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Determination of Nutritive Values of Jamun Fruit *(Eugenia jambolana)* Products

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Abstract: Study on the nutritive values of stored Jamun (*Eugenia jambolana)* products, namely jam, squash, ready-to-drink juice, seed powder and pulp powder was carried out at the Institute of Food Sciences and Technology, Sindh Agriculture University Tandojam. The specific fruit cultivar undertaken for this scientific evaluation was commonly known as (Improved) variety of Jamun. Besides of jam, squash and juice products, Jamun seed and pulp powder also have good nutritive values and were quite rich in carbohydrates accompanied by enough protein, ash, crude fibers but were not sufficient in fat composition. It was observed that nutritional values were varied at different packaging and storage temperature. The glass package among the packages and refrigerator temperature among the storage temperatures showed good results in terms of retaining good quality nutritive values and extensive shelf life of the products. The results were statistically significant. This study could be a beneficial source to the dieticians/nutritionist to consider Jamun as best nutraceutical fruit with natural curing and food industries for manufacturing commercially viable food products.

Key words: Jamun fruit, crude fibers, seed powder, pulp powder, nutritive values

INTRODUCTION

Human body requires various macro and micronutrients such as protein, carbohydrate, fat or lipid as macronutrients and vitamins, minerals, water and fiber as micronutrients. Likewise, human beings require a number of complex organic compounds as added caloric requirements to meet the need for their muscular activities (William Benton, 1972). Obviously, human food is mostly derived from plant and animal sources. Amongst the plant sources, Jamun fruit is one of those which contain a variety of important nutritional compositions. For instance, the fruit syrup is very useful for curing diarrhea. It is stomachache, carminative and diuretic, apart from having cooling and digestive properties (Thaper, 1958). Carbohydrates, fats and proteins form the major portion of the diet, while minerals and vitamins form comparatively a smaller part. Plant materials form a major portion of the diet; their nutritive value is important. Thus, in the present study, the nutritional and medicinal segment of *Eugenia jambolana was* taken for investigation. In relevance to this matter, a general view on the importance of various chemical compositions of fruit is given hereunder.

Among the nutritional composition of fruit, as food quality, Total Soluble Solids (TSS) of fruit represent various chemical substances present in it in soluble form. The amount of TSS present in the fruit sample is also considered to be a reliable index in judging its maturity. In accordance with the harvest maturity of many fruits is assessed in considering the TSS of their juices (Mazumdar and Majumder, 2003). A part from this, unlike most mammals, humans do not have the ability to make their own vitamin C. Therefore, we must obtain vitamin C through our diet particularly from berry fruits like jamun. Vitamin C is one of the most crucial vitamins in human that plays a large role in hundreds of the body's functions. The most plentiful tissue in the body is collagen, which is a connective tissue. The primary role of Vitamin C is to help this connective tissue. Because collagen is the defense mechanism against disease and infection and because Vitamin C helps build collagen, it makes sense that it is also a remedy for scurvy by contributes to hemoglobin production. Even in small amounts, vitamin C can protect indispensable molecules in the body, such as proteins, lipids (fats), carbohydrates and nucleic acids (DNA and RNA) from damage by free radicals and reactive oxygen species that can be generated during normal metabolism as well as through exposure to toxins and pollutants (e.g. smoking). Vitamin C may also be able to regenerate other antioxidants such as vitamin E (Carr and Frei, 1999 and Simon and Hudes, 2000)

Similarly, in fruits, various sugars are also present in certain forms like reducing and non-reducing in varying amount. Reducing sugars are those hexose ($C_6H_{12}O_6$) sugars, which can reduce compounds such as alkaline silver nitrate solution, cupric salt solution etc. When they make reduction reactions, they themselves are oxidized (Mazumdar and Majumder, 2003). Among these nutritional compositions, crude fiber also has pivotal role in human diet. Crude fiber is considered as the material left after making digestion of the tissue. It is manly composed of cellulose, lignin and some minerals. Cellulose and lignin in plant tissue are digested by reacting with acid and alkali. Ashing may also be used as the first step in preparing samples for analysis of

