STUDIES ON NUTRITIVE VALUE OF PAPAYA (*CARICA PAPAYA* L.) FRUITS AT DIFFERENT STAGES FOR THEIR AMENABILITY TO SPECIFIC USE

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ABSTRACT

The composition and food value of papaya fruit *cv*. Sinta were assessed at four stages *viz*. green stage (vegetable purpose), ripe stage, papain-extracted ripe fruit and at the end of storage (10 days after storage) for their amenability to specific use. Papaya fruits at all stages were analysed for specific gravity, moisture content, β-carotene, total carotenoid, ascorbic acid, fat, fiber, protein, carbohydrate, total ash and minerals. Unripe mature green papaya did not contains total carotenoid or β-carotene but all other nutrients were present. Vitamin C content varied from 19.8 mg for green papaya, 40.8 mg for ripe papaya and 32.0 mg/100g pulp for papain-extracted fruit. There was a slight decrease in ascorbic acid content during storage. Fat (0.28%), protein (0.47%), total ash (8.2%) and minerals potassium (189.0mg/ 100g pulp), phosphorus (26.2 mg/100g pulp), calcium (38.5 mg/100g pulp) and iron (0.66) were found higher in green papaya as compared to ripe and papain -extracted fruits whereas, fiber (1.52%) and carbohydrates (8.30%) were found the highest in ripe papaya and lowest in green fruit (1.12% and 6.37%, respectively). Nutrient composition of papain-extracted ripe fruits was slightly lower than the ripe fresh fruits and stored fruit except fat and carbohydrate content.

KEY WORDS: Papaya, papain extraction, nutritive value, minerals, β- carotene

INTRODUCTION

The Papaya (*Carica papaya* L.) is an important fruit of tropical and subtropical regions of the world. It is an ideal fruit for growing in kitchen gardens, backyards of homes as well as in orchards. In India Papaya is grown commercially in Kerla, Orissa, Andhra Pradesh, Tamil Nadu, Bihar, Maharastra, Uttar Pradesh and Karnatka. Plains and frost-free areas of north-eastern states India offer vast potentialities for the successful production of papaya. Papaya is the fourth

important fruit crop next to citrus, banana and pineapple in the north-eastern region and is cultivated in about 12,700 ha with an annual production of 1,58,900 mt with a productivity of 12.51 t /ha which is far below the national productivity of 31.69 t/ha (Anonymous, 2006). Papaya has good potential in the tropical and subtropical areas of the region, which is mostly in Assam, Tripura, Arunchal Pradesh, Meghalaya and Nagaland**.** Among the northeastern states, Assam alone contributed more than 60% area and 80% production of papaya, but still Tripura, Nagaland and Mizoram has shown its potentiality in papaya production during last few years. Besides Assam and Manipur, the production of this crop is now gaining popularity in the mid and low hill regions of Meghalaya, Mizoram, Nagaland and Arunachal Pradesh (Singh *et al.*, 2010). Unripe green fruits are commonly used as vegetable for cooking in Assam, Tripura and other parts of north east and there is a great scope for the expansion of papaya cultivation in such areas as a vegetable papaya. From frost prone areas, green papaya can be harvested and sent to the markets of subtropical plains area during off season as a vegetable before the onset of frost, thus avoiding the damage of frost during ripening. Backyards or homestead gardening with other component are predominant feature of agriculture system in north eastern sates, thus papaya can be very remunerative under prevailing system as it is an ideal fruit for growing in kitchen gardening, backyards of home or as a filler plant in the other orchards.

Papaya is a considered multi purpose plant producing fruits for many uses. Ripe papaya is a wholesome, refreshing and delicious fruit. Green fruits are diuretic and mildly laxative and are used as vegetables. Papain prepared from the dried latex of immature fruits, is a proteolytic enzyme which is similar in action to pepsin and is used in many ways in pharmaceutical industry, tannin industry, cosmetics, tenderization of meat *etc* (Mitra, 1999). Papaya is one of the best natural sources of antioxidant such as β-carotene and vitamin C and fairly rich in minerals that prevent or even reverse serious diseases like cancer, diabetes, heart disease, stomach ulcers and helps in lowering the cholesterol levels (Sies and Stahl, 1995). As antioxidants, the carotenes, caricaxanthin and ascorbate have the potential to prevent and treat malignant diseases (Byers and Perry, 1992). Papaya is also rich in many minerals, including potassium, calcium, phosphorus and iron that are frequently deficient in the diets of most of the people.

