ABSTRACT

Background: The present scenario suggests that reduced antioxidant status is the key factor of obesity and hence a management strategy aiming at recommending a healthy eating plan of reduced fat, and increased fiber intake in obesity is envisaged. Aims & Objectives: To evaluate the relationship of antioxidants, ascorbic acid and alpha tocopherol to obesity in Gujarati and Non-Gujarati girls before and after maize diet. Materials and method: The present study emphasizes on an anthropometric and clinical study with maize diet in 1001 Gujarati and Non Gujarati girls, aged between 18-30 years. Every subject was asked to replace the wheat chapatti by maize chapatti for 30 days. Out of the 1001 girls, 526 girls were Gujaratis and 475 girls were Non Gujaratis. They were further distributed according to age, inhabitant, socioeconomic status, dietary habits, weight, height, body mass index, waist circumference, hip circumference, waist hip ratio, obesity indices, body fat percent, total body fat, lean body mass, skinfold thickness, family history and blood pressure. In the second part of the study the girls were examined for ascorbic acid and vitamin E, before and after maize diet along with the statistical evaluation of all the parameters. Results: Values of vitamin-C and vitamin E were 1.14 ± 0.19mg/dl and 8.32 ± 2.72mg/l respectively before the diet, which improved to 1.17± 0.19mg/dl and 10.18 ± 2.45mg/l respectively after the maize diet for thirty days. Vitamin C and E showed significant changes (P < 0.001). Conclusion: The effect of maize diet was positive on the levels of vitamin C and vitamin E in all the categories.

Key words: Obesity; antioxidants; ascorbic acid; alpha tocopherol; maize diet.
the international level, and those with BMI of 32.5kg/m² will require bariatric surgery to estimate excess flab. Every subject blood pressure was measured with a standardized protocol with an aneroid sphygmomanometer.

Waist Circumference was measured in centimeters at the midpoint between the bottom of the ribs and the top of the iliac crest. Women with a waist circumference less than 80 cm is considered as normal while with 80 – 87.9 cm were classified as overweight, and women with waist circumference > 88 cm were classified as obese. Recently, the Health Ministry has declared that cut off’s for waist circumference will now be 90 cm for Indian men as opposed to 102 cm globally, and 80 cm for Indian women as opposed to 88 cm at the international level. Hip Circumference was measured at the largest posterior extension of the buttocks.

Waist Hip Ratio was determined by dividing WC by HC. WHR= WC/HC. Women with a WHR less than 0.80 was categorized as normal while between 0.80 – 0.84 were classified as overweight and women with a WHR > 0.85 were classified as obese.

For measurement of Skin fold Thickness all measurements were taken, with the subject seated on a stool, on the right side of the body. The sites selected were biceps, triceps and subscapular, supra iliac. At these four sites, the skin fold was pinched up firmly between the thumb and forefinger and pulled away slightly from the underlying tissues before applying the calipers for the measurements. The average of the four sites was taken as skin fold thickness in centimeter. The instrument used was the Harpenden skin fold caliper (British Indicators Ltd. St. Albans, Herts.); which exerts a constant pressure at varying openings of the jaws.

Total body fat percent was calculated using the following formula as reported by YMCA formula (Young men Christian association). It uses only body weight and waist (at naval) measurements to calculate body fat percentage.

\[
\text{Body Fat \%} = \frac{-76.76+4.15 \times \text{Waist} - 0.082 \times \text{Weight} \times 100}{\text{Weight}}
\]

Body Fat was calculated by multiplying body weight (kg) with body fat percentage. Lean Body Mass (LBM) was obtained by subtracting the body fat (kg) from total body weight.

Ascorbic acid (Normal range: 0.8-1.5 mg/dl) was done according to method of Natelson.

Alpha-tocopherol (Normal range: 0.8-1.5 mg/dl) was done according to method of Baker and Frank. This method is based on the reduction of the ferric chloride ions by tocopherols after xylene extraction of the blood samples. The ferrous ions react with alpha, alpha biopyridyl to give a red color, which is measured in a 520 nm.

Statistical Analysis was done by SPSS V.16 to calculate Mean SD and t values. P value was determined and if P value was more than 0.05 it is not significant, if it is less than 0.05 then it is significant, P value: a=<0.05; b=<0.01; c=<0.001.

Results

For antioxidant vitamins E and C, the acceptable ranges are 6-19 mg/l and 0.8-1.5 mg/dl. Values of vitamin-C and vitamin E were 1.14 ± 0.19 mg/dl and 8.32 ± 2.72 mg/l respectively before the diet, which improved to 1.17 ± 0.19 mg/dl and 10.18 ± 2.45 mg/l respectively after the maize diet for thirty days. Vitamin C and E showed significant changes (P < 0.001).

