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Total antioxidant capacity of fruits commonly consumed in Gujarat

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The total antioxidant activity, vitamin C and total phenols were measured from sixteen fruits and four peels. The vitamin C content ranged from 8.33 to 72 mg per cent for fruits and 8.25 to 23.33 mg per cent for fruit peels. Total phenols levels were found between 156.7 to 670.7 mg per cent for fruits and 441.0 to 1042.9 mg per cent for fruit peels. Orange, pupnus, pineapple, lemon, mango, date (red) and grape(red) had high vitamin C content whereas plum, pear, papaya, apple, pineapple, orange, date(red), mango and date (yellow) had high content of phenols on fresh weight basis. The total antioxidant capacity (TAC) expressed as per cent inhibition of lenoleic acid oxidation ranged from a high of 70.88 per cent in pineapple to a low of 8.85 per cent in sapota. In case of fruit peels, it was highest for apple peel (81.47%) and lowest for pupnus peel (16.48%). Other fruits found to have higher TAC (>30%) were plum, date (red), apple, date (yellow), orange, pupnus, banana, pear and mango.

Key Words : Antioxidant capacity, TBA, Vitamin C, Total phenols, Fruits

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INTRODUCTION

A general consensus has been reached during a last few year that diet has major role in the development of chronic diseases, such as cancer, coronary heart disease, obesity, diabetes type II, hypertension. This consensus suggests that a predominantly plant-based diet rich in fruits and vegetables, pulses and minimally processed starches staple foods reduces the risk for development of these diseases significantly. The recommendations, which are mainly based on epidemiological studies, are thus, that fruits, vegetables and less processed staple foods provide the best protection against the development of diseases with little or no merit in recommending vitamin or other micronutrients supplement for disease prevention (Willet, 1999 and Khushi, 1999). In most of the chronic diseases, the involvement of oxidative stress is a common cause. The oxidative stress in human body is caused by various free radicals, which may be a result of normal metabolism or smoking, sunlight, phagocytosis and exposure to various environmental pollutants. These free radicals may initiate damaging to biomolecules like DNA, protein, lipid, carbohydrates etc and ultimately develop a chronic disease. These also affect the food quality due to the oxidation of lipids in high fat contained food products.

The fruits are rich sources of various vitamins, minerals and fibre required by human body for optimal health. In the recent years, more attention has been paid to the antioxidant contained in fruits because epidemiological studies revealed that high fruits intake was associated with reduced mortality and mobility of cardio-vascular disease and some types of cancer and

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one of possible mechanisms was attributed to the antioxidant activity presented by the fruits (Guo and Yang, 2001 and Nagao *et al*., 1999). Fruits contained the polyphenols (such as flavonols, flavanols, anthocyanins and phenylpropanoids) and the antioxidant capacity of fruits may be due to the presence of these polyphenols in addition to vitamin C and carotenoids. These polyphenols may act as antioxidants or as agents of other mechanisms contributing to anticarcinogenic or cardio protective action (Barlow, 1990). Presently, food industries use synthetic antioxidants to prevent lipid oxidation and thereby extending shelf life of food products. However, there have been concerns about synthetic antioxidants such as BHA and BHT because of their possible activity as promoters of carcinogenesis (Rangana, 1979). Looking to this, replacement of synthetic antioxidants with natural is an urgent need. Fruits peels are also consider as rich source of polyphenols and may serve a good source for natural antioxidants to be extracted and used in food processing to prevent lipid oxidation.

India is bestowed with diverse climatic conditions (ranged from temperate to arid), conducive for the growth of varieties of fruits known for their nutritional values. The fruits which are produced are being processed for their preservation and large amount of their by product (peel) is left out which are also to be consider as rich sources of total phenols. Therefore, the present work deals with the determining vitamin C, total phenols and total antioxidant capacity (TAC) of selected fruits available and consumed in the diet and peel of four fruits. The TAC of these fruits was compared with standard antioxidants like vitamin C, vitamin E, Gallic acid and BHT.

METHODOLOGY

Total sixteen fruits selected for the present study were purchased from the local market of anand during June to September. The analysis of vitamin C the total phenols and total antioxidant capacity were carried out in triplicate. The chemicals used for assay were purchased from Sigma, Hi-media and Fluka companies.