specific minerals, by atomic spectroscopy or the various traditional methods. Besides, Total Solids refers to the matter suspended or dissolved in food item or water and is related to both specific conductance and turbidity. Thus total solids are those materials which are left in a substance after evaporation and drying of water. This material can include carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions and other ions. Furthermore, fats are one of the major constituents of foods and are important in our diet for a number of reasons. They are a major source of energy and provide essential lipid nutrients. In many foods the fat component plays a major role in determining the overall physical characteristics, such as flavor, texture, mouth feel and appearance etc. Furthermore, proteins are important constituents of foods for a number of different reasons. They are a major source of energy, as well as containing essential amino-acids, such as lysine, tryptophan, methionine, leucine, isoleucine and valine, which are essential to human health, but which the body cannot synthesize. Proteins are also the major structural components of many natural foods, often determining their overall texture, *e.g.*, tenderness of meat or fish products. Food analysts are interested in knowing the total concentration, type, molecular structure and functional properties of the proteins in foods (American Public Health Association, 1998).

Many other researchers like Noomrio and Dahot (1996) studied on the evaluation of nutritive value of *Eugenia Jambosa* fruit like minerals, vitamins, free sugars and amino acids. The chromatographic analysis showed that fruit contains glucose, mannose, sucrose, alanine, arginine, asparagine, tyrosine, glutamine and cysteine. Punna and Paruchuri (2003) provided new data on total (TDF), Insoluble (IDF) and Soluble (SDF) dietary fiber contents of Jamun fruits, which play an important role in human nutrition. Anita and Malkit (2005) analyzed the Jamun seeds for proximate composition, available carbohydrates, dietary fibers and anti-nutritional factors (anti-nutrient content helps in controlling blood sugar). Protein, fat, ash, crude fiber, carbohydrate and energy contents were significantly reported. Indrayan *et al.* (2005) determined the nutritive value and analysis of mineral elements for some medicinally valued plant seeds including E. jambolana. Recently, (Rathi *et al.*, 2002) used the plant extract of *E. jambolana* for prevention of experimental diabetic cataract.

Keeping in view the multi-dimensional functionalities of Jamun fruit, the present study was aimed to make first various products to ensure Jamuns's availability round the year and finally their nutritional values were assessed after two years storage at various temperature in different packaging. It was a complex study chosen to make PhD thesis.

MATERIALS AND METHODS

Some valuable products were made from *E. jambolana*. *The fruits* were procured from the vicinity of university campus at Tandojam Sindh, Pakistan. Specimens of the products like jam, squash, ready-to-drink juice, seed powder and pulp powder were prepared in the laboratory of Institute of Food Science and Technology. These products were packed in different packaging material and stored at various temperatures. These stored products were used in subsequent analysis.

Determination of ash content: For determination of ash content, method of AOAC (2000) was followed. According to the method, 10 g of each sample was weighed in a silica crucible. The crucible was heated in a muffle furnace for about 3-5 h at 600°C. It was cooled in a desiccator and weighed to completion of ashing. To ensure completion of ashing, it was heated again in the furnace for half an hour more, cooled and weighed. This was repeated consequently till the weight became constant (ash became white or grayish white). Weight of ash gave the ash content was calculated by the following formula.

$$\text{Ash\%} = \frac{\text{Weight of ashed sample}}{\text{Weight of sample taken}} \text{X } 100$$

Determination of total solids: Total solids were estimated by deducting percent moisture from hundred as described by James (1995)

$$\text{\% total solids} = 100 - \text{\% moisture}$$

Determination of crude fat: Crude fat was determined by Mojonnier method (James, 1995). The fat content was determined gravimetrically after extraction with diethyle ether (ethoxyethane) and petroleum ether from an ammonia alcoholic solution of the sample. About 10 g of sample was taken into a Mojonnier tube. Added 1 ml of 0.880 with 10 ml ethanol mixed well and cooled. Added 25 ml diethyl ether, stopper the tube, shacked vigorously and than added 25 ml petroleum ether and left the tube to be stand for 1 h. The extraction was repeated thrice using a mixture of 5 ml ethanol, 25 ml diethyl ether and 25 ml petroleum ether and adding the extraction to the distillation flask. Distilled off the solvents, dried the flask for 1 h at 100°C and reweighed. The percentage fat content of the sample was calculated by the following formula which gave that the difference in the weights or the original flask and the flask plus extracted fat represent the weight of fat present in the original sample.