Although many nutrients are know to be present in papaya the nutrient composition of papaya fruits could vary at different stages. Therefore the present

study was conducted to estimate the food value of papaya at four different stages namely green stage (vegetable purpose), ripe fruit stage, papain-extracted ripe fruit and 10 days after storage to see its amenability to specific use.

MATERIALS AND METHODS

Study was conducted during 2007-08 at ICAR (Indian Council for Agriculture Researrh) Research complex for NEH (North Eastern) region Umiam, Meghalaya, India to estimate the composition and chemical nutrient in papaya at different stage of fruit growth and development. Twenty plants of papaya *cv*. Sinta were randomly selected in orchard and composite sample of ten fruits from five plants were assessed at four stages of growth and development *viz*. green full mature (vegetable purpose), ripe fruit, papain-extracted ripe fruit and at 10 days after storage for specific gravity, moisture content, β-carotene, total carotenoid, ascorbic acid, fat, fiber, protein, carbohydrate, total ash and some minerals. Moisture content of the fruit was estimated by oven drying method suggested by Ranganna (1997). Specific gravity was calculated weight divided by volume of the fruit. Carotenoids were extracted and partitioned in acetone and petroleum ether respectively, as described by Thimmiah (1999). The fresh sample (2 g) was ground in 20 ml of distilled acetone and a trace was filtered with a Buchner funnel through Whatman No. 42 filter paper. The filtrates were pooled and portioned thrice with equal volume of peroxide-free ether using a separator funnel. The combined ether layers were evaporated under reduced pressure at 35^0C in a Buchii type rotatory evaporator. The residue was dissolved in ethanol. Aqueous 60% KOH was added to saponify the residue. The mixture was boiled, an equal volume of water was added and the mixture partitioned twice with ether. The combined ether layers were evaporated and the residue dissolved in ethanol. The absorbance at 452 nm was measured in a UV 1601 Shimadzu double beam spectrophotometer and the β-carotene content (mg/100g) calculated using a calibration curve prepared against a high purity β- carotene obtained from Sigma Chemical Co. USA. Vitamin C, reported as ascorbic acid content, was estimated titrimetrically, using 2, 6-di-chlorophenol indophenol dye, as per the methods of A.O.A.C. (1985). Fat, fiber, protein and carbohydrates were estimated as per the methods suggested by Ranganna, 1997.

Concentrations of mineral nutrients like Calcium, Phosphorus, Potassium and Iron were determined in diacid digest with a flame photometer and an atomic

absorption spectrophotometer (Model GNS 932) using the procedure of Bhargava and Raghupathi (1984). Total total ash was estimated by dry total ashing method suggested by Ranganna (1997). A sample (2-3 g) was weighed in a previously weighed silica crucible. The crucible was first heated over a low flame, and then in a muffle furnace at 600^0C for 3-4 hours. Thereafter cooled in desiccators and weighed. The total ash content was expressed as %.

The sampling was done for five times in each stage of analysis in completely randomized design. The data recorded were subjected to statistical analysis as per the method outlined by Gomez and Gomez (1984). Least significant difference at 5 % level was used for testing the significant differences among the different stage of development.

RESULTS AND DISCUSSION

Changes in composition and phytonutrients in papaya *cv*. Sinta were assayed at four different stages and it was found that green papaya had the minimum specific gravity (1.02) whereas, ripe papaya had the maximum (1.18) which decreased slightly in papain -extracted and stored fruits (Figure 1). Moisture content of fruits ranged from 88.5 % in ripe fruit to 94.0 % in green papaya. Unripe mature green papaya, used as vegetable did not contain total carotenoid or β-carotene but all other nutrients were present. Ripe papaya is a rich source of anti-oxidant nutrients such as β- carotene which gives it the orange color. The highest β-carotene content (8.94 mg/100g) was found in ripe fruit followed by papain -extracted ripe fruit (8.90 mg/100g) and minimum in stored fruit (3.34 mg/100g). Similar trend was also found for total carotenoid but the difference in total carotenoid content in ripe papaya and papain-extracted fruit was very small (Table 1).

However, it was reduced in stored fruit (8.66 mg/100 g) as compared to ripe papaya (13.86 mg/100g) and papain-extracted fruit (13.75 mg/100g). β-Carotene is an important antioxidant found in lipid soluble fractions of biological system, which protects cellular membrane by scavenging/quenching free radicals (Singh *et al.,* 2006). This is the reason that it is found in the later part of the development of fruit when it has the maximum ability to quench peroxyl radicals. As far as the ability to quench the peroxyl radicals is concerned, β-Carotene has the highest antioxidant activity followed by α-tocopherol and ascorbate, respectively (Sies

and Stahl, 1995). The other important role of β-Carotene's is that it is converted to vitamin A in the body which is necessary for vision, healthy skin, fighting infections, reproduction, and normal growth and development.