Vitamin C :

Vitamin C was analysed by the method given by Malik and Sing (1971). The known weight of the sample was homogenized using 3 per cent metaphosphoric acid and centrifuged for getting supernatant. The volume was made up 50 ml with 3 per cent metaphosphoric acid solution. The known volume of aliquot was taken in a 100 ml conical flask and titrated against dye solution using a burette. Titration was continued till the light pink colour persisted for more than 15 seconds. The dye (2,6 dichlorophenol indophenol) was standardized by titrating against standard ascorbic acid and the dye factor was calculated.

Total phenols :

Total phenol was analysed by the method given by Ohkawa *et al*. (1979). Known quantity of fruit was mixed with 25 ml 0.3 N HCl and shook for an hour. After shaking, crude extract was centrifuged at 8000 for about 10 minutes. The supernatant obtained was evaporated to dryness in a water bath. To the residue, hot water was added and final volume was adjusted to 100 ml with distilled water. 1 ml aliquot of the above was taken in a test tube. To this, 1 ml each of Folin Ciocalteau reagent (diluted 1:2) and 35 per cent sodium carbonate were added and mixed. After 1 hour, 2 ml of distilled water was added to adjust the final volume to 5 ml. Intensity of the colour was recorded at 620 nm in a spectrophotometer (systronic) against the reagent blank. Gallic acid at varying concentrations was used as standard.

Total antioxidant capacity :

Sample preparation :

Known weight of fresh fruits was extracted with methanol: water mixture (80:20) and filtered through Whatman number. 1 filter paper. Volume of extract was made upto 50 ml and then it was reduced to 10 ml in water bath at 60^{o} C.

Procedure :

Twenty mg of linoleic acid (0.5 ml chloroform) was taken in two test tubes. The chloroform was evaporated completely. To one test tube 0.2 ml of methanol water mixture (80:20) was added considered as control and to another tube 0.2 ml of fruit extract was added. Both the tubes were vortex mixed. Then in these tubes, 4.55 ml of Trizma buffer, 0.1 ml of (0.1%) SDS (Sodium Lauryl Sulphate) and 0.05 ml ferrous sulfate were added. The mixture in the tubes was mixed properly. The total volume of the reacting solution was adjusted to 5 ml. Incubation was continued for 16 hours at 37^{0}C in the water bath. The reaction was stopped by adding 0.1ml alcoholic

solution of butylated hydroxy toluene (BHT) to the tubes. The reacted solution was used for TAC by thiobarbituric acid assay (TBA).

Thiobarbituric acid assay :

TBA was analysed by the method given by Humle (1971). The reacted solution (0.2 ml) mentioned above was derivatized to thiobarbituric acid : reactive substance by incubation with thiobarbituric acid reactive substance by incubation with thiobarbituric acid (1.0ml) and 0.5N HCl (3.0ml) for 30 minute at 95 per cent over a water bath. The solution was then cooled on ice for five min. The coloured substances were extracted by 4.0ml of n-butanol. The absorbance of the n-butanol layer was measured at 535 nm. The results are expressed in terms of malonaldehyde production. N-butanol was used as blank.

Statistical analysis :

The analysis of variance (ANOVA) was applied and S.E.M, critical difference (C.D) and co-efficient of variance (C.V%) were calculated. The regression analysis was analyzed using Micro Soft Excel-2010.

OBSERVATIONS AND ASSESSMENT

The present experiment, total sixteen fruits and four fruit peels were analyzed for their vitamin C, total phenols and total antioxidant capacity (TAC). The TAC of four standard compounds were also studied and compared with the TAC of the fruits.

The Vitamin C content of fruits varied widely and is believed that it contributes a large extent of the total antioxidant capacity. The Vitamin C content of selected fruits is shown in Table 1. The vitamin C contents of the fruits and fruit peels ranged from 8.25 to 72 mg per cent and 8.25 to 23.33 mg per cent, respectively. The general mean and critical difference was found about 23.14 and 2.21, respectively. The analyzed fruits were arranged in descending order for their vitamin C content and found as follows: orange > pupnus > pineapple > lemon > mango

Table 1 : Vitamin C, total phenol and TAC of selected fruits and four fruit peels

