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Physicochemical properties of raw and ripe papaya (*Carica papaya* L.) peel powder

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Abstract
India is the world's top producer of papaya, which results in a large production of the fruit's waste products, such as peels and seeds. The goal of the current study was to assess the physicochemical characteristics of powdered raw and ripe papaya peel. The parameters investigated included water absorption index, water solubility index, dehydration ratio, rehydration ratio, colour, pH, titratable acidity, water absorption capacity and oil absorption capacity. The research findings showed that raw papaya peel powder had significantly higher water absorption index (14.23 mg/g), water solubility index (6.3 mg/g), pH (5.16) and titratable acidity (0.63) than ripe papaya peel powder, while ripe papaya peel powder was having significantly higher oil absorption capacity (1.90 ml/g)), water absorption capacity (4.56 ml/g), dehydration ratio (0.12) and rehydration ratio (0.16), respectively. Based on the findings, it is concluded that papaya peel powder from both raw and ripe papayas have good physicochemical qualities, suggesting that these powders may be used by food processing industries to improve the final quality of the products.

Keywords: Dehydration ratio, papaya peel powder, physicochemical properties, rehydration ratio, water absorption index

1. Introduction

The plant *Carica papaya* Linn, a member of the *Caricaceae* family, is also known as "Papaya" in English, *"Papita"* in Hindi, and *"Erandakarkati"* in Sanskrit. In the world, there are four genera of *caricaceae.* In India, the genus *Carica* Linn. is represented by four species, the most popular and commonly grown of which is *Carica papaya* Linn. Papaya plants grow well in the tropics and can reach up to 10m high. The plant can reach a height of 20 meters and is identified by its soft, typically unbranched, weak stem that produces copious amounts of white latex and is packed by a terminal cluster of enormous, long-stemmed leaves (Yogiraj *et al*., 2014) [23]. A 45 cm-deep, rich sandy loam soil or a medium black soil without standing water is best for papaya growth. If they are sufficiently fertilized, light soils with a pH range of 6.5-7 are excellent for papaya. Despite being a tropical crop, papaya thrives in a moderate tropical climate. It thrives from sea level to a height of 1,000 meters. Fruits are sweeter when they are in a dry atmosphere as they are maturing. Between 25 and 30 °C is the ideal temperature for producing papaya. (National Horticulture Board, 2010) [8]. According to FAO (2020) [4], India ranked first in the production of papaya with the total harvested area of 142,000 ha and production of 6,011,000 tonnes. Andhra Pradesh, Gujarat and Karnataka are the top papaya producing states of India with 28.19%, 20.99% and 9.92% share, respectively (National Horticulture Board, 2019) [9].

Papaya has the largest production and productivity in India but due to its perishable nature, a major portion of the production goes waste, which is around 40-60% of the total production in different papaya growing regions (Prasad and Paul, 2021) [18]. Fruit processing industry produces a large amount of waste products such as peels and seeds, the disposal of which is compounded by legal restrictions (Djilas *et al*. 2009) [5]. These by-products are a great source of sugars, minerals, organic acids, fiber, and phenolic compounds which have a wide range of pharmacological activities (Koubala *et al.*, 2014) [11].

Physicochemical properties are the intrinsic physical, functional and chemical properties of a substance or food which are mainly responsible for the final quality of the product. These properties explain how foods work in a system, either as a processing aid or as a direct contributor to product features, and they play a vital influence in the cooking and processing characteristics (Oyebode *et al*., 2007) [15].

A lot of research has been conducted on the papaya fruit, but scanty information is available on the physicochemical properties of its waste products i.e. peels. As a result, the current study was carried out to examine the physicochemical characteristics of powdered raw and ripe papaya peels.

2. Materials and Methods

2.1 Procurement of raw material

The current study was carried out at Pantnagar, Uttarakhand's G. B. Pant University of Agriculture and Technology's College of Home Science's Department of Food Science and Nutrition, w.e.f. July 2021-June 2022. Both raw and ripe papaya fruits were procured from Chadha farm, Kaladhungi, Nainital. Papaya was collected in two different stages for the study i.e. Raw (50-60 days after flowering) and ripe (155-165 days after flowering).

2.2 Development of raw and ripe papaya peel powder

From papaya, two powders were produced: raw and ripe papaya peel powder. For making powder, papayas were peeled manually using peeler and cut in small pieces. Peel pieces were oven dried at 60±3 °C till completely dry followed by grinding. Both raw and ripe papaya peel powders were stored in air tight container for further analysis (Fig. 1).

