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VALORIZATION OF PAPAYA PEEL WASTE: DEVELOPMENT AND QUALITY CHARACTERIZATION OF FORTIFIED COOKIES AND YOGURT

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ABSTRACT

This study focuses on the formulationof cookies and yoghurt incorporating papaya peel powder (PPP) as a functional ingredient and its quality evaluation. Papaya peel is very beneficial byproduct, it isrich indietary fiber, antioxidants, and bioactive compounds. The papaya peel was processed into powder and is incorporated in different amounts, in order to increase the nutritional profile and the functional properties of the products. The cookies were formulated by incorporating the papaya peel powder at three different levels: 2%, 4% and 10% (PPC1, PPC2, PPC3, respectively) and yoghurt was also enriched with PPP at three different levels: 1%, 2%, 3% (PPY1, PPY2, PPY3, respectively). The papaya peel powder was evaluated to analyze the proximate composition andnutritional properties. The incorporation of PPP imparted distinct color and flavor characteristics, which influenced consumer acceptability. The sensory evaluation revealed that PPC2 has the highest overall acceptability 7.06± 0.64, with 7.2± 1.31 for color, 7.2± 1.54 for appearance, 6.5± 1.17 for texture and 7± 1.63 for taste.In the case of yoghurt, PPY1 has shown the highest overall acceptability 7.76± 0.56, with 8.2± 0.91 for color, 8± 0.47 for appearance,7.5± 0.52 for aroma and 7.4± 0.69 for taste.

INTRODUCTION

Fruits and vegetables are abundant in natural antioxidant, which help neutralizing free radicals in the body [1]. India is leading global cultivator of papaya (Carica papaya L), producing 13.9 million tonnes (mt) year, or 43% of the world's total production, according to a recent papaya production report (2020),it is a fruit from Caricaceae family which is known for its medicinal application in many diseases [2]. Papaya is used in great amount for the production of candy, squash, jam, jellies etc by which these industries generate large amount of papaya peel as a byproduct which is considered as waste and discarded [3].

Because papaya is high in antioxidants, B vitamins, folate, pantothenic acid, potassium, magnesium, and fiber, it can also work as a detoxifier, metabolism booster, body rejuvenator, and aid in maintaining homeostasis [4]. Numerous studies have shown that it has therapeutic traits such as anti-inflammatory, hypoglycemic, anti-fertility, abortifacient, hepatoprotective, wound healing, and recently, its anti-hypertensive and antitumor effects have also been confirmed[5].

Papaya peel's antioxidant capacity and the presence of phytoconstituents including phenols, flavonoids, and tannins in significant concentrations were demonstrated by the different extracts and thus Papaya peel can be utilized as a functional food to prevent and treat illnesses[6].Papaya peel prevents cholesterol from oxidizing since it is high in iron, calcium, and vitamins A, Cand E [7]. The peel has a notably high potassium content. This suggested that consuming papaya peel can support normal blood pressure and fluid regulation. The peel's vitamin A content aided in the reconstruction and restoration of injured skin [8].

In addition to the high need for adequate nutritional standards, today's society is marked by rising expenses, frequently declining raw material availability, and widespread environmental pollution concerns. As a result, recovery, recycling, and upgrading of waste are given a lot of attention. This is particularly reasonable in the food and food processing sector, where wastes, effluents, residues, and byproducts can be recovered and can be frequently modified into more valuable, useful and practical goods[9].Papaya peel is a rich source of bioactive chemicals that can be fermented to create a variety of value-added products, including dietary fibers, medicines, biomaterials, adsorbents, and biofuels. Incorporating papaya peels into the biorefinery process will undoubtedly increase the peel's perceived value, leading to zero waste pollution [10].

This research's main aim of this research is to formulate yogurt and cookies incorporating papaya peel powder to enhance their nutritional quality and functional properties.It also investigates the acceptability of the products based on the sensory analysis of papaya peel powder-based food formulations for consumers.

2. Material and methods:

Raw materials: Fresh papaya peels were obtained from ripe *Carica papaya L.* fruits sourced from a local market. The fruits were thoroughly washed under running water to remove dust, dirt, and any residues. Only fully ripe fruits were used, as overripe or underripe fruits could affect the quality of the peel. Figure 1 and figure 2, represents ripe papaya peel and papaya peel powder respectively.

Figure 1: Papaya peel

Figure 2. Papaya peel powder

Figure 3.Dried papaya peel

Papaya peels had crucial levels of proteins, crude fiber, carbohydrates, ash, and fat. mineral analysis revealed that papaya peels were particularly high in phosphorus and potassium. The phytochemical composition indicated a significant concentration of tannins, flavonoids, and total phenolics. Papaya peel methanolic extracts shown strong DPPH radical scavenging properties [11].

Preparation of papaya peel powder:

The Papaya peels were first rinsed with cold water to remove any remaining pulp or dirt from papaya packing. The peels were then peeled thinly using sharp knife but it is preferable to use vegetable peeler to get a standard thickness.The peels were washed and carefully arranged on a tray and dried at 60°C for 24 hours in a tray dryer [12]. The drying time varied based on humidity levels and thickness of the peel.they were then dried and pulverized. when they became fully dry and brittle,they were grinded into fine powder and sieved [13].The resultant papaya peel powder (PPP) was kept in an analytically airtight container and placed in a cool dry area to minimize bulk moisture adsorption and retain its nutritional and functional properties until next time of usage.