Sr. No.	Name of fruits	Vitamin C (mg%)	Total phenols (mg%)	TAC (% inhibition)
1.	Grape (*Vitis vinifera*)[Red]	25.33	287.8	26.31
2.	Grape (*Vitis vinifera*)[Green]	21.00	205.4	23.89
3.	Lemon (*Citrus limon*)	33.96	161.7	28.18
4.	Orange (*Citrus aurantium*)	72.00	243.8	46.22
5.	Pupnus (*Citrus maxima*)	37.49	156.7	44.10
6.	Banana (*Musa paradisica*)	15.34	232.6	40.36
7.	Mango (*Mangifera indica*)	29.99	410.9	30.03
8.	Papaya (*Carcia papaya*)	13.19	208.5	15.67
9.	Sapota (*Achras sapota*)	14.00	413.7	8.85
10.	Apple *Malus sylvestris*)	13.48	450.8	54.86
11.	Date (*Phoenix dactylifera*) [Red]	27.03	670.7	56.10
12.	Date (*Phoenix dactylifera*) [Yellow]	24.52	585.0	48.10
13.	Pear (*Prunus persica*)	8.33	369.5	34.06
14.	Pineapple (*Ananas comosus*)	37.10	278.1	70.88
15.	Plum (*Prunus domestica*)	13.32	451.6	66.58
16.	Pomegranate (*Punica garantum*)	16.00	410.2	20.86
17.	Lemon peel	18.86	441.0	48.40
18.	Orange Peel	23.33	1042.9	55.91
19.	Pupnus peel	10.41	648.6	16.48
20.	Apple peel	8.25	503.0	81.47
	General Mean	23.15	408.7	41.33
	S.E.±	0.77	1.9	0.736
	C.D. (P=0.05)	2.21	5.6	2.104
	C.V.%	5.80	0.82	3.08

Values are mean of three observations.

> date (red) > grape(red) > date (yellow) > grape (green) > pomegranate > banana > sapota > apple > palm > papaya > pear. The vitamin C content in the fruits showed similar or higher values for some of the fruits for which other authors have reported the vitamin C in various fruits (Wright and Manbeck, 1992; Duke, 1992; Kanazawa and Sakakibara, 2000; Barden and Bramlage, 1994 and Eberhardt *et al*., 2000). The reviewed literature suggested that the vitamin C content of fruits depend on many factors like variety, maturity, growing conditions, freshness and possibly analytical method. Therefore, the difference in vitamin C content of selected fruits and reported values may be of one or more vitamin C determinant as mentioned above.

The total phenols and total antioxidant capacity of fruits and their peels are presented in Table 1. The mean value of total phenols of sixteen fruits ranged from 156.7 to 670.7 mg per cent and 441.0 to 1042.9 mg per cent in four fruit peel. General mean of sixteen fruits and four peels was found to be 408.73 and the critical difference (C.D.) was 5.6. The total phenols showed significant difference among each other. Only lemon and pupnus juices showed the total phenols level less than 200 mg per cent while remaining fruits had total phenols ranging between 200 to 500 mg per cent. Fruit peels showed high total phenols as compared to their respective whole fruit extracts. Pupnus and lemon juices possessed low levels of total phenols whereas other fourteen fruits showed a high amount of total phenols. Interestingly, red and yellow varieties of date fruit showed the highest amount of total phenols *i.e.* 670.7 and 585.0 mg per cent, respectively. The total phenols in fruits are expressed on fresh weight basis and therefore moisture content of fruits may be a good determinant for total phenols values.

The total phenolic content on fresh weight basis is 450.8 mg per cent for whole apple and 503.0 mg per cent for apple peel extract which are higher than the values reported by Eberhardt *et al*., 1994 and 2000. In the present study, the total phenol content in banana was 0.232 g per cent whereas in plum it was 0.45 g per cent. These values may be approximately similar or higher when they will be converted on dry weight basis. The phenolic compounds of red grape varieties is higher than the green ones (Hertog *et al.*, 1995). Similar results were also observed in the present study *i.e.* red grape varieties (287.8 mg %) and had higher levels of total phenolics than the green one (205.4mg %). Similarly, red date had a higher total phenolic content than the yellow variety on fresh weight basis. Total antioxidant activity of fruits may be due to the presence of vitamin C, E, carotenoids and also from bio-active compounds such as flavonoids. Flavonoids are small molecular weight polyphenolic compounds that are widely distributed in the vegetables and fruits (Bors and Saran, 1987). Many fruits flavonoids such as kaempherol, quercetin, luteolin, myricetin, eridictyol and catechin have been shown to have antioxidant activity (Bors *et al*., 1990 and Cao *et al*., 1996).