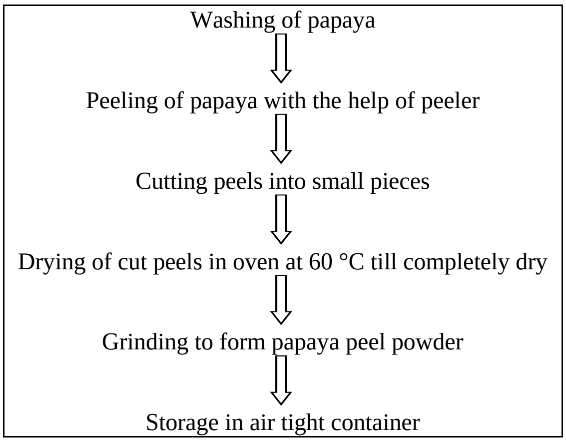

Fig 1: Systematic representation of development of papaya peels powder (PPP)

2.3 Physicochemical properties of raw and ripe papaya peel powder

Both raw and ripe papaya peel powders were analyzed for their physicochemical properties. Water solubility index (WSI) and water absorption index (WAI) were analyzed using the method given by Anderson *et al.* (1969) [1]. Dehydration and rehydration ratio were measured as per the method of Sheshma and Raj (2014) [21]. Pathare *et al.* (2013) [16] method was used to determine the colour of the powders using Munsell color chart. Jackson (1967) [10] method was used to measure the pH and titrable acidity was measured by the method of Ranganna (1986) [19]. Method given by Lin *et al.* (1974) [12] was used to determine the water absorption capacity and oil absorption capacity of raw and ripe papaya peel powders.

2.4 Statistical Analysis

To lessen the variability in the results, each of the tests was performed three times. The statistical analysis of the results was done using the mean and standard deviation. OPSTAT software developed by Sheoron *et al.* (1998) [20] was used for comparing and determining the significance of difference between two means at 5% level of significance (t- test).

3. Results and Discussion

Physical, functional, and chemical characteristics of food known as physicochemical properties reflect the intricate relationships between the components' compositions, molecular conformations, and structural characteristics with the environment in which they are measured and associated (Chandra and Samsher, 2013) [3]. Functional qualities define how components behave during preparation and cooking as well as how they influence the texture, taste, and color of the final products (Manju and Dobhal, 2023) [13]. The data on the physicochemical properties of raw and ripe papaya peel powders is given in Table 1.

The volume that the granule or starch polymer occupies after expanding excessively in water is measured by the water absorption index (WAI). Water solubility index (WSI) gives an indication of the amount of soluble solids present in a dried sample which 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 such as protein, fat and fiber in the raw material (Moura *et al*., 2017) [14]. Water absorption index of raw and ripe papaya peel powder was estimated as 14.23±0.26 and 11.58±0.28 mg/ g, respectively; whereas the water solubility index of raw and ripe papaya peel powder was 6.3±0.24 and 5.3±0.04 mg/ g, respectively. A significantly ($p \leq 0.05$) lower value of WAI and WSI was observed in ripe papaya peel powder.

Table 1: Physicochemical properties of raw and ripe papaya peel powder (PPP)

Properties	Raw PPP*	Ripe PPP*	CD Value (5%)
Water absorption index (mg/ g)	14.23±0.26	11.58±0.28	0.83
Water solubility index (mg/ g)	6.3±0.24	5.3±0.04	0.35
Dehydration ratio	0.10±0.06	0.12±0.04	NS
Rehydration ratio	0.15±0.02	0.16±0.01	NS
Colour	2.5Y6/6	5Y5/4	-
pH	4.7±0.3	5.16±0.03	0.39
Titratable acidity	0.63±0.01	0.5±0.02	0.02
Water absorption capacity (ml/g)	3.43±0.15	4.56±0.11	0.40
Oil absorption capacity (ml/g)	1.86±0.11	1.90±0.10	0.09

*Values are expressed as mean ± standard deviation of three determinations

WAI depends on the protein, gluten and fiber content of the sample hence ripe papaya peel powder may have comparatively higher content of protein, gluten and dietary fiber than raw papaya peel. High gluten content can signify a good binding capacity. Data on WAI and WSI for raw and ripe papaya peel powder is shown in figure 2.

Dehydration ratio is reported as the ratio of sample mass before loading into the drier to the mass of dehydrated products. Dehydration ratio for raw and ripe papaya peel powders was 0.10±0.06 and 0.12±0.04, respectively, which is almost similar to the findings of Pavithra *et al.* (2017) [17]. Rehydration ratio is considered as a measure of the injury to the material caused by drying and treatment preceding dehydration (Sheshma and Raj, 2014) [21]. The rehydration ratio of raw and ripe papaya peel powders was 0.15±0.02 and 0.16±0.01, respectively. A non- significantly ($p \leq 0.05$) higher value of both dehydration and rehydration ratio was observed in case of ripe papaya peel powder.

