ROLE OF WHEAT FORTIFICATION WITH ZINC COMPOUNDS IN CHANGES OF ZINC BLOOD LEVEL OF COMMUNITY

SHAKER SALARILAK*

SUMMARY: Bread is the main food of Iranian people. The consumption of bread supplies a significant portion of the protein (70%) and calories (20%) needed by body. Agricultural soil in Iran contains less than 0.7 milligram/kg of zinc, while in standard cases, soil should contains more than 1 milligram/kg. Studies revealed that the content of zinc in produced wheat in Iran's calcareous lands is less than 15 milligram/kg whereas American wheat contains 27 milligram/kg. Zinc deficiency mainly affects on different parts of body such as immunity and digestive systems. Zinc is most important on reproduction, skin health, behavioral nervous development, physical growth and body resistance against diseases. With regards to its vital role in body, zinc deficiency in soil and produce (e.g. corns) and consequently its deficiency in body, counts as one of the most important problems in the national nutritional programs. This study was carried out to assess the effect of soil fortification with zinc compounds in the level of zinc serum.

In the first stage, agriculture soil was fortified with values of 15 kg/hectare iron sexsothirin, 40 kg/hectare manganese sulfate and 50kg/hectare zinc sulfate. The value of zinc in consuming flour under intervention before and during the study was measured by atomic absorption machine through dry oxidation. A total of 1795 local people were selected from Urmia city, Iran and went under intervention. Blood sample were taken from 1% of the population before and after intervention, blood serum was separated and the value of zinc was measured with the use of UK Randox kit by auto analyzer machine Hitadin 704.This study has been carried out as a field trial study. Statistical analysis, in form of means, standar deviations with 95% confidence intervals with comparison between values before and after intervention were presented.

The mean blood serum zinc before and after intervention was 80.05, 109.73 microgram/deciliter blood respectively with 95% confidence interval (CI= 102.58, 116.89), considered to be significant (P=0.001). The mean serum zinc in women and men before intervention was 75.23, 87.92 respectively and difference between two groups was significant (p=0.028). The mean serum zinc after intervention in women and men was similar (110.39, 108.66 respectively with P=0.818). Differences between the mean serum level of zinc before and after intervention were significant for women (P=0.001) as well as for men (P=0.001).

These findings indicated that using zinc compounds as soil fortification led to improvement of zinc standards in wheat produce and causes to increase the level of zinc serum in all sex and age group of community with the use of enriched flour for 6 months continuously.

Key Words: Community, wheat, zinc.

INTRODUCTION

Bread is the main food of Iranian people. The consumption of beard supplies an important portion of the protein (70%) and calories (20%) needed by body. Studies show that the rate of consumption of wheat per

*From Department of Epidemiology, Urmia University of Medical Sciences Urmia, Weat Azarbijan, Iran.

Table 1: Distribution of mean, standard deviation and also 95% confidence interval serum zinc before and after intervention in age groups of studying samples.

Serum Zinc of age group	Before intervention		After intervention	
	Mean and standard Deviation (mcg/dl)	95% Confidence Interval	Mean and standard Deviation (mcg/dl)	95% Confidence Interval
0-9	75.48 ± 40.58	75.93 , 93.02	93.35 ± 42.59	73.93 , 111.76
10-19	78.77 ± 33.95	70.36 , 87.18	114.14 ± 48.63	102.09 , 126.19
20-29	77.68 ± 46.16	61.57 , 93.78	114.24 ± 54.33	95.28 , 113.19
30-39	90.59 ± 47.41	66.21 , 114.96	107.94 ± 49.14	82.68 , 133.21
40-49	77.90 ± 35.93	64.72 , 91.08	108.84 ± 54.85	88.72 , 128.96
50-59	81.83 ± 19.85	61 , 102.67	96.83 ± 22.66	73.06 , 120.61
60-69	103.71 ± 41.16	65.65 , 141.78	123 ± 63.48	64.29 , 181.71
> 70	75 ±17.74	46.77 , 103.23	104.75 ± 28.63	59.20 , 150.30
Total	80.05 ± 38.44	74.50 , 85.59	109.73 ± 49.58	102.58 , 116.89

capita has increased during the past 20 years and it's more than 200 kg for anyone per year (1). As the most of the wheat produced from calcareous lands so its content of zinc is very low. On the other hand, phosphate content has increased in agricultural lands considerably due to over utilization of phosphate fertilizers.