Total antioxidant capacity gives an idea about the presence of total antioxidant compounds in fruits. Total antioxidant capacity was studied for five standard antioxidants *i.e.* Vitamin C, gallic acid, α-tocopherol and BHT at 60.0 μg concentration. Total antioxidant capacity of fruits is expressed as per cent inhibition of linoleic acid oxidation. The results obtained for the total antioxidant capacity of selected fruits and four fruit peels are presented in Table 1. The values varied considerably from one kind of fruits to another among the studied fruits and ranged from 8.85 to 81.47 per cent. The minimum value was found for sapota (8.85 %) whereas maximum value was found for the apple peel (81.47%). The values obtained for the total antioxidant capacity are arranged in descending order and was found as follow: apple peel > pineapple > plum > date (red) >orange peel >apple >lemon peel>date yellow >orange >pupnus >banana >pear >mango > lemon >grape red>grape green >pomegranate >pupnus peel >papaya>sapota.

In the present study, apple peel showed higher value than the whole apple with peel. These results suggested that apple peel contain higher amount of antioxidant compounds than the pulp and these may be the polyphenols. Higher antioxidant activity of green grape than the two synthetic antioxidants BHT and TBHQ (Lau *et al*., 2003). It was also confirmed that the potential activity of grape phenolics (Kalt *et al.*, 1999). The different activities of the grape extracts can be described to their different phenolic compounds. In the present study, lower value was observed for grape red and grape green. The lower values are due to higher moisture content compared to other fruits.

The antioxidant capacity of any food materials is not only depends on their antioxidant compound contained in them but it is also based on the methodology

