ABSTRACT

In the present time health plays a significant role in human well-being. Antioxidants are the compounds that promote positive health free of various lifestyle diseases. Polyphenols are secondary metabolites that are present in the majority of plants and plant foods. Flavonoids & total phenols are most commonly known for their antioxidant activity. Hence the present study was planned on `Dietary Flavonoid intake and its relation with plasma antioxidant capacity among the population of Vallabh Vidyanagar - Semi Urban Population. Commonly consumed Indian foods were selected and their total phenols, flavonoid and total antioxidant capacity were measured. The influence of diet on plasma antioxidant capacity was analysed for which healthy adults, both men and women, age group between 18-70 and above years were selected. Their dietary intake was assessed by food frequency questionnaire. Fasting blood samples were drawn and the plasma total antioxidant capacity was estimated by FRAP method.

Analysis of various food commodities revealed that the phenolic content of cereals and cereal products, legumes and split legumes, vegetables, nuts & oilseeds, fruits, and miscellaneous foods ranged from 23.84 to 301.77 GAE/100g, 111.64 to 267.45 mg GAE/100g, 63.44 to 665.41 mg GAE/100g, 133.02 to 334.53 mg GAE/100g, 47.37 to 314.84 mg GAE/100g and 93.41 to 378.57 mg GAE/100g respectively.

Flavonoid content of various foods like, cereals and cereal products, legumes and split legumes, vegetables, nuts and oilseeds, fruits and miscellaneous foods was found to be ranging from 1.54 to 14.67 mg RE/100g, 17.54 to 105.24 mg RE/100g, 16.43 to 202.23 mg RE/100g, 13.57 to 21.06 mg RE/100g, 15.62 to 220.28 mg RE/100g and 4.56 to 74.13 mg RE/100g respectively.

The total antioxidant content (DPPH RSA) of cereals and cereal products, pulses and split pulses, vegetables, nuts & oilseeds, fruits, and miscellaneous foods ranged from 163.87 to 218.37 mg RE/100g, 66.70 to 263.38 mg RE/100g, 10.70 to 162.55 mg RE/100g, 133.35 to 159.65 mg RE/100g, 12.70 to 51.52 mg GAE/100g and 81.32 to 161.76 mg GAE/100g respectively.
For the surveyed population BMI was calculated and it was found that 1509 (61.4%) respondents were within normal BMI range, 477 (19.4%) were pre-obese and 4% were in obese category.

Chi-square ($\chi^2$) analysis of every socio-economic factors with BMI revealed that the gender, marital status, occupation, education, type of family and income with corresponding P-values of 0.000, 0.000, 0.000, 0.051, 0.019 and 0.043 had a significant association (at 0.05 level) with BMI. From ANOVA results it was found that there was a statistically significant difference in the BMI among different age groups ($F=3.630$, $P=0.003$) at 0.05 level. It also indicated that there was a statistically significant difference in the mean values of BMI of two genders ($F= 17.188$, $P=0.000$) at 0.05 level. ANOVA further indicated that there was a significant difference between various categories of occupation and BMI ($F=10.044$, $P=0.000$) at 0.05 level, with highest average BMI was found in the students. Different levels of education (elementary, high school, diploma, graduate, post graduate, Ph.D.) had shown significant ($P=0.05$) association with BMI at 0.05 level. According to ANOVA results a statistically significant difference was found in the mean values of their BMI among subject with different categories of education ($F=10.044$, $P=0.000$) at 0.05 level. Type of family showed significance ($P=0.019$) with BMI at 0.05 level. Chi square results indicated that there was no significance of blood pressure and diabetes with BMI, however other diseases showed a significance ($P= 0.000$) with BMI at 0.05 level. ANOVA also validated the same results that there was no significant difference in BMI of people with normal blood pressure and blood pressure related problems as well as diabetic and non-diabetic respondents. For other diseases it showed significant difference in BMI ($F= 3.009$, $P=0.006$) at 0.05 level.