Zinc value in Iran's agricultural soils is less than 0.7 mg/kg, while it should be over 1mg/kg in standard soil (2,5). Surveys indicated that zinc value in produced wheats is less than 15 mg in Iran calcareous lands mean while it reaches to 27 mg/kg in American wheat.

Flour's bran contains phytic acid which is the principal stored form of phosphate and with utilizing of phosphate fertilizers, phosphate contents increases in wheat grain and with bread consuming, phosphate compounded with other elements such as calcium, zinc and iron and change into inactive complex of phytate salts which is non absorbable and excreted through the digestive system (2) and this can results in zinc deficiency.

Table 2: Distribution and comparison of mean, standard deviation and confidence interval (95%) of serum zinc in sex groups of studying samples before and after intervention.

Serum Zinc of sex group	Before intervention		After intervention	
	Mean and standard Deviation (mcg/dl)	95% Confidence Interval	Mean and standard Deviation (mcg/dl)	95% Confidence Interval
Female	75.23 ± 39.40	67.99 , 82.48	110.39 ± 53	100.64 , 120.13
Male	87.92 ± 35.72	79.46 , 96.37	108.66 ± 43.78	108.66 , 119.03
p value	P = 0.028		P = 0.818	

Table 3: Comparison of serum zinc in studying samples before and after Intervention

Zinc serum	Mean and standard Deviation (mcg/dl)	95% Confidence Interval	P Value
Before intervention	80.05 ± 38.44	74.50 , 85.59	P= 0.001
After intervention	109.73 ± 49.58	102.58 , 116.89	

Table 4: Comparison of serum zinc in male and female of studying samples before and after intervention.

Serum Zinc of sex group	Before intervention		After intervention		P Value
	Mean and standard Deviation (mcg/dl)	95% Confidence Interval	Mean and standard Deviation (mcg/dl)	95% Confidence Interval	
Female	75.23 ± 39.40	67.46 - 82.48	110.39 ± 53	100.64 - 120.13	P= 0.001
Male	87.92 ± 35.72	79.46 - 96.37	108.66 ± 43.78	108.66 - 119.03	P= 0.001

The importance of zinc as a necessary element for survival of the plants has been known since 1869 zinc. Its importance in the life of animals was reported since 1954. and for the first time in 1961, complications of this element's deficiency was noted by Prasad in south villages of Iran (15). zinc is a necessary constituent of over 200 enzymes and it plays a central roles in growth, cellular division, sexual maturity, fertility and reproduction, as well as in night vision and immune system (6).

The total body content of zinc has been estimated to be 1.5 - 2.5 gr with high concentrations in muscles, bones and liver. Skin, hair and nail content's of zinc is low. Zinc deficiency mainly affects different parts of body such as immune and digestive systems. The most important zinc roles are on reproduction, skin health, behavioral nervous development, physical growth and body resistance against diseases (8).

The major sources of zinc are animal products such as beef, mutton, liver, and kidney and plant's sources like corns, seeds and grains. Tea, coffee, fruits and vegetables contain little zinc (8). Zinc deficiency is one of the most important nutritional problems in Iran. It affects the majority of community groups as wheat is the main food of Iranian people. This study was carried out to assess the effect of soil fortification with zinc compounds on the zinc serum level.

MATERIALS AND METHODS

A joint study between Urmia University of Medical Sciences and Jihad Agriculture Organization was conducted to fortify the agricultural land which considered for planting wheat. It was fortified with values of 15 kg/hectare iron sexsothirin, 40 kg/hectare manganese sulfate and 50 kg/hectare zinc sulfate. Zinc level in the consumed flour was measured by atomic absorption machine through dry oxidation before and after the intervention. Also, in this study, a rural village from the geographical region of Urmia city (Gol Tappeh) was selected. This village has a population of 1795 residents and randomly selected sample of 0.1 of the population were studied to determine the zinc level in serum before and after the intervention.

The study methodology was a field trial where subjects served as their own control. Subjects were selected with simple random method using a list of the names from the Vital Records of Gol Tappeh.

Education was continuously performed for the community as well as the workers of bakery at Gol Tappeh village. The bakery managers were admitted to use fortified flour and villagers used only bread which was baked by this bakery all the time of intervention.

