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FOOD FORTIFICATION AS A STRATEGY IN ACHIEVING BETTER NUTRITIONAL STATUS OF PRE-SCHOOL CHILDREN

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Abstract:
The baseline serum levels of beta-carotene, vitamin E, vitamin C and zinc for experimental (N = I 17) group in a double blind study among pre-school children (4 - 6 years) were 5.11 ± 2.41, 307.69 ± 157.44 mcg, 0.16 ± 0.07 and 0.52 ± 0.11 mg, respectively. The baseline serum levels for the same in the control (N = 104) group were 5.29 ± 2.46, 330.52 ± 73.93 mcg, 0.14 ± 0.05 and 0.52 ± 0.09 mg, respectively. After the intervention with fortified antioxidants in a cup of 100 ml ice cream, five days a week for a duration of six months the experimental group had serum levels for beta-carotene, vitamin E, vitamin C and zinc as 22.64 ± 3.72, 938.27 ± 163.643 mcg, 0.96 ± 0.28 and 1.11 ± 0.14 mg, respectively (Paired t-test = 0.000) whereas n control group they were 4.80 ± 2.26, 326.50 ± 72.54 rncg, 0.15 ± 0.06 and 0.53 .t 0.09 rng, respectively with no significant change.

Key words.’ Control, double blind, intervention, antioxidants. Fortified

Introduction:
Oxidative stress is produced when free radicals inrease relatively to the cells capable of eliminating them. It can be also told a&an imbalance between production of reactive oxygen species (ROS) and antioxidant protection, where the later being weaker. So far it affects all the organs of human body and leads o many disease conditions. Ma1iutrition makes the people of all ages particularly children vulnerable to more oxidative damage. In Bangladesh, malnutrition is a major child health problem (Kabir and Moslehuddin 1986) like many other third world countries of the planet. About 56% of Bangladeshi children under five suffer from moderate to severe malnutrition and 21% of them are severely underweight (UNICEF 1998). As stated b World Health Organization (WHO), about 13 million children die every year all over the world, 95% of them in developing countries where pneumonia (infection) s o:e of the leading causes, accounting for about four million deaths (WHO 1991). 01 the total children who die every year all over the world, 55% of the deaths are d’rectly or indirectly due to malnutrition. In Bangladesh the problem is more serious. Oul of total children deaths in a year 65% are directly or indirectly attributable to malnutrition (Baqui et al. 1998).

Antioxidants under study are found to be very protective to combat such a grave nature of malnutrition and its consequences. Beta-carotene is very aciive. in deactiva6ng free radicals and excited osygen, both of which are implicated in a multitude of degenerative diseases and in inborn errors of metabolism (Ames 1983). T3-carotene is pro-vitamin A as well as found to be the most effective quencher of ROS (Tsukaguchi et al. 1999). It prevents lipid peroxidation (Cooke 1998) and oxidative modification of LDL

(Jialal et al. 1991). Besides being a potential source of vitamin A for inftnts in breast milk, f3-carotene may also confer long-term protection against chronic disease such as cancer, and enhance the immunopro.ective effect of human milk. Vitamin E is also a very effective natural antioxidant and plays a very important role in biological process, which includes maintenance of cell integrity, anti-inflammation effects, DNA synthesis and stimulation of immune response. Subnormal serum level importantly causes loss of appetite, reduced growth, liver necrosis, renal and testicular degeneration as well as causes REC haemolysis contributing to the development of anemia. Plasma E level is inversely associated with risk of angina (Gerald 1998).

Water soluble vitamin C is ao an effective scavenger of free radicals having synergistic action along with vitamin and its plasma concentra'ion is inversely -elated to mortality from all causes, and from CVD, and 11-ID in men and women (Khaw et at. 2001). Vitamin C rich foods are capable.nf preventing cancer of oral cavity, esophagus, stomach, and pancreas as well as cancer of cervix: rectum and breast (Block 1991). It generates vitamin E and augments its antioxidant property.