Impact of various sociodemographic factors on total phenol, flavonoid and dietary antioxidant intake (DPPH RSA) showed statistically significant differences between different age groups. Mean values were determined by one-way ANOVA for total phenol ($F=4.351$, $P=0.001$), flavonoid ($F=8.622$, $P=0.000$) and dietary antioxidant (DPPH RSA) intake ($F=7.266$, $P=0.000$) at 0.05 level. For various BMI range groups no significant difference was found in the mean values of total phenol and dietary antioxidant (DPPH RSA) intake. However, it was found that there was a statistically significant difference in the mean values of flavonoid ($F=3.699$, $P=0.011$) among
various BMI ranges at 0.05 level. For various health related factors like Blood Pressure, diabetes and other diseases, it was found that there was no statistically significant difference in the mean values of total phenol, flavonoid and dietary antioxidant (DPPH RSA) intake. However for diabetes related groups little significant difference was found for the mean values of flavonoid (F=2.951, P=0.052). Between a group of people consuming alcohol and not consuming alcohol there was a statistically significant difference in the mean values of dietary antioxidant intake (DPPH RSA) (F= 4.284, P=0.039) at 0.05 level. Dietary factors had some impact on total phenol, flavonoid and dietary antioxidant (DPPH RSA) intake. There were statistically significant differences between vegetarian, non vegetarian and ovo vegetarian group of respondents determined by one-way ANOVA in the mean values of total phenol (F=5.097, P=0.006) and dietary antioxidant (DPPH RSA) intake (F=8.024, P=0.000) at 0.05 level.

With help of correlation analysis it was found that age had shown negative correlation with total phenol, flavonoid and dietary antioxidant intake (DPPH RSA) of foods with r= -0.088, P=0.000; r= -0.123, P=0.000 and r= -0.114, P=0.000 respectively at 0.01 level. Total family income had shown a significant positive correlation with total phenol intake (r=0.054, P=0.007) at 90% confidence level. Total family income also showed a significant positive correlation with flavonoid intake (r=0.40, P=0.047) at 95% confidence level. However it did not show specific correlation with dietary antioxidant intake (DPPH RSA). Consumption of tobacco and habit of smoking did not show correlation with the total phenol, flavonoid and dietary antioxidant intake (DPPH RSA). Consumption of alcohol also did not show significant correlation with total phenol, flavonoid. However it was found that there was a correlation of alcohol with dietary antioxidant intake (DPPH RSA) (r=0.042, P=0.039). Exercise did not show any significant correlation with any three parameters. Correlation with dietary habits like vegetarian, non-vegetarian and ovo vegetarian showed significant correlation at 90% confidence level with total phenol (r=0.063, P= 0.002) and dietary antioxidant intake (DPPH RSA) (r=0.080, P=0.000). It did not show significant correlation with flavonoid though.

Cereal intake had shown a significant correlation with total phenol (r=0.245, P=0.000) and DPPH RSA (r=0.314, P=0.000) of foods at 90% confidence level. Cereals intake
did not show a significant correlation with flavonoid intake of respondents. Pulse intake had a significant correlation with total phenol ($r=0.170$, $P=0.000$), flavonoid ($r=0.120$, $P=0.000$) and dietary antioxidant (DPPH RSA) ($r=0.229$, $P=0.000$) at 0.01 level. Vegetables intake had shown a significant correlation with total phenol ($r=0.301$, $P=0.000$), flavonoid ($r=0.186$, $P=0.000$) and dietary antioxidant (DPPH RSA) ($r=0.397$, $P=0.000$) at 0.01 level. Fruits intake had also shown a significant correlation with total phenol ($r=0.366$, $P=0.000$), flavonoid ($r=0.230$, $P=0.000$) and DPPH RSA ($r=0.237$, $P=0.000$) at 0.01 level. Nuts and oilseeds intake had a significant correlation with total phenol ($r=0.651$, $P=0.000$), flavonoid ($r=0.839$, $P=0.000$) and DPPH RSA ($r=0.295$, $P=0.000$) at 0.01 level.