$$\text{\% fat content of sample} = \frac{W_2}{W_3}\frac{W_1}{} \times 100$$

Where W_1 = Weight of empty flask (g), W_2= Weight of flask + fat (g) and W_3 = Weight of sample taken (g).

Determination of crude protein: The crude protein was determined using micro Kjeldahl method as describe in AOAC (2000). 2 g of sample material was taken in a Kjeldahl flask and 30 ml concentrated sulfuric acid (H_2SO_4) was added followed by the addition of 10 g potassium sulphate and 1 g copper sulphate. The mixture was heated first gently and then strongly once the frothing had ceased. When the solution became colorless or clear, it was heated for another hour, allowed to cool, diluted with distilled water (washing the digestion flask) and transferred to 800 ml Kjeldahl flask. Three or four pieces of granulated zinc and 100 ml of 40% caustic soda were added and the flask was connected with the splash heads of the distillation apparatus. Next 25 ml of 0.1 N sulphuric acid was taken in the receiving flask and distilled. When two-thirds of the liquid had been distilled, it was tested for completion of reaction. The flask was removed and titrated against 0.1 N caustic soda solution using methyl red indicator for determination of Kjeldahl nitrogen, which in turn gave the protein content. The nitrogen percent was calculated by the following formula.

$$N\% = \frac{1.4(V2 - V1) \times \text{Normality of HCl}}{\text{Weight of sample}} X\ 250\ (\text{dilution})$$

Whereas, protein content was estimated by conversion of nitrogen percentage to protein (James, 1995).

$$\text{Protein \%} = N\% \times \text{Conversion factor (6.25)}$$

Where conversion factor = 100/N (N% in fruit products)

Determination of crude fibers: 2 g of moisture and fat-free material was treated with 200 ml of 1.25% H_2SO_4. After filtration with wattman paper No. 4 and washing, the residue was treated with 1.25% NaOH. It was filtered, washed with hot water and then 1% HNO_3 and again with hot water. The residue was ignited and the ash weighed. Loss in weight gave the weight of crude fiber (Chopra and Kanwar, 1991 and Mazumdar and Majumder, 2003).

$$\text{Crud fiber \%} = \frac{(c - b) - (d - b)}{(a)} X\ 100$$

Where; a = weight of sample; b = weight of crucible; c = initial weight of crucible containing tissue sample before ignition and d = final weight of crucible containing ash after ignition.

Determination of carbohydrates; Determination of available carbohydrate in the sample was calculated by difference method as described by (James, 1995).

% carbohydrates =Total solids - (% ash-% fat-% protein)

Determination of ascorbic acid: Vitamin C (ascorbic acid) was determined by titromateric method as described by Mazumdar and Majumder (2003) and James (1995). An amount of 10 ml/g (liquid/solid or semi solid) was taken and made volume up to 100 ml with 3% HPO_3 and filtered. Pipetted 10 ml of filtrate into a conical flask and titrated with the standard dye of a pink end point. The titration reading was calculated by the following formula;

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre X Dye factor X Volume made up}}{\text{Volu of filterate taken X Wt or Volu of sample}} X\ 100$$

Dye standardization: Diluted 5 ml of standard ascorbic acid solution with 5 ml of 3% of metaphosphoric acid. Titrate with dye solution till pink color persists for 10 seconds. Dye factor was calculated (mg of ascorbic acid per ml of dye) as follow;

$$\text{Dye Factor (D.F)} = 0.5/\text{Titration}$$

Determination of sugars: Determination of sugars (total sugar, reducing sugar and non-reducing sugar) were carried out though Lane and Eynon Method as described by James (1995).