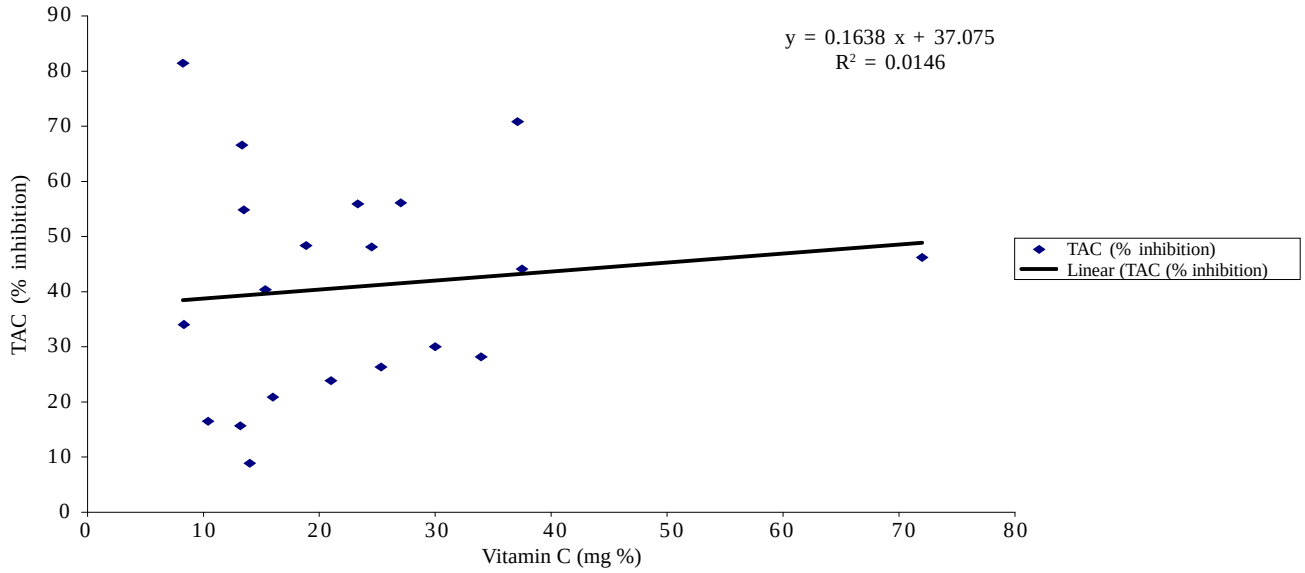

Fig. 1 : Relationship between vitamin C and total antioxidant capacity of fruits

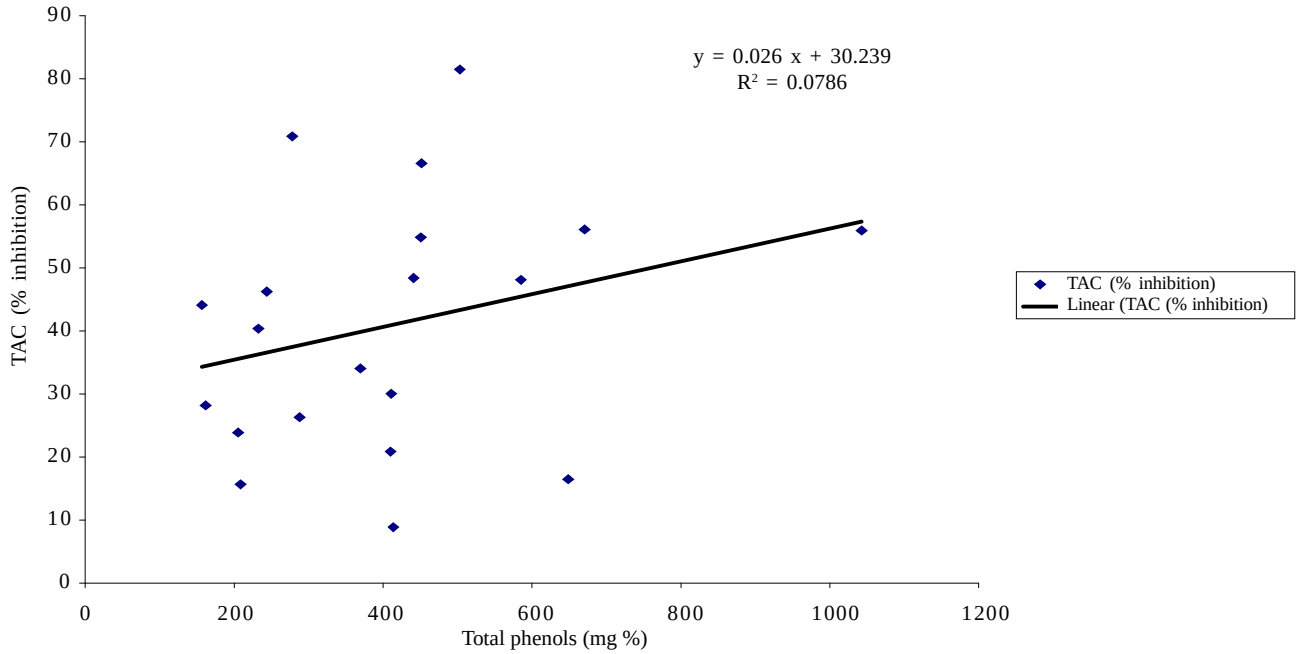

Fig. 2 : Relationship between total phenols and total antioxidant activity

used for estimation. The source of free radicals plays very important role in the reaction with the antioxidants present in foods. In the present study, linoleic acid oxidation products were inhibited by the antioxidants present in fruits and fruit peels. The antioxidant capacity of various fruits reported by other researchers showed the difference in the results of TAC. This difference is mainly due to the difference in the source of free radicals used by other researchers. Based on this, it is recommended that antioxidant capacity of fruits should be evaluated by different methods rather than depending on a single method.

In the present study total antioxidant capacity of standard vitamin C (43.34%), gallic acid (40.06%), α-

tocopherol (37.41%), β-carotene (45.29%) and BHT (39.24%) at 60.00 µg/ml concentration were found. α-carotene showed highest TAC indicated that the β-carotene has the best response against the source of free radical used in the present study. Total eight fruits and three fruit peels showed higher TAC values than 40.0 per cent.

The vitamin C (r-0.014, p-0.61) and total phenols (r-0.13, p-0.10) did not show any significant relationship with TAC (Fig. 1 and 2). The difference in results obtained may be due to the source of free radicals. Different phenolic compounds have different response with specific free radicals. Total sixteen fruits and four peels were studied in the present study, so varieties of phenolic compounds are present in them.

Conclusion :

This study involved a simple overview of the total antioxidant capacity of fruits consumed in Gujarat state of India and also determined the concentration of the principal compounds known to have antioxidant capacity in plant tissues. It appears that there is a significant variation in antioxidant capacity and the concentration of antioxidant compounds between fruits. Nine out of sixteen fruits showed TAC more than 30 per cent indicate that regular consumption of fruits provide good amount of antioxidant and help in prevention of chronic diseases. Fruit peels also showed good TAC and as they are the byproduct of fruit processing units, we can use these sources to extract natural antioxidant and can be used in food processing.

