Breads. J. Food Sci., 47: 926- 929.

Faridi, H.A. and P.L. Finney, 1980. Technical and nutritional aspects of Iranian breads. Bakers Digest. 54: 14.

Franz, K.B., B.M. Kennedy and D.A. Fellers, 1980. Relative bioavailability of zinc from selected cereals and legumes using rat growth. J. Nutr., 110: 2272.

Fraker, P.J., M.E. Gershwin, R.A. Good and A.S. Prasad, 1986. Interrelationships between zinc and immune function. Fed Proc., 45: 1474-9.

Gibson, R., 1994. Zinc nutrition in developing countries. Nutr. Res. Rev., 7:151-73.

Hussein, L. and J. Brauggeman, 1997. Zinc analysis of Egyptian foods and estimated daily intakes among an Urban Population group. Food Chem., 58: 391-398.

Kirksey, A., G.G. Harrison, O.M. Galal, G.P. McCabe, T.D. Wachs and A. Rahmanifar, 1992. The human costs of moderate malnutrition in an Egyption village. Human Nutrition Collaborative Research Support Program, Final Report to the U.S. Agency for Internationa; Development Cooperative Agreement # DAN 1309-A-00-9090-00.

Mahindru, S.N., 2004. Food Contaminants-origin, propagation and analysis. A.P.H. Publishing Corporation, New Delhi, India.

Navert, B.B. Sandstorm and A. Cederblad, 1985. Reduction of the phytate content of bran by leaving in bread and its effect on zinc absorption in man. Br. J. Nutr., 53: 47-53.

Nicoleta, M., L. Ramona, G. Rita and E. Muntean, 1996. Heavy metal,s content in some Food products. Institute of public health cluj Nopoca, Romania.

O'Dell, B.L., A.R. Boland and S.R. Koirtyohann, 1972. Distribution of phytate and nutritionally important elements among the morphological components of cereal grains. J. Agri. Food Chem., 20: 718-721.

Onianwa, P.G., A.O. O.E. Adeyemo, Idowu and E.E. Ogabiela, 2001. Copper and Zinc contents of Nigerian foods and estimates of the adult dietary intakes. Food Chem., 72: 89-95.

Pennington, J.A.T., S.A. Schen, G.D. Salmon, B. Young, R.D. John and R.W. Mart, 1995. Composition of core foods of the USA food supply 1982-1991. II. Calcium, magnesium, iron, and zinc. J. Food Compos. Annal, 8: 129-169.

Prasad, S.A., 1984. Discovery and importance of zinc in human nutrition. Federation Proceeding, 43: 2829-2834.

Reinholdt, J.G., B. Faraji, P. Abadi and F. Ismil-Beigi, 1981. An extended study of the effect of Iranian village and urban flatbreads on the mineral balances of two men before and after supplementation with vitamin D. Ecol. Fd. Nutr., 10: 169-177.

Sandstrom, B., B. Arvidsson, A. Cederblad and E. Bijorn-Rasmussen, 1980. Zinc absorption from compositemeals, the significance of wheat extraction rate, Zinc, Calcium, and Protein content in meals based on bread. Am. J. Clin. Nutr., 33: 739-745.

Waslien, C., 1976. Intake of trace elements in Human. Health and Disease, 11: 347-366.