Total sugar and reducing sugar: Took 5 g of sample into a beaker and added 100 ml of warm water. The solution was stired until all the soluble matters were dissolved and filtered through wattman paper into a 250 volumetric flask. Pipetted 100 ml of the solution prepared into a conical flask, added 10 ml diluted HCl and boiled for 5 min. On cooling, neutralize the solution to phenolphthalein with 10% NaOH and make up to volume in a 250 volumetric flask. This solution was used for titration against Fehling's solution and reading was calculated as follow.

$$\text{\% total sugar} = \frac{\text{Factor (4.95) X dilution (250) X 2.5}}{\text{Titre X wt of sample X 10}}$$

$$\text{\% reducing sugar} = \frac{\text{Factor (49.5) X dilution (250)}}{\text{Titre X wt of sample X 10}}$$

Non-reducing sugar was estimated as the difference between the total sugar content and reducing sugar content.

RESULTS AND DISCUSSION

Results shown in the Table 1 demonstrate the nutritional compositions of Eugenia jambolana fruit of improved variety products. It is evidently witnessed that

fruit is very rich in carbohydrates such as 17.37, 61.43, 63.29, 2.31, 5.88, 4.94, 7.39, 96.51 and 71.39% in fresh extraction, fresh and stored jam, fresh and stored squash, fresh and stored drinkable juice, pulp and seed powder respectively. These findings have resemblance with the results of other researchers for Jamun fruit (Diem and Lenter, 1970). Carbohydrates are one of the most important components in many foods. Carbohydrates may be present as isolated molecules or they may be physically associated or chemically bound to other molecules. Some carbohydrates are digestible by humans and therefore provide an important source of energy. Carbohydrates also contribute to the sweetness, appearance and textural characteristics of many foods (FAO/WHO, 1974).

Fresh extraction and stored products aforementioned of Jamun were also examined for Vitamin C (ascorbic acid) content which was 19.14, 10.00, 7.77, 4.47, 3.65, 12.24, 9.86, 4.76 and 1.56 mg/100 g respectively (Table 1). Ascorbic acid content of Eugenia jambosa fruit is favorably comparable with the content of Salvadora oleides (0.23 mg, 0.26 mg and 35.0 mg respectively) (Dahot *et al*., 1986). Cucumismelo (0.04 mg, 0.60 mg and 33.0 mg), Ribes grossularia (0.15 mg, 0.30 mg and 25 mg) and Citrus nobilis (0.07 mg, 0.02 mg and 31.0 mg) (Diem and Lenter, 1970). Vitamin C, is a water-soluble vitamin. Unlike most mammals, humans do not have the ability to make their own vitamin C. Therefore, we must obtain vitamin C through our diet. Vitamin C is one of the most crucial vitamins in human that plays a large role in hundreds of the body's functions (Carr and Frei, 1999). The most plentiful tissue in the body is collagen, Vitamin C helps build collagen, it makes sense that it is also a remedy for scurvy by contributes to hemoglobin production. It promotes the production of red-blood-cell in bone marrow. Ascorbic Acid also supports healthy capillaries, gums, teeth and even helps heal wounds, burns and broken tissues (Simon and Hudes, 2000). It also functions as a promoter of interferon, a compound that fights cancer. Vitamin C is also a highly effective antioxidant. Even in small amounts vitamin C can protect indispensable molecules in the body, such as proteins, lipids (fats), carbohydrates and nucleic acids (DNA and RNA) from damage by free radicals and reactive oxygen species that can be generated during normal metabolism as well as through exposure to toxins and pollutants (e.g. smoking). Vitamin C may also be able to regenerate other antioxidants such as vitamin E (Carr and Frei, 1999 and Simon and Hudes, 2000)