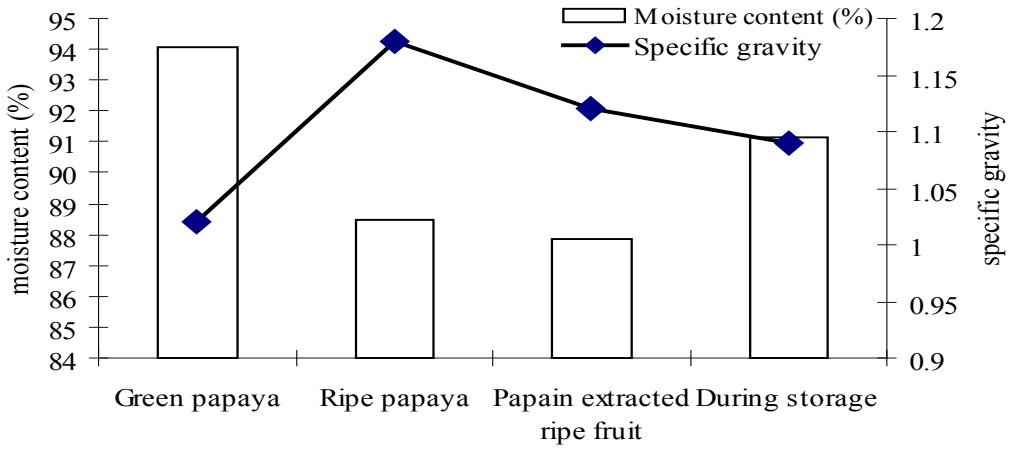

Fig.1. Moisture content and specific gravity of papaya fruits at different stages

Data contained in table 1 revealed that, ascorbic acid content varied from 19.8 mg for green papaya, 40.8 mg for ripe papaya and 32.0 mgs/100 g for papain-extracted fruit. There was a slight decrease in ascorbic acid content (33.32 mg) during storage. Singh *et al*. (2006), also reported that maximum ascorbic acid content in passion fruit was recorded in later stage of fruit development i.e. when fruits attained 3/4th surface colour. It appears that active synthesis of ascorbic acid during later stage of fruit development might be attributed to inactivation of ascorbic acid oxidase due to phenols (Deshpande *et al.*, 1984). Fat and protein content were found maximum (0.28% and 0.47%t, respectively) in green papaya followed by ripe papaya. Protein content in papain-extracted ripe papaya was reduced to 0.28% as compared to ripe papaya (0.39%). This may be due to the fact that latex, which has more protein had been extracted with the latex.

Fiber and carbohydrate content were recorded maximum (1.52% and 8.30%, respectively) in fresh ripe papaya and minimum in green papaya (1.12% and 6.37%, respectively) whereas, total ash content was found maximum in green papaya (8.2%) and minimum in papain-extracted fruits. Ripe fruits under storage had less total ash content (5.4 %) compared to fresh ripe fruit (6.1%). Minerals, especially calcium, phosphorus, iron and potassium were also analysed at all

Table 1. Food value of Papaya fruits at different stages

Stages	β- carotene*	TC*	AC*	Fats (%)	Fiber (%)	Protein (%)	CAB (%)	Total ash (%)	Ca*	P*	Fe*	K*
Green papaya	0.0	0.0	19.8	0.28	1.12	0.47	6.37	8.2	38.5	26.2	0.66	189.0
Ripe papaya	8.94	13.86	40.8	0.179	1.52	0.39	8.30	6.1	35.8	19.5	0.52	60.38
Papain -extracted ripe fruit	8.90	13.75	32.0	0.178	1.48	0.28	7.65	5.14	31.4	17.6	0.48	58.25
10 days after storage	3.34	8.66	33.32	0.142	1.26	0.32	7.16	5.4	36.2	18.3	0.53	60.17
Range	0.0-8.94	0.0-13.86	19.8-40.8	0.142-0.28	1.12-1.52	0.28-0.47	6.37-8.30	5.14-8.2	31.4-38.5	17.6-26.2	0.48-0.66	58.25-189.0
CD (0.05%)	1.26	1.73	4.60	0.086	0.16	0.06	0.68	0.87	2.31	1.87	0.09	4.62