To analyse the impact of sociodemographic factors with plasma total antioxidant capacity ANOVA was performed. There were no significant differences between means of plasma total antioxidant capacity among various age groups. For different gender, marital status, occupation, income and BMI groups, it was found that there was no statistically significant difference in the mean value of plasma total antioxidant capacity. ANOVA further resulted in to statistically significant difference in the mean values of plasma total antioxidant capacity for different types of families. It was also inferred with the results of ANOVA that there were no statistically significant differences in the mean values of plasma total antioxidant capacity among various groups like respondents with normal and high blood pressure; with the two types of diabetics and respondents without diabetes and among the other diseases. The results of ANOVA for impact of various lifestyle factors on plasma total antioxidant capacity revealed that there were statistically significant differences in the mean values of plasma total antioxidant capacity of respondents consuming alcohol and the others who are not consuming it ($F=4.499$, $P=0.034$ at 0.05 level). No significant difference was found in the mean values of plasma total antioxidant capacity among respondents with and without a habit of tobacco consumption. The same result was obtained for the two groups with or without a habit of smoking. A statistically significant difference was found in the mean values of plasma total antioxidant capacity of respondents who exercise and who did not ($F=12.336$, $P=0.000$ at 0.05 level). The mean of plasma total antioxidant capacity of respondents who exercise ($11.06\pm2.46$) was found to be higher than the ones who did not exercise ($10.45\pm2.45$). No significant difference was found in the mean values of plasma total antioxidant capacity.
capacity of respondents falling in to vegetarian, non-vegetarian and ovo-vegetarian dietary groups.

Pearson correlation analysis between sociodemographic factors and plasma total antioxidant capacity depicted that age, gender, marital status, occupation, income and BMI did not show any significant correlation with plasma total antioxidant capacity. Level of education and type of family showed positive correlation with plasma total antioxidant capacity \((r=0.052, P=0.028)\) and \((r=0.052, P=0.025)\) at 0.05 level. With these results it can be interpreted that with increase in education the plasma total antioxidant capacity also showed improvement. There was no significant correlation of the health factors namely blood pressure, diabetes and other diseases with plasma total antioxidant capacity. Correlation between lifestyle factors and plasma total antioxidant capacity showed that there was no significant correlation of tobacco and smoking with plasma total antioxidant capacity. Correlation of alcohol and plasma total antioxidant capacity was negative \((r=-0.050, P=0.034)\) at 0.05 level. Even correlation of exercise with plasma total antioxidant capacity was significant \((r=-0.082, P=0.000)\) at 0.01 level. Vegetarian, non-vegetarian and ovo-vegetarian type of dietary patterns did not show any significant correlation with plasma total antioxidant capacity.

Correlation analysis was carried between intakes of foods according to different food groups and plasma antioxidant capacity. It was found that pulses, fruits and nuts had a positive correlation with plasma total antioxidant capacity while cereals and vegetables intake did not show statistically significant correlation with plasma total antioxidant capacity. Pulses intake had a statistically significant correlation with plasma total antioxidant capacity \((r=0.047, P=0.043)\) at 95% confidence level. Fruits as well as nuts & oilseeds showed a significant correlation with plasma total antioxidant capacity \((r=0.105, P=0.000); (r=0.324, P=0.000)\) at 90% confidence level.

Pearson correlation analysis suggested that there was a statistically significant correlation of total phenol intake with plasma total antioxidant capacity \((r=0.342, P=0.000)\) at 0.01 level. Flavonoid intake also showed a strong and significant correlation with plasma total antioxidant capacity \((r=0.386, P=0.000)\) at 0.01 level. It was found that dietary antioxidant intake (DPPH RSA) showed a significant
correlation with plasma total antioxidant capacity (r=0.211, P=0.000) at 0.01 level. With regression analysis with r² values of 0.1172, 0.1489 and 0.0446 it was concluded that there was a moderate relationship between total phenol, flavonoid and dietary antioxidant intake (DPPH RSA) with plasma total antioxidant capacity.

**Conclusion:**
The study concludes that there was a positive and significant relationship between dietary flavonoid intakes with plasma antioxidant capacity among the population of Vallabh Vidyanagar.