An appropriate amount of protein in Jamun products were observed as 0.72, 0.77, 0.57, 0.69, 0.53, 0.43, 0.25, 0.64 and 5.36 %, total sugar 14.31, 68.57, 68.76, 45.58, 45.90, 18.56, 18.72, 9.25 and 3.08 %, reducing sugar 5.72, 27.43, 27.51, 18.27, 18.36, 7.42, 7.49, 3.70 and 1.22 % and non-reducing sugar 8.58, 41.14, 41.25, 27.34, 27.54, 11.14, 11.23, 5.55 and 1.85% respectively. All these sugars were determined though Lane and Eynon Method as described by James, (1995). Other researchers like Mazumdar and Majumder (2003) reported that in fruits, both reducing and non-reducing sugars are present in varying amount. Reducing sugars are those hexose ($C_6H_{12}O_6$) sugars, which can reduce compounds such as alkaline (ammoniacal) silver nitrate solution, cupric salt solution etc. When they make reduction reactions, they themselves are oxidized. Hexose sugars which contain aldehyde groups e.g. glucose, glactose, mannose etc are reducing sugars. Likewise, non-reducing sugars, eg. Sucrose is a disaccharide and cannot reduce alkaline silver nitrate or cupric salt solution. When sugars are extracted and titrated the reducing sugars only take part in the reaction in making reduction but the non-reducing sugars that are present in it do not take pat in reduction reaction and remains as such. Accordingly, only the reducing sugars are estimated by titration. Dewani *et al*. (1993) has also an agreement regarding amino acid and sugar constituents of Capparis deciduas fruit.

The same products of jamun were also analyzed for many other compositions such as percent ash, total solids and crude fiber contents. Ash was found as 0.32, 0.28, 0.25, 0.13, 0.11, 0.06, 0.06, 0.30 and 18.33% respectively. FAO/WHO (1974) described the human nutritional requirements obtained from plant Kingdome. Ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of oxidizing agents, which provides a measure of the total amount of minerals within a food. Analytical techniques for providing information about the total mineral content are based on the fact that the minerals can be distinguished from all the other components within a food in some measurable way (Jain *et al*., 1992 and Nielsen, 1998). The most widely used methods are based on the fact that minerals are not destroyed by heating and that they have a low volatility compared to other food components (James, 1995). Moreover, total solids were investigated as 18.68, 62.57, 64.21, 3.18, 6.54, 5.50, 7.74, 95.24 and 96.03% respectively. Total solids are measure of the amount of material dissolved in water. This material can include carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions and other ions (American Public Health Association, 1998). In addition, the crud fibers in fresh extraction, fresh jam, stored jam, pulp and seed powder were determined as 0.22, 0.19, 0.18, 0.21 and 12.46% respectively. Crude fiber is considered as the material left after making digestion of the tissue. These results are in agreement with many other researchers on jamun aqueous extract as described in detail by (Dahot *et al*., 1986 and Dahot *et al*., 1989). These results further indicate that these nutritive values are retained in better way through glass