Blood samples were obtained to measure the level of zinc as mentioned above. Collected samples were transferred to a standard laboratory; serum was separated and stored at -20^{o}C. Samples were then analyzed UK Randox kit by (Hitadin 704) auto analyzer.

A questionnaire was completed to take demographic features of studying population. Data were analyzed by SPSS software. Blood serum values were reported before and after the intervention as mean and standard deviation. Paired T test and student T test were utilized.

RESULTS

Serum zinc was measured in 187 subjects divided into groups according to age. The mean serum zinc level before and after the intervention along with the 95% confidance intervals is shown in Table 1. The mean serum zinc level before the intervention was 80.05 mcg/dl with CI= (74.50, 85.59) and it rose to 109.73 mcg/dl with CI= (102.58, 116.89). The difference was significant (p=0.001) (Table 3).

In women, serum zinc level before the intervention was 75.23 mcg/dl with CI= (67.99, 82.48) and in men 87.92 mcg/dl with CI= (79.48, 96.37). The difference was statistically significant (p= 0.028) (Table 2).

After the intervention, serum zinc level in women was 110.39 mcg/dl with CI= (100.64, 20.13) and in men 108.66 mcg/dl with CI= (108.66, 119.03). The difference was not significant (p= 0.818) (Table 2).

A paired t-test for the alterations in the mean serum zinc level after the intervention in females and males was significant with p=0.001 and p=0.001 respectively (Table 4).

DISCUSSION

Zinc has been known to be necessary for plant's survival since 1509. In 1934 this element was shown to be important factor in animals. For the first time in 1961, zinc deficiency and its complications were studied in south villages of Iran (15). Bread is the main food of Iranian people and supplies 70% of the protein and 20% of the calories requirments. Unfortunately conducted studies indicated zinc deficiency in wheat products especially in calcareous lands.

A study was done by Khosravi *et al.* showed that 5.8% of mothers breastfeed in the first month were suffering from zinc deficiency. In this study the mean serum zinc before and after intervention was respectively 80.05 and109.73 per mg/deciliter and it was significant (p=0.001).

Mahmoudi and his colleagues carried out another study among junior high school females' students in Tehran and revealed that 65% of them suffered from zinc deficiency to different rates. Studies carried out in the 70s showed that the majority of Iranian population are affected by zinc deficiency because the lack of nutritional fibers, the lack of consumed animal products, the presence of phytate and low level of zinc in food dietary (15).

Sheikh Al Eslam and *et al.* in a study on 4400 pregnant women indicated that the level of serum zinc was low in 39% of them. High level of zinc deficiency with 50% was found in south of Khorasan, south of Kerman and Sistan baluchestan. Low level of zinc deficiency with 15% was found in provinces of Chahar mahal bakhtiari, Esfahan, Iazd and north of Kerman (8).

Hakimi M. *et al.* studied the effect of zinc on weight and height percentiles of children and showed that using zinc supplementation cause to increase height and weight percentiles (4).

In a study performed on Japanese children found that using 5 mg sulfate zinc for six months had effects on children's growth considerably (10).

Bilan N. showed that the level of zinc serum in children with rich nutrition was 63.72 mg/deciliter whereas in children with poor nutrition was 48.5 mg/deciliter and this difference was significant P<0.0005 (3).

A national survey in Mexico stated the value of serum zinc was ≥ 10 mmol/deciliter in 25% of children less than 11 years old (16).

Another study by Iapex D. and colleagues con-

firmed that zinc absorption from bread and fast food was 16.2% and 7.65 respectively and the difference was significant (P< 0.001).

Because of the greater phytate content in fast foods, zinc absorption is low. There was no difference in the rate of zinc absorbed from fortified foods with zinc sulfate and zinc oxide (17).

Fallahi and others, in a field trial study investigated on the effect of flour fortification of consumed bread with iron compounds showed that the only significant difference was the value of hemoglobin level in age groups of 5-12 years compared with other groups (7).

A field trial study carried out by Safari M marked that the fortification of bread flour with iron had no effect in improving of hematological indexes like RBC and hemoglobin (HGB) before and after intervention of study population. But ratio of individuals with low level of serum ferritin changed from 43.6% to 27.4% after intervention (9).