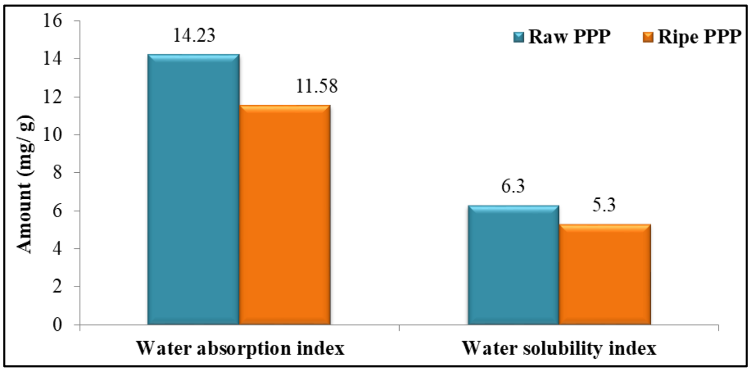

Fig 2: Water absorption index and Water solubility index of raw and ripe Papaya peel powder (PPP)

The readings for the color of raw and ripe sample as measured using Munsell colour chart came out as 2.5Y6/6 and 5Y5/4, respectively. These values signify the Hue, Value and Chroma of the sample which depicted the colour for raw and ripe papaya peel powder to be olive yellow and olive, respectively. Destruction of chlorophyll and formation of carotenoids pigment on ripening might be the possible reason for change in colour.

The pH values of raw papaya peel powder was estimated as 5.16±0.03 which decreased significantly ($p≤0.05$) to 4.7±0.3 with ripening. With ripening most of the organic acids get changed to sugar by the process of respiration, which might be the possible reason for increase in pH on ripening.

Titratable acidity is the measure of the total acid concentration within a food. Total acidity is determined by the presence of organic acid, malic acid and citric acid concentration (Etienne *et. al*., 2013) [7]. A significantly lower ($p≤0.05$) value of titratable acidity was observed in ripe papaya peel powder (0.50±0.20) as compared to raw papaya peel powder (0.63±0.01). Conversion of organic acid to simple sugars on ripening might be the possible explanation for decrease in titratable acidity in ripe papaya peel powder.

Water absorption capacity (WAC) is a trapped water parameter that includes both bound and hydrodynamic water. It impacts the texture, juiciness, and flavor of the products and plays an important role in the food preparation process (Dobhal and Raghuvanshi, 2018) [6]. Water absorption capacity of raw and ripepapaya peel powder in the present study was estimated as 3.43±0.15 and 4.56±0.11 ml/g, respectively, which shows a significantly ($p≤0.05$) higher value in ripe papaya peel powder. The high water absorption capacity of ripe papaya peel powder shows that it has comparatively higher application in making sausage, dough and bakery products. High WAC of ripe papaya peel powder may be desirable in products demanding high viscosity such as soup and gravies. WAC is directly related to the amount of fiber (Tosh and Yada, 2010) [22].

Oil absorption capacity of raw and ripe papaya peel powder in the present research was 1.86±0.11and 1.90±0.10 ml/g, respectively. There was a non- significant ($p≤0.05$) increase in oil absorption capacity with ripening. Flour oil absorption capability may be beneficial in providing connectedness in food, particularly in flavor retention, palatability improvement, and shelf life extension in baked or mashed products where fat absorption is necessary (Aremu *et. al*., 2009) [2]. Water absorption capacity and oil absorption capacity of raw and ripe papaya peel powder is shown in figure 3.

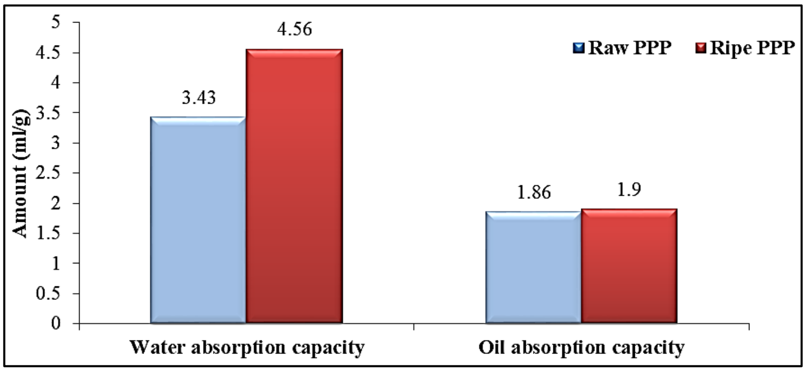

Fig 3: Water absorption capacity and oil absorption capacity of raw and ripe papaya peel powder (PPP)

4. Conclusion

The food processing sector produces a significant amount of waste byproducts. The use of these industrial byproducts may improve food process profitability and ensure long-term food production. The present study was carried out on analysis of physicochemical properties of raw and ripe papaya peel powder. The results showed the high value of water absorption capacity of ripe papaya peel powder which makes it a good additive in product demanding viscosity such as soup, gravies along with various bakery products. The high oil absorption capacity of papaya peel powders can be advantageous in providing connectivity in food, improve flavour retention, and improve shelf life of product. The results of the present study revealed that both raw and ripe papaya peel powder had good physicochemical properties, hence can be used in suitable quantity to enhance the performance of product in terms of texture, colour, taste and over all acceptability.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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