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Nutritional properties of papaya peel

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Abstract
Papaya owing second position to hydrogen peroxide and hydroxyl radical scavenging activity and the by-products accounts for approximately 20-25% of fruit weight. The fruit by products are good sources of bioactive compounds such as β-carotene, lycopene, anthocyanins and flavonoids when compared to fruit pulps. The dehydration and rehydration ratio of PPP was 15.32 and 11.6%. Colour of PPP was increased compared to PSP. Crude fiber content of PPP and PSP was 12.43 and 0.94%. Total dietary fiber content of PPP and PSP was 44.66 and 2.0%. Sodium and Potassium content of PPP and PSP were 3.61 and 2.09 mg/100g and 79.34 and 74.61 mg/100g. β-carotenecontent of PPP and PSP was 15.46 and 2.06 µg/100g.

Key words: Papaya peel powder, papaya peel paste, dehydration ratio, rehydration ratio, crude fiber, dietary fiberand β-carotene.

Introduction
Fruits and vegetables are rich source of natural antioxidants and they quench the free radiclals (John and Shahidi, 2010) [20]. India is the world's largest producer of papaya and belonging to caricaceae family and is used as medication against a variety of diseases like cancer and cardiac diseases (Mello *et al*., 2008) [23].
Murcia *et al*. (2001) [25] reported that Papaya and second position owing to hydrogen peroxide and hydroxyl radical scavenging activity. Phenolic compounds are important fruit constituents because they exhibit antioxidant activity by inactivating lipid free radicals or preventing decomposition of hydroperoxides into free radicals
The agro-industrial by-products are good sources of bioactive compounds and the exploitation of these abundant and low-cost renewable resources can be used to develop new products with uses in pharmaceutical and food industries. They are sources of minerals, fibre and phenolic compounds that have antiviral, antibacterial and cardio protective properties (Djilas *et al*., 2009) [14]. The present study was undertaken to analyse the physicochemical and nutritional properties of papaya peel powder and papaya peel paste.

Methods and Materials
Procurement of raw materials: Ripe papaya fruit was procured from local market, in Hyderabad. The glassware and equipment were from Post Graduate and Research Center, PJTSAU, Rajendranagar, Hyderabad.

Preparation of blanched papaya peel powder and paste: Papaya peel paste (PSP) was prepared by taking mature papaya that was washed, peeled blanched at 100^0 C for 3-4 min. The blanched peel was cooled and ground to a fine paste, stored in sterilized glass container and kept under refrigerator till further use. Papaya peel powder (PPP) was prepared with slight modification of procedure given by Ajila *et al*., 2007 [1].

Physical properties of PPP and PSP
Dehydration ratio and Rehydration ratio: Dehydration and rehydration ratio of PPP was calculated as per the procedure given by.

Water absorption index (WAI) and water solubility index (WSI): WAIand WSI were carried as given by Anderson *et al.* (1969) [3].

Colour: Colour quality of the samples were estimated by using Hunter lab colorimeter- Colour Quest XE Hunter Lab, USA (Hunter Lab, 2013) [18].

Nutritional analysis: The analysis were carried out as per the standard AOAC procedures. Moisture, ash and protein (AOAC, 2005) [9-11], fat carbohydrate and energy (AOAC, 1980) [5], crude fiber (AOAC, 1990) [6, 7] and total dietary fiber (AOAC 2000) [8] were used. Minerals like sodium and potassium in flame photometer (AOAC, 1990) [6, 7] and β-carotene content (Ranganna, 2003) [27] were estimated for the PPP and PSP samples.

Result and Discussion

Rehydration ratio: Rehydration can be considered as a measure of the injury to the material caused by drying and treatment preceding dehydration. Rehydration ratio of dehydrated PPP was 15.32%.

Dehydration ratio: Dehydration ratio reported as ratio of mass of papaya peel slices before loading into the drier to the mass of dehydrated products. In the present study, dehydration ratio was 11.6% and total moisture content of PPP was 8.04%.

WAI and WSI: The WAI is related to the availability of hydrophilic groups (-OH) to bind to water molecules and to the gel forming capacity of starch molecules (Ferreira, 2012) [17]. Mean value of WAI of PPP was 14.75 (ml/g).The WSI is related to the amount of soluble solids present in a dried sample and can be used to verify the intensity of the heat treatment, depending on the gelatinization, dextrinization and consequent solubilization of starch among the other components in the raw material, such as protein, fat and fiber (Moura, 2010) [24]. Mean value of WSI of peel powder was 5.34%.The results of WAI and WSI were given in the table below.