Results were almost similar for Gujarati and NonGujarati girls except that vitamin C for Gujarati, NonGujarati was P<0.05. The subjects were divided into categories like age, inhabitance, socioeconomic status, diet, weight, body mass index, waist circumference, hip circumference, waist hip ratio, obesity indices, total body fat percentage, body fat, lean body mass, skinfold thickness, family history and blood pressure and the parameters were studied along with statistical evaluation in all the categories. Nearly both the parameters showed significant changes when comparison was done before and after maize diet (P<0.001).

Gujarati girls showed significant changes (P<0.05) but NonGujarati girls of same age range showed no significant change in vitamin-C, before and after the diet. When comparison was between Gujarati and NonGujarati of this age group, statistically significant changes were observed only for vitamin C (P<0.05), after the maize diet Almost similar results were obtained for age > 20 years for total girls.

However, more significant parameters as compared to the group age < 20 years were obtained when comparison was between Gujarati and Nongujaratis. The parameters that were significant before as well as after the maize diet were vitamin-C (P<0.01), vitamin E (P<0.05). Vitamin C was statistically significant for only urban girls (P<0.001). Keeping in view that obesity is a disorder mainly of affluent class; the girls were divided as lower, middle and upper socio economic class.

The antioxidant for lower socio economic class was better as compared to that in upper socio economic class. Vitamin C, vitamin E, for lower category was 1.15± 0.19 mg/dl, 8.32, ± 2.53 mg/l, v/s upper class 1.13± 0.1919 mg/dl, 8.31± 2.69 mg/l. Vitamin C was significant for middle and upper socioeconomic class (P<0.05) but insignificant for lower class. As diet plays an important role in development of obesity, subjects were divided as vegetarian and non-vegetarian. The effect of maize diet was almost similar for both the groups.

When the antioxidant activity of lower weight category was compared which that of higher weight category the mean values of vitamin C, vitamin E, were in acceptable range for lower weight group (1.4 ± 0.11 mg/dl v/s 0.92 ± 0.10mg/dl; 12.92 ± 3.1mg/l v/s 6.01 ± 0.67mg/l), Both the parameters for all three-weight ranges were highly significant when matched for maize diet.
As far as effect of maize diet is concerned all four groups of body mass index showed almost similar results in form of highly significant parameters (P < 0.001). There were three categories as waist circumference < 80 cm, waist circumference 80-87.9 cm and waist circumference > 88 cm and two categories of hip Circumference as < 36” and > 36”. Effect of maize was significant for nearly all parameters (P < 0.001). In both the groups of hip circumference both parameters were statistically significant when matched for maize diet except vitamin C which was significant (P < 0.001) for hip circumference < 36” but insignificant for the other group. There were three groups of waist hip ratio as underweight (< 0.8), normal (0.80-0.84) and obese (>0.84). Vitamin C and vitamin E in all groups altered significantly after maize (P <0.001). Dietary effect of maize was highly significant in all categories of obesity indices (P < 0.001). Comparison of Gujarati and NonGujarati exhibited statistically significant value (P < 0.05) for them in body mass index > 25 kg/m2 along with vitamin E (P < 0.05).

Discussion
According to Aronne in the recent past, no other research area has generated more cajoling enthusiasm than “Antioxidants” in the modern medicine. Antioxidants come into picture because a sound antioxidant status should logically serve as a guard against obesity and overweight states.