Table 1: Mean values of nutritional compositions of Jamun products

Samples	% Ash	Vita. C mg /100g	% Redu. sugar	% Non R. sugar	% Total sugars	% CH_2O	% Protein	% Fats	% T. Solids	% Crude Fibers
Fresh Extraction /pulp	0.32	19.14	5.72	8.58	14.31	17.37	0.72	0.27	18.68	0.22
Jam Fresh	0.28	10.00	27.43	41.14	68.57	61.43	0.77	0.17	62.57	0.19
Jam in Glass jar at room temperature	0.25	7.77	27.51	41.25	68.76	63.29	0.57	0.12	64.21	0.18
Jam in Glass jar at refrigerator temperature	0.27	8.34	27.34	41.03	68.37	62.28	0.76	0.14	63.45	0.18
Jam in Plastic jar at room temperature	0.25	6.02	27.55	41.35	68.90	67.62	0.39	0.09	68.35	0.17
Jam in Plastic jar at Refrigerator temperature	0.26	7.22	27.46	41.19	68.65	64.80	0.58	0.12	65.76	0.18
Jam in Plastic jar wrapped with aluminum foil at room temperature	0.27	7.68	27.52	41.29	68.81	64.32	0.54	0.11	65.24	0.18
Jam in Plastic jar wrapped with aluminum foil at refrigerator temperature	0.27	8.26	27.45	41.17	68.62	62.60	0.74	0.13	63.74	0.19
Squash Fresh	0.13	4.47	18.27	27.34	45.58	2.31	0.69	0.05	3.18	-
Squash in glass bottle at room temperature	0.11	3.65	18.36	27.54	45.90	5.88	0.53	0.02	6.54	-
Squash in glass bottle at refrigerator temperature	0.10	4.23	18.26	27.39	45.66	3.44	0.68	0.04	4.26	-
Squash in plastic bottle at room temperature	0.11	3.07	18.78	28.17	46.95	7.65	0.51	0.01	8.28	-
Squash in plastic bottle at refrigerator temperature	0.10	3.65	18.30	27.45	46.09	6.96	0.64	0.02	7.72	-
Squash in plastic bottle wrapped with aluminum foil at room temperature	0.12	3.63	18.49	27.73	45.88	6.00	0.52	0.02	6.66	-
Squash in plastic bottle wrapped with aluminum foil at refrigerator temperature	0.11	4.21	18.26	27.40	45.66	3.62	0.67	0.03	4.43	-
Ready to Drink juice fresh	0.06	12.24	7.42	11.14	18.56	4.94	0.43	0.07	5.50	-
Ready to Drink juice in glass bottle at room temperature	0.06	9.86	7.49	11.23	18.72	7.39	0.25	0.04	7.74	-
Ready to Drink juice in glass bottle at refrigerator temperature	0.06	10.44	7.43	11.14	18.57	5.83	0.42	0.06	6.37	-
Ready to Drink juice in plastic bottle at room temperature	0.04	8.29	7.52	11.28	18.81	8.34	0.24	0.02	8.64	-
Ready to Drink juice in plastic bottle at refrigerator temperature	0.07	9.30	7.49	11.24	18.72	6.73	0.41	0.03	7.24	-
Ready to Drink juice in plastic bottle wrapped with aluminum foil at room temperature	0.06	9.78	7.47	11.19	18.66	7.47	0.24	0.04	7.81	-
Ready to Drink juice in plastic bottle wrapped with aluminum foil at refrigerator temperature	0.04	10.35	7.44	11.18	18.61	6.06	0.44	0.05	6.58	-
Pulp Powder freeze dried at refrigerator temperature	0.30	4.76	3.70	5.55	9.25	96.51	0.64	0.32	95.24	0.21
Pulp Powder freeze dried at room temperature	0.30	4.18	3.70	5.56	9.26	94.63	0.39	0.31	95.63	0.20
Pulp Powder shade dried at refrigerator temperature	0.29	4.55	3.70	5.55	9.25	94.87	0.61	0.32	96.09	0.19
Pulp Powder shade dried at room temperature	0.28	3.90	3.70	5.56	9.26	95.58	0.37	0.31	96.54	0.19
Pulp Powder sun dried at refrigerator temperature	0.25	3.51	3.70	5.55	9.25	95.86	0.27	0.27	96.65	0.18
Pulp Powder sun dried at room temperature	0.27	2.81	3.73	5.59	9.32	96.07	0.18	0.24	96.76	0.19
Seed Powder freeze dried at refrigerator temperature	18.33	1.56	1.22	1.85	3.08	71.39	5.36	0.95	96.03	12.46
Seed Powder freeze dried at room temperature	18.27	0.98	1.24	1.87	3.11	71.95	5.12	0.94	96.28	12.42
Seed Powder shade dried at refrigerator temperature	18.33	1.39	1.23	1.85	3.07	71.78	5.29	0.94	96.33	12.46
Seed Powder shade dried at room temperature	18.30	0.81	1.22	1.84	3.06	72.17	5.18	0.91	96.49	12.44
Seed Powder sun dried at refrigerator temperature	18.19	0.98	1.22	1.84	3.06	73.19	4.69	0.83	96.90	12.38
Seed Powder sun dried at room temperature	18.21	0.40	1.41	2.12	3.64	73.61	4.47	0.78	97.07	12.38

package than any other like plastic package. Besides, refrigerator temperature shown better results which are subsequently followed by room temperature (Table 1).