Table 1: WAI and WSI of papaya peel powder

S. No.	Parameters	Values
1.	WAI	14.75±0.08 (mg/ml)
2.	WSI	5.34± 0.04(%)

Note: Values are expressed as mean ± standard deviation of three determinations

These findings were in conformity with the results of who reported the water absorption capacity of various fruits and vegetable peels. Higher WAI for water melon peel (11.5 ml/g) followed by garlic peel (11.2 ml/g), pineapple peel (8.5 ml/g), green pea peel (8.2 ml/g), pomegranate peel (6 ml/g) while WAI is lowest for pigeon pea peel (5.5 ml/g). The increase in porosity increased the volume of the entrapped air. The hydrophilic groups in the fibres of fruits and vegetable peels are responsible for the high water absorption capacity.

Colour: Food colour is governed by the chemical, biochemical, microbial and physical changes which occur during growth, maturation, post-harvest handling and processing. Colour measurement of food products has been used as an indirect measure of other quality attributes such as flavour and contents of pigments because it is simpler, faster and correlates well with other physicochemical properties. The L*a*b* units are often used in food research studies to determine the uniform distribution of colours as L*a*b* units are very close to human perception of colour (Sahin *et al.,* 2011) [30].

Table 2: Colour analysis of PPP and PSP

S. No.	Samples	ΔL	Δa	Δb
1.	PPP	44.05±0.26	7.85±0.204	19.86±0.22
2.	PSP	41.20±0.10	6.03±0.130	15.19±0.14
3.	Mean	42.62	6.94	17.52
4.	C.D	0.71	0.68	1.9
5.	S.E of mean	1.51	0.35	0.70
6.	C.V (%)	0.95	4.36	9.89

Note: Values are expressed as mean ± standard deviation of three determinations.
PPP: Papaya peel powder
PSP: Papaya peel paste

The ΔL, Δa and Δb values of PPP were 44.05, 7.85 and 19.86. The ΔL, Δa and Δb values of PSP were 41.20, 6.03 and 15.19. The maximum ΔL value was observed for PPP (44.05±0.26). The percentage of increase in colour values of PPP compared to PSP was given in figure 1. These findings are in conformity with the results as reported by Hussein *et al*. (2015) [19] who analysed colour parameters for banana, mandrins, carrot peels and apple pomace samples and reported that banana peel was darker than other peel samples, lowest lightness (L* = 24.82), redness (a* = 3.09) and yellowness (b* = 6.64). Lightness (L*) value was maximum in mandarin peels (52.83), then slightly decreased in apple pomace and carrot peels from 50.97 and 48.71. The highest redness (a*) value was found in mandarin peels (33.61) followed by carrot peels (32.64) and apple pomace (17.3). The highest yellowness value (b*) was also found in mandarin peels (50.32) followed by carrot peels (41.37) and apple pomace (21.27).

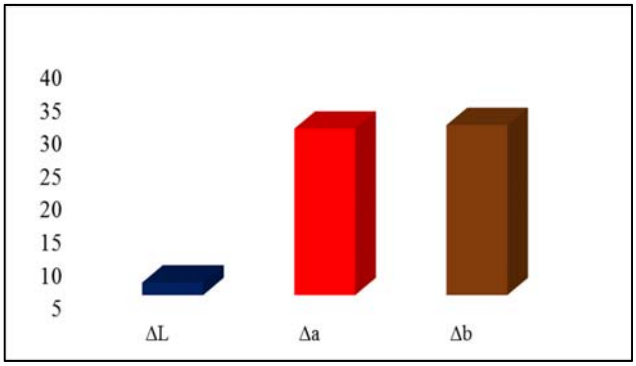

Fig 1: Percentage of increase in colour values of PPP compared to PSP

Proximate composition of PPP and PSP: The PPP and PSP were analysed for the proximate composition and presented in Table 3.

Moisture: The moisture content of papaya peel powder was 8.04% and papaya peel paste was 87.46%. There was a significant difference ($p<0.05$) in the moisture content of the PPP and PSP.
These findings are in conformity with the results of potatopeel flour with moisture content of 9.72 % (Fernandes *et al*., 2008). The moisture content of the banana peel to be 6.70% and was relatively low due to the time of harvest. The low value moisture content of banana peel can help to preserve for a longer time without mouldy growth (Anhwange *et al.,* 2009) [4].