* mg/100g; TC= Total carotenoid; AC= Ascorbic acid; CAB=Carbohydrates

four stages and it was found that all minerals were higher in green papaya as compared to ripe, papain-extracted and minimum in stored fruits. Phosphorus and potassium content decreased drastically from green stage to ripening stage but it was constant in papain-extracted fruits and stored fruit. Calcium and iron contents were more or less same at all the stages and they ranged from 31.4-38.5 mg/100g and 0.48-0.66mg/100g, respectively. Similar pattern of rapid increase of minerals and other phytonutrients at later stage of fruit development from green mature to colour break stage was reported by Arturo *et al*. (2001), Ghanta *et al*. (1994) and Pal and Selvaraj (1987).

CONCLUSION

Nutrient composition analysis studies are important for creating awareness from a health point of view and are also helpful for specific use of papaya at different stages. Thus from the present study, it can be concluded that, most of the minerals, protein and fat are found maximum in full mature green papaya, whereas, ripe papaya are rich in antioxidants i.e. total carotenoids including β-carotene , ascorbic acid, fiber. Further it is inferred from the present study that there is a little change in most of the nutrient after papain extraction.

REFERENCES

Ananymous, 2006. Indian Horticulture data base, National Horticulture Board (http//www.nhb.org).

AOAC 1985. Official methods of analysis. Association of official analytical chemists, Wtotal ash ington, DC USA.

Arturo, H., R. Carmen, B. Alejandro, M.M. Maria and A.Roberto. 2001. Mineral composition of the papaya (*Carica papaya*) cv. Sunrise from Tenerife Island. European Food Research and Technology. 212(2):175-181.

Bharrgava, B.S. and H.B. Raghupathi. 1984. Analysis of plant materials for macro and micronutrients, pp. 49-82. In Tandon H.L.S. (ed.) Methods of analysis of soils, plants, waters and fertilizers. Fertilizer development and consultation organization, New Delhi.

Byers, T. and G. Perry. 1992. Dietary carotenes, Vitamin C and Vitamin E as protective antioxidants in human cancers. Annual Review of Nutrition. 12:139-159.

Deshpande, S.S., S.K. Sathe and D.K. Salunkhe. 1984. Dry beans of Phaseolus: A Review. Part 3: Processing and Food Applications, *CRC* Critical Reviews in Food Science and Nutrition 21:137–180.

Ghanta, P.K., R.S. Dhua and S.K. Mitra. 1994. Studies on fruit growth and development of papaya *cv*. Wtotal ash ington. Indian Journal of Horticulture. 51:246-50.

Gomez, A.A. and K.A. Gomez. 1984. Statistical procedures for agricultural research. John Wiley and sons, Inc New York pp. 680.

Mitra, S.K. 1999. Papaya. In Tropical Horticulture. Eds T.K. Bose, Mitra, S. K., Farooqi, A.A. and M.K. Sadhu. Naya Proktotal ash, Calcutta, India. Pp. 784.

Pal, D.K. and Y. Selvaraj. 1987. Biochemistry of papaya (*Carica papaya* L.) fruit ripening: changes in RNA, DNA, protein and enzymes of mitochondrial, carbohydrate, respiratory and phosphate metabolism. Journal of Horticulture Science. 62:117-24.

Ranganna, S. 1997. Manual of analysis of fruits and vegetable products, Tata McGraw hill publication company Ltd. New Delhi, India.

Sies, H. and W. Stahl. 1995. Vitamin E and C, carotene and other carotenoids as antioxidants. American Journal of Clinical Nutrition. 62:1315-1321.

Singh, A., B.C. Deka, J. Praktotal ash, R.K. Patel and H. Ojha. 2010. Problem and prospect of papaya cultivation in North Eastern states of India. Acta Horticulturae. 851: 61-66.

Singh, A., R.K. Patel, K.D. Babu and M. Bhuyan. 2006. Flowering fruiting and ripening physiology of passion fruit. Environment and Ecology. 24(3):693-697.

Singh, J., A.K. Upadhyay, A. Bahadur, B. Singh, K.P. Singh and Rai Mathura. 2006. Antioxidant phytochemicals in cabbage (*Brassica oleracea* L. *var*. capitata). Scientia Horticulturae. 108:233-237.

Thimmiah, S.K. 1999. Standard methods of biochemical analysis. Kalyani Publ., New Delhi.