As per Table 1,

Table 1. Antioxidants, Vitamin C and vitamin E in total, Gujarati and NonGujarati girls in relation to weight, BMI, W/H, and obesity indices before and after maize diet.
The effect of maize diet was positive on all the levels of antioxidant enzymes in all the categories. Vitamin C and vitamin E were significantly increased in all the categories of BMI (1.26 mg/dl v/s 1.29mg/dl; 9.42mg/l v/s 11.23mg/l). Effect of maize diet showed diverse effects on activities of vitamin C and vitamin E levels. They were significant for age category but insignificant for rural category. This was in accordance to study done by Olusi (2000).11 Vitamin C and vitamin E showed significant changes (1.14mg/dl; 8.32mg/l) v/s (1.17mg/dl; 10.18mg/l) respectively after maize diet. These results were like those of Lalita Kaul15 who used high fiber diet rich in antioxidants in treatment of obesity. There was significant weight loss. It should not be forgotten that health promoting vitamins, minerals and antioxidants are also present in dietary fiber, which may be responsible for above stated beneficial effects of maize noted in clinical trials before.16,22-24 The level of vitamin C and vitamin E before as well as after the diet were higher for the girls who were less than 20 years (1.15±0.19 mg/dl and 1.18±0.18 mg/dl; 8.43±2.73 mg/l and 10.30±2.47 mg/l) as compared to the girls who were more than 20 years of age (1.12±0.2 mg/dl and 1.15±0.2 mg/dl; 8.20±2.71 mg/l and 10.05±2.43 mg/l). Their levels were higher for lower socioeconomic class (1.15±0.19 mg/dl; 8.32±2.53), for rural and vegetarian girls (1.14±0.19 mg/dl and 8.36±2.55 mg/l), (1.14±0.19 mg/dl and 8.34±2.67 mg/l). Level of these vitamins was remarkably low for higher weight and body mass index categories (0.92±0.1 mg/dl and 6.01±0.67 mg/l), (0.74±0.07 mg/dl and 5.40±0.06). Waist circumference of more than 88 cm had even low levels of these enzymes (0.85±0.08 mg/dl and 5.63±0.21 mg/l). Waist hip ratio of more than 0.84 had vitamin C level as 0.97±0.11 mg/l and vitamin E level as 6.35±0.91 mg/l. Last but not the least, the levels of these antioxidants in category of higher obesity indices were much lower than that in normal obesity indices (0.91±0.09 mg/dl v/s 1.30±0.12 mg/dl), (5.88±0.47 mg/l v/s 10.40±2.64 mg/l).

All the parameters, nutrient antioxidants like vitamin C and vitamin E were well within acceptable ranges as per ATP III guidelines in total, Gujarati and Non Gujarati girls. Vitamin C and vitamin E were inversely related with age (1.15 mg/dl v/s 1.12mg/dl; 8.43mg/l v/s 8.20mg/l). Non-vegetarian category showed low antioxidant profile when compared with the vegetarian category. Antioxidant level decreased with weight but increased with height; Antioxidant profile was least for girls with family history of CAD.

Ascorbic acid level decreased with increasing waist circumference (0.96mg/dl v/s 0.85mg/dl). Maximum value of vitamin C was in the category of WC <80cm (1.21mg/dl). Alpha tocopherol also followed the same trend. It was lowest for WC >88cm, acceptable for WC 80-87.9 (6.15mg/lit) and maximum for WC <80cm. Effect of maize diet was quite evident and almost equal (P<0.001) on all parameters in total, Gujarati and Non Gujarati girls. The nutrient antioxidants showed significant higher values after the consumption of the diet (P<0.001). Vitamin C, vitamin E was significantly increased after the maize diet was consumed for thirty days (P<0.001). For Gujarati girls, vitamin C levels showed significant changes (P<0.05), when matched for age, vitamin E, ascorbic acid was significantly increased for both the age groups. When the two groups were compared with each other, only vitamin C was statistically significant (P<0.001).

Effect of maize was seen for all socio economic classes. Vitamin C did not increase much for middle class. Highly significant changes were observed for almost all parameters in rural and urban categories for antioxidants when matched for diet. Vitamin C was increased only for the Gujarati urban girls (P<0.001). For the vegetarian group of girls most of the parameters improved (P<0.001), for the non-vegetarian category, vitamin C did not increase for Gujaratis and Non Gujaratis, vitamin E increased only for Non Gujaratis (P<0.001). The effect of diet was highly significant for all three categories of BMI. Antioxidant status was high for high BMI group after diet.

Antioxidants, which were quite low for the high WHR category, were markedly increased after the diet (P<0.001). Almost all parameters were significantly changed in the comparative analysis in family history of hypertension and coronary artery disease before as well as after the diet. DF modulate glucose response, prevents against carbohydrate induced hypercholesterolemia and hypertriglyceridemia, has sustained energy release-part of energy released in small intestine as glucose (source of energy for brain), part is released in large intestine as SCFA (source in muscles and fat tissue), increases glucose uptake in cells, stimulate action of insulin, slows absorption of carbohydrates by causing delay in gastric emptying, increases glucagon secretion, stimulate gluconeogenesis, divert acetyl Co A to form glucose not cholesterol, protect against atherosclerosis, favorably alters lipid metabolism, decreases TG, LDL, BP, increases HDL, antioxidants, protect against chronic diseases, affect properties like volume, bulk, viscosity, in intestinal lumen, which alters metabolic path of hepatic cholesterol and lipoprotein metabolism and lowers LDL-C -increases fat oxidation, decreases fat storage, fat cell size and its synthesis, change sequence in which body burns food-brings fat on top list, restore normal intestinal functions.25

**Conclusion**

It was concluded that oxidative stress in obese was in excess while defensive antioxidant levels were depleted and that an association exists between lower antioxidants and high oxidative stress and increased risk of obesity. Free radicals play an important role in pathophysiology of obesity and they are destroyed by antioxidant defenses.

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