Ash: The results indicated that fruit peels are good source of minerals, ash content showed significant difference ($p<0.05$)

between PPP and PSP. The ash content of papaya peel powder was 7.56% and blanched papaya peel paste was 0.37%.

The results obtained from the present study showed similar findings from Souza *et al*. (2008) [31] in which they found an ash content of 8.13% in passion fruit peel flour. Emaga *et al*. (2007) [15] reported that the ash content in different varieties of banana peels varied from 6.4 to 12.8%.

Fat: The fat content in papaya peel powder was 2.27% and papaya peel paste was 0.01%. Baddi *et al*. (2015) [12] analysed the moisture, protein, fat, crude fiber, carbohydrates and ash of mango peel powder and values were 3.90, 3.80, 2.61, 8.90, 86.40, and 3.29 g/100g sample, respectively and energy of 384 Kcal/100g.

Protein: The protein content of papaya peel powder was 5.31% and papaya peel paste was 1.40%. Romelle *et al.* (2016) [28] analysed eight fruit peels like apple, paw paw, mango, pineapple, banana, grape, mango, orange and reported that the protein content ranged from 2.80 to 18.96 %. The minimum level was found in apple peel and the maximum in pawpaw peels.

Carbohydrates and Energy: The carbohydrate content of papaya peel powder was 64.65 %and papaya peel paste was 9.82 %. The energy content of blanched papaya peel powder was 300 Kcal and blanched papaya peel paste was 43 Kcal/ 100g.The carbohydrate content of mango peel powder (MPP) 80.70% (Ajila, *et al*., 2008) [2]

Table 3: Proximate composition of PPP and PSP

Samples	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Energy (Kcal/ 100g)
PPP	8.04±0.06	7.56±0.01	2.27±0.01	5.31±0.03	64.65±0.24	300±0.10
PSP	87.46±0.47	0.37±0.01	0.01±0.01	1.40±0.01	9.82±0.51	43±0.8
Mean	45.75	3.97	1.14	3.35	37.23	171.5
CD	1.05	0.13	0.05	0.06	0.97	3.12
SE of mean	8.52	0.83	0.24	0.40	4.06	18.83
CV (%)	1.76	2.28	3.0	0.47	1.10	0.74

Note: Values are expressed as mean ± standard deviation of three determinations.
PPP: Papaya peel powder
PSP: Papaya peel paste

Crude and Total dietary fiber (TDF): Crude fiber is the material which remains after vigorous treatment of food with acid and alkaline agents (Mehta and Kaur, 1992) [2].

The crude fiber content in PPP is 12.43 % and PPS is 0.94 %. The dietary fiber content in PPP is 44.66 % and PSP is 2.0 %. Romelle *et al.* (2016) [28] reported the crude fibre content of fruit peels ranged from 11.81 to 26.31%. Rowayshed *et al.,* (2013) [18] reported that crude fiber content pomegranate peel was 11.2%.The crude fiber content of banana peel was 31.70%. The higher fiber content of peel can help in treat constipation, improve the general health and wellbeing (Anhwange *et al.,* 2009) [4].

Mineral content in PPP and PSP: The sodium content of PPP was 3.61 mg/ 100gand PSP was 2.09 mg/100g. The potassium content of PPP was 79.34 mg/100g and PSC was 74.61 mg/100g.Anhwange*et al.* (2009) [4] reported that potassium and sodium content of *Musasapintum*peelwere 78.10 and 19.20 mg/100g respectively. The appreciably high content of potassium signifies that if the peel is taken, it can regulate the body fluids and maintain normal blood pressure. It acts as a buffer in controlling kidney failure, heart oddities and respiratory flaw.

β-carotene content in PPP and PSP: Carotenoids are a diverse group of yellow–orange pigments found in many biological systems acting as accessory pigments in photosynthesis, immune-enhancement and reduce of the risk of development of degenerative diseases like cancers, cardiovascular diseases, cataract and macular degeneration (Krinsky and Johnson, 2005) [21].

In this study the β-carotene content of papaya peel powder was 15.46 and papaya peel paste was 2.06 µg/100 g. Yan *et al*. (2016) [32] reported the total carotene content of banana peel was 1.86 µg/g. Ripened banana peel contained 0.84 µg/g of β-carotene were extracted from ripening stage with a solvent combination solvents.

Conclusion

The composition of papaya peel showed that it is a good source of protein, fiber, minerals and β-carotene contents. The WAI of PPP was high due to high fiber content and fiber tends to retain more water due to hydrophilic property of proteins.

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