Conclusion: Keeping in view the results obtained, it may be concluded that Jamun fruit possess good amount of nutritional value and rich in carbohydrates. Glass package and cold storage can retain good quality nutritive values and leading to more extensive shelf life of the products. Hence, the fruit can be highly considerable in beverage industry and can be explored for nutraceutical food products since the fruit found to have enough neutral cum medicinal potential.

REFERENCES

American Public Health Association, 1998. Standard Methods for the Examination of Water and Wastewater. 20th Edn., 127-131.

Anita, K. and N. Malkit, 2005. Effect of Supplementation of Traditional Medicinal Plants on Blood Glucose in Non-Insulin-Dependent Diabetics: A Pilot Study. Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, Ludhiana, Punjab, India, 8: 545-549.

AOAC, 2000. Official methods of analysis of the association of the analytical chemists. 17th Ed. Inc. Virginia, USA.

Carr, A.C. and B.A. Frei, 1999. Toward a new recommended dietary allowance for vitamin C based on antioxidant and health effects in humans. 69: 1086-1107.

Chopra, S.L. and J.S. Kanwar, 1991. Analytical Agricultural Chemistry, Kalyani Publications, New Delhi. Vol. IV, p: 297.

Dahot, M.U., A.N. Memon and F.D. Khand, 1989. Studies on the constituents of Acacia arabia premature pods. Pak. J. Sci. Ind. Res., 32: 405-407.

Dahot, M.U., A.N. Memon and S.A. Ali, 1986. Estimation of water soluble vitamins from fruits. J. Pharm. Univ. Kar., 5: 25-27.

Dewani, V.K., M.H. Noomario and M.U. Dahot, 1993. Amino acid and sugar constituents of Capparis decidua flowers. Scient Sindh, 1: 65-70.

Diem, K. and C. Lenter, 1970. Ducumenta Geigy Scientific Tables. IV: 499.

FAO/WHO., 1974. Hand Book on Human Nutritional Requirements, FAO Nutritional Studies, 28: 63-64.

Indrayan, A.K., S. Sudeep, D. Deepak, N. Kumar and M. Kumar, 2005. Determination of nutritive value and analysis of mineral elements for some medicinally valued plants. Current science, 89: 1252-1254.

Jain, N., R.K. Shahid and S.M. Sondhi, 1992. Analysis for mineral elements of some medicinal plants. Indian Drugs, 29: 187-190.

James, C.S., 1995. Analytical chemistry of food. Seale-Hayne Faculty of Agriculture, Food and Land use, Department of Agriculture and Food studies, University of Polymouth, UK., 1: 96-97.

Mazumdar, B.C. and K. Majumder, 2003. Methods on physico-chemical Analysis of Fruits. University college of Agriculture, Calcutta University. 108-109.

Nielsen, S.S., 1998. Introduction to Food Analysis techniques. Text Book. Aspen Publishers, USA.

Noomrio, M.H. and M. Umar Dahot, 1996. Nutritive value of Eugenia jambosa fruit. J. Islamic Academy of Sci., 9: 9-12.

Punna, R. and U.R. Paruchuri, 2003. Total insoluble and soluble dietary fiber contents of Indian fruits. J. Food Composition and Analysis, 16: 677-685.

Rathi, S.S., J.K. Grover, V. Vikrant and N.R. Biswas, 2002. Prevention of experimental diabetic cataract by Indian Ayurvedic plant extracts. Phytother. Res., 16: 774-777.

Simon, J.A. and E.S. Hudes, 2000. Serum ascorbic acid and gallbladder disease prevalence among US adults: the Third National Health and Nutrition Examination Survey (NHANES III). Arch Intern Med. 160: 931-936.

Thaper, A.R., 1958. Jamun, ICAR, Farm Bull, 42.

William Benton, 1972. Encylopaedia Britannica Inc, vol. 16: 802-805.