LITERATURE CITED

Barden, C.L. and Bramlage, W.J. (1994). Relationships of antioxidants in apple peel to changes in α-farnesene and conjugated trienes during storage and to superficial scald development after storage. *Postharvest Biol. & Technol.*, **4**(1) : 23-33.

Barlow, S.M. (1990). Toxicological aspects of antioxidants used as food additives. In : *Food antioxidants* (pp. 253-307). Springer, NETHERLANDS.

Bors, W. and Saran, M. (1987). Radical scavenging by flavonoid antioxidants. *Free Radical Res. Commu.*, **2**(4-6) : 289-294.

Bors, W., Heller, W., Michel, C. and Saran, M. (1990). Flavonoids as antioxidants: Determination of radical-scavenging efficiencies. *Methods Enzymol.*, **186** :343-355.

Cao, G., Sofic, E. and Prior, R.L. (1996). Antioxidant capacity of tea and common vegetables. *J. Agric. & Food Chem.*, **44**(11) : 3426-3431.

Duke, J.A. (1992). *Handbook of phytochemical constituent grass, herbs and other economic plants*. CRC Press.

Eberhardt, M.V., Lee, C.Y. and Liu, R.H. (2000). Nutrition: Antioxidant activity of fresh apples. *Nature*, **405**(6789) : 903-904.

Guo, C.J. and Yang, J.J. (2001). Progress in the study of antioxidant capacity of fruits and vegetables. *China Public Health*, **17** : 87-88.

Hertog, M.G., Kromhout, D., Aravanis, C., Blackburn, H., Buzina, R., Fidanza, F. and Pekkarinen, M. (1995). Flavonoid intake and long-term risk of coronary heart disease and cancer in the seven countries study. *Archiv. Internal Medicine*, **155**(4) : 381-386.

Hulme, A.C. (1971). The biochemistry of fruits and their products. **2** : 333–373.

Kalt, W., Forney, C.F., Martin, A. and Prior, R.L. (1999). Antioxidant capacity, vitamin C, phenolics, and anthocyanins after fresh storage of small fruits. *J. Agric. & Food Chem.*, **47**(11) : 4638-4644.

Kanazawa, K. and Sakakibara, H. (2000). High content of dopamine, a strong antioxidant, in cavendish banana. *J. Agric. & Food Chem.*, **48**(3) : 844-848.

Kanner, J., Frankel, E., Granit, R., German, B. and Kinsella, J.E. (1994). Natural antioxidants in grapes and wines. *J. Agric. & Food Chem.*, **42**(1) : 64-69.

Kushi, L.H., Meyer, K.A. and Jacobs, D.R. (1999). Cereals, legumes, and chronic disease risk reduction: evidence from epidemiologic studies. *American J. Clinic. Nutr.*, **70**(3) : 451-458.

Lau, D.W., King, A.J. and Waterhouse, A.L. (2003). An assay to estimate tannins added to postmortem turkey meat. *J. Agric. & Food Chem.*, **51**(23) : 6640-6644.

Malik, C.P. and Sing, M.B. (1971). Extraction and estimation of total phenols, In : *Plant Enzymology and Histo-Enzymology*, Kalyani Publication, NEW DELHI, INDIA.

Nagao, A., Seki, M. and Kobayashi, H. (1999). Inhibition of xanthine oxidase by flavonoids. *Biosci., Biotechnol. & Biochem.*, **63**(10) : 1787-1790.

Ohkawa, H., Ohishi, N. and Yagi, K. (1979). Assay for lipid peroxides in animal tissues by thiobarbituric acid reaction. *Analytical Biochem.*, **95**(2) : 351-358.

Rangana, S. (1979). *Manual of analysis of fruit and vegetable*

products. Tata McGraw-Hill. 94-95.

Willet, W.C. (1999). Goals for nutrition in the year 2000. *Cancer J. Clin*; **49**: 331-352.

Wright, B.W. and Manbeck, H.B. (1992). Theoretical prediction models for diaphragm panel behaviour - A review. *Trans. ASAE*, **35**(1) : 287-295.

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