Zinc too plays an important role as an antioxidant. It is engaged in scavenging free radicals, thus preventing lipid peroxidation and cell membrane damage. It is present in more than 70 metalloenzyiaes, which carry various metabolic rctivities (Schofield and Ashworth 1996). Most of hem are involved in DNA and protein synthesis. Zinc deficiency results in poor growth, poor appetite in infants and children and also weight loss (Harnbidge 1972). An existence of growth limiting syndrome of mild zinc deficiency is also reported (Walraven et at. 1983). There was a dramatic and immediate increase in the rate of weight gain where children were supplemented with zinc in the later stages of rehabilitation. It favours lean tissue formation and heals infectious and non-infectious skin lesions (Pories er a), 1967). Anorexia, diarrhoea, stunting, wasting, skin desquamation with ulceration, a reduction in lymphoid tissue and an increased susceptibility to infections are common to both zinc deficiency and malnutrition. Zinc provides an improved cell mediated immune (CMI) response and improved impact of zinc suplementation on diarrhoeal morbidity (Girodon et al. 1997). Mild zinc deficiency can cause abnormalities of immune functions, electrolyte hmeostasis, body composition, and growth without or even overt clinical signs. The responss to supplementation are extremely rapid (Golden 1981), being measured in hours or at most days. It has capability for membrane stabilization (Fagiotto 1998). When antioxidants are given together, vitamin F and C show strong synergistic action. Vitamii E and f3-carotene also have s'nergistic action but vitamin C and 3-carotene have not shown any such action so far (Niki et al. 1995). Zinc has not.been combined before along with these antioxidants but it might have played good synergism with vitamin E and C.

This type of study is the first of its kind in Bangladesh and worth contributing for new national food fortification strategy in attainment of a better nuthtional status.

A double blind experimental study was designed and :onducted among children of 4 - 6 years age group in some Government Primary Schools of Dhaka city. While selecting the sample the whole class either play, nursery or kindergarten was taken as experimental or control group. B-carotene, vitamin E, vitamin C and zinc were added to 100gm of ice cream in the dose of 2, 6, 30mg, 10mg, respectively for daily consumption, five days a week for a period of six ñonths by the experimental group. The control group was served with same ice cream without antioxidants. Any individual student making himself/herself absent from school for 15% of the total classes was considered as a dropout case. Also the student having any chronic illness was excluded from the study. Before the start of the intervention the whole study population (experimental and non-experimental group) was administrated with antihelminthic drugs to ensure proper deworming.

A pretested, modified and corrected questionnaire was used to collect the required information. Biochemical assessment: The blood sample was collected and preserved in sterile test tubes and kept its upper end sealed to avoid possible contamination. Each time the collected sample was transported to the laboratory within an hour. There the samples were centrifuged at 3000 rpm to isolate the serum. Serum level of vitamin E, vitamin C, carotenoids and zinc were measured at 0 and 180 days of the ttudy period to find out the changes due to intervention. The serum level of carotenoids was measured by using HPLC. Serum level of vitamin E was also measured by HPLC. Plasma ascorbic acid level Materials and Methods Was measured by dinitro phenyl hydrazine method and zinc was assessed by following the AOAC official methods of analysis.

Results and Discussion

Serum level of all antioxidants/micronutrients under study was assessed on 0 and 180 days of intervention. Table 1 Showed that serum level of 13-carotene in experimental anl control children before intervention were 5.11 ± 2.41 and 5.29 ± 2.46 mcg, respectively. But after intervention the same were found to be 22.64 ± 3.72 and 4.80 ± 2.26 mcg, respectively and the change was found to be quite significant (Paired I-test = 0.000) in experimental children.

Table 1. Changes of mean carotenoid level in serum (mcg/l00 ml) of study children before and after intervention.

Carotenoid level in serum	Experimental mean ± SD; (N = 117)	Non- experimental mean ± SD; (N = 104)
Before intervention	5.11 ± 2.41	5.29±2.46
After intervention	22.64 ± 3.72	4.80 ± 2.26
Difference	17.53 ± 3.19	(-) 0.49 ± 1.23
Paired t-test	0.000	0.000

Table 2 showed that the serum level of vitamin E of both experimental and control children before intervention were 307.69 ± 157.44 and 330.52 ± 73.93 mcg, respectively. But after intervention the same were found to be 938.27 ± 163.64 and 326.53 ± 72.54 mcg, respectively and the change in experimental group was significant (Paired t-test 0.000).

Table 2. Changes of mean vitamin E level in serum (mcg/100 ml) of study children before and after intervention.

Vitamin E level in serum	Experimental mean ± SD; (N=l17)	Non-experimental mean ±SD; (N=104)
Before intervention	307.69 ± 157.44	330.52 ± 73.93
After intervention	938.27 ± 163.64	326.53 ± 72.54
Difference	630.57 ± 174.72	(-) 3.99 ± 27.82
Paired t-test	0.000	0.146

In the same way Table 3 revealed the serum level of vitamin C in both experimental and control children before intervention as 0.16 ± (1.07 and 0.14 ± 0.05 mg, respectively whereas the same after intervention were found to be 0.96 ± 0.28 and 0.15 ±0.06 mg, respectively. The change in serum level in experimental children was significant (Paired t-test = 0.000).