Findings of our study indicated that using zinc compounds to fortify soils led to improve zinc standards in wheat products and cause to increase the level of zinc serum levels in all groups of community in period of 6 months.

Zinc has an important role in public health and its deficiency can cause many complications, A special attention should be payed to the role of zinc in women and children.

It is suggested to apply education methods for appropriate nutrition, expand social justice for access to rich nutritional sources and fortification to reduce its deficiency among vulnerable groups.

ACKNOWLEDGEMENTS

The authors are grateful to the General Office for Grain, Jihad Agriculture Organization, Agriculture Researches Center of West Azerbaijan for all the help and support provided and special thanks to the health workers and people of Urmia Gol Tapeh village.

REFERENCES

1. Malakouti MR: Increasing of wheat product and to improve public health through fortification of zinc sulfate in wheat fields. Research and Scientific Journal of soil and water, Vol 12, No 1 1998.

2. Malakouti MR, Savaghebi GR: Methods for reducing phytic Acid in wheat along with improving of bread quality. Agriculture Ministry, 1999.

3. Bilan N: Survey on relation between level of serum copper and zinc in children aged < 6 years with malnutrition in Tabriz children hospital. Research and Scientific Quarterly of Shahed University, Vol 7, No.26, pp. 62-65, 1999.

4. Hakimi SM, et al : The effect of zinc supplementation on children's weight and height percentiles. Feiz Research and Scientific Quartery, No 11, pp 1-9, 1999.

5. Farnahaki AR, et al : Survey on zinc deficiency in calcareous lands and soils with phosphorus" fortification of wheat pub., Research institute of soil and water, jihad Agriculture Ministry, 2001.

6. Mozafari Khosravi H, et al : Study on zinc status on mothers to breast feed and growth of infants in shiryazd. Medical Journal of Shahid Sadoughi Yazd, Vol 9 No 4, pp 74-67, 2001.

7. Fallahi E, et al : The effects of bread consuming at result of fortified wheat with micro fertilizers on iron blood indexes. Quartery of Lorestan University of Medical Sciences (yafteh). Vol 5, No 17, pp 4-9, 2003.

8. Sheikh Al Eslam R, et al : Survey on prevalence of zinc deficiency on Iranian pregnant women. Tabib Shargh, Vol 6, No1, p 136, 2004.

9. Safavi M, et al : Bread flour fortification with iron to prevent anemia. Journal of Research in Medical Sciences. Vol 5, No 4, pp 303-306,

10. Mahmoodi et al : Epidemiological study of zinc deficiency in school children of Tehran 1999 fifth National Nutrition Congress Iran Tehran.

11. Black MM : Zinc deficiency and child development. AmJ clin Nurt, 68:464-469, 1988.

12. Brown KH : Effect of zinc supplementation on children' growth Bibl Nurt Dieta, (76-831), 1998.

13. Kilic J : The effect of zinc supplementation. bread consumption on school children with asymptomatic zinc deficiency. J pediatr Gastroenteral Nutr, 26: 167 - 171, 1998.

14. Rosado JL : Zinc and copper: proposed fortification levels and recommended zinc compounds. Journal of Nutrition, vol 133, Iss 9, pg: (2985-2989), 2003.

15. Prased SA, Halsted JA, Nadimim M : Syndrome, pg: (59-

62) Iran deficiency anemia, splenomegaly, hypogonadism , dwarfism and geophgia. AMJ Clini Nutr, 31: 532-46, 1961.

16. Eking HSA Bagai, Kiral AS, Eker S, Takin A : Alkana and I 1998 effects of zinc fertilization an gracie yield and zinc conceived of various cereal grown in zinc plant Nutrition, 21. (io): 2245-2256.

17. Daniel lapex de Romana, Bolannerdal, Kenneth Hbrown: Absorption of zinc from wheat products fortified with Iron and either zinc sulfat or zinc oxide. The American Jaurnal of clinical Nutrition, vol 78, Iss: 2, pg 279, 2003.

Correspondence:
Shaker Salarilak,
Department of Epidemiology,
Urmia University of Medical Sciences
Urmia, 57135, P.O.Box 1138, Weat Azarbijan, IRAN.
e-mails: salarilak@umsu.ac.ir,
salarilak@yahoo.com, ssalari_lak@hotmail.com