Table 3. Changes of mean vitamin C level in serum (mg/100 ml) of study children before and after intervention.

Vitamin C level in serum	Experimental mean ± SD; (N= 117) mg/100 ml	Non-experimental mean SD; (Nl04) mg/l00 ml
Before intervention	0.16 ± 0.07	0.14 ± 0.05
After intervention	0.96 ± 0 28	0.15 ± 0.06
Difference	0.80 ± 0.27.	0.01 ± 0.04
Paired t-test	0.000	0.333

It was highlighted in Table 4 that the serum level of zinc in the experimental and control children before and after intervention were 0.52 ± 0.11 and 0.52± 0.09mg respectively. But after intervention the same were found to be 1.11 ± 0.14 and 0.53 ± 0.09 mg, respectively. It became obvious from the finding that experimental children had significant change of serum level after intervention (Paired t-test=0.000).

Table 4. Average changes of zinc level in serum (mg/lOOml) of study children before and after intervention.

Zinc level in serum	Experimental mean ±SD: (N = 117) mg/l00 ml	Non-experimental mean ± SD; (N = 104) mg/100 ml
Before intervention	0.52±0.11	0.52±0.09
After intervention	1.11±0.14	0.53±0.09
Difference	0.59±0.14	0.01±0.06
Pred t-test	0.000	0.333

The normal serum level of beta-carotene; vitamin E, vitamin C and zinc are 50 - 250, 500- 1500, 0.4- 1.0 mg/dI (Gerald 1998) and 0.102 rng/dl (Eric 1997), respectively. The normal level of antioxidants in serum clearly indicates that the children under study had very subnormal level of all the antioxidants except zinc. As it has been already highlighted in brief that these antioxidants are absolutely essential for normal growth and development, development of immunity and leading a normal health and functional life.

Adequate nutrition and health during first several years of life is fundamental to the attainment of Millennium Development Goals (MDGs) for survival of child and prevention of malnutrition. The irreversible faltering of linear growth and cognitive deficits found to be associated with anemia only during infancy and early childhood.

Short-term consequences are more morbidity and mortality with delayed physical and mental development Long-term outcomes include impaired intellectual work performances and impaired intellectual capacity with increased susceptibility to chronic diseases. Throughout the world children fail to grow in length and weight in a remarkable similar age specific pattern though there prevails vast differences of low weight-for-age, length-for-age from region to region. But it is well recogmzed that the first several years of life represents a window of cipportuniy to prevent irreversible growth faltenng (Shrimpton 2001). Fafteriug in length may extend for first 40 months of life. The prevalence of anemia is higher during infancy and early chldhood than at any other cycle in the life cycle (Yip and Ramakrishnãn 2002). Vitamin A and vitamin C deficiency too directly contribute to the development of anemia. Recent randomized trials also showed that the effect of iron supplementation provides development on motor and language meaning iron supplementation is likely to yield significant benefits (Logan et al. 2001). Diarrhoea and ARI are highly prevalent in early life. These types of morbidity cause stunting by suppressing appetite, increasing energy needs, and in case of diarrhoea, loss of nutrients through sool. Diarrhea can reduce the intake of complimentary food up to 30% (Martorell 1980. Zinc, iron and vitamin E deficiency have negative impact on appetite. The effects of poor nutrition and stunting continue throughout life, contributing to poor school performances, reduced productivity, and impaired intellectual and social development.

A recent authoritative report on child survival ranked nutrition interventions among the most effective preventive action to reduce under five mortality (Jones 2003). The micronutrients/trace element deficiency in diet varies from country to country but the deficiencies are iron, zrnc and vitamin B-6. Also deficiencies of riboflavin, niacin, calcium, vitamin A, thiamine, folate and vitamin C (Dewey and Brown 2003) are observed. But it has become clear from biochemical parameters that young children are also having deficiency of 13-carotene, vitamin E and vitamin C. 13-carotene itself is the precursor of vitamin A. So if sufficient amount of this antioxidant could be ensured in the diet, vitamin A suppImentation could have been avoided and in addition combating oxidative stress could have been easier and effective.

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