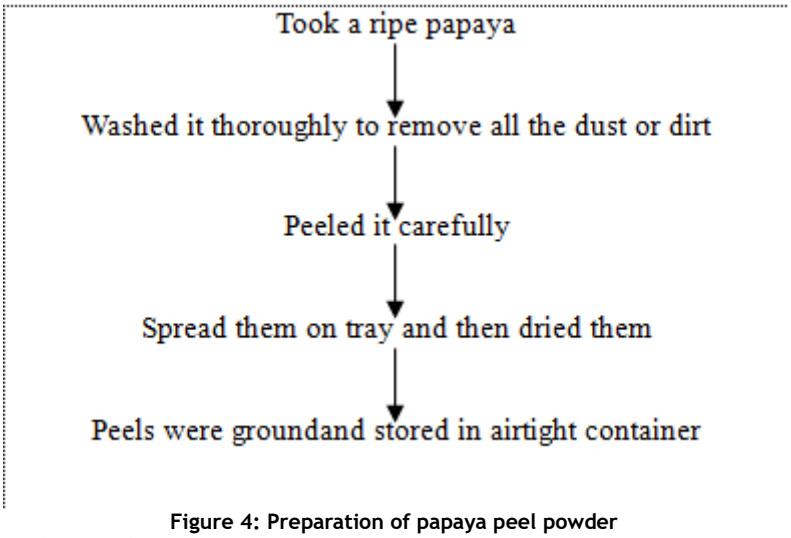

Figure 4: Preparation of papaya peel powder

Formulation of papaya peelpowder-based cookies:

A standard cookies formulation was prepared using all-purpose flour. The ingredients included 120g of all-purposeflour, 40 g of icing sugar, 80 g of butter, 25 mL of milk, 2-3 drops of vanilla essence.Papaya peel powder (PPP) was incorporated into cookies formulations by adding papaya peel powder at three different levels: 2%, 4% and 10%. For example, in the 2% addition formulation, 1g of PPPis added in 50g of dough. The dough was divided into 3 portions, 50gm each and then papaya peel powder is added in 3 different quantities i.e. 1g, 2g and 5g. The cookies were made of these three different portions.To make the cookie dough, ingredients were weighed accurately according to each formulation. Sugar and butter were creamed together until light and fluffy. After this, the dry ingredient i.e.all-purpose flour was added and mixed properly to the creamed mixture. Then the milk and vanilla extract were gradually added and mixed well. The dough was mixed until uniform in consistency. After the dough was formed, it was divided into equal parts (50gm each) and then papaya peel powder was added in different quantities (1g, 2g, 5g) in each part. The dough was rolled into small balls and flattened to form cookies of different shapes. The cookies were then placed on a baking tray lined with parchment paper. They were baked at 180°C for 15 minutes in a preheated oven. After baking, the cookies were allowed to cool at room temperature and were stored in airtight containers until further analysis.

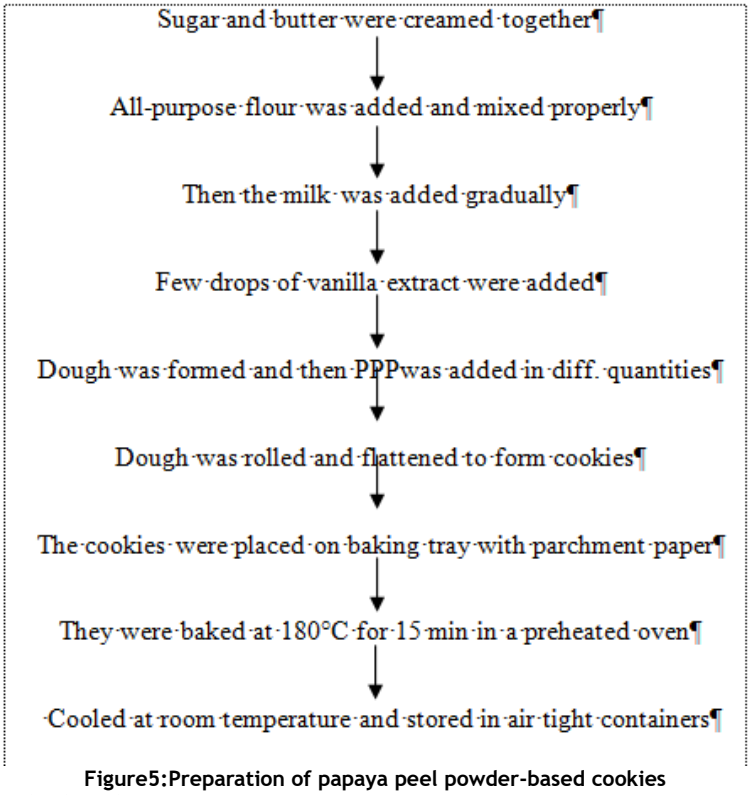

Figure5:Preparation of papaya peel powder-based cookies

Formulation of papaya peel powder-based yogurt

About 500g of normal curd was brought from a local market. A laboratory investigation revealed that peptides extracted from digested curd (digested with pepsin, trypsin, and carboxypeptidase-A at optimal temperature and pH) exhibit ACE (angiotensin converting enzyme) inhibitory properties, suggesting that curd could serve as a functional food to help prevent hypertension [14]. A control yoghurtwas made by hanging the curd for 30 minutes in a muslin cloth.Papaya peel powder (PPP) was added into the yoghurtformulation at three levels: 1%, 2%, and 3%. For example: 1g of papaya peel powder was added in 100g of yoghurt. The 500g of curd was hung for about 30 minutes and then it was placed in 3 different bowls containing 100g each. After this, papaya peel powder was added in three different amounts i.e. 1g, 2g and 3g in different bowls and mixed properly. After thoroughly mixing the PPP and the hung curd, the mixture was poured into sterile containers. The yoghurtsamples were stored for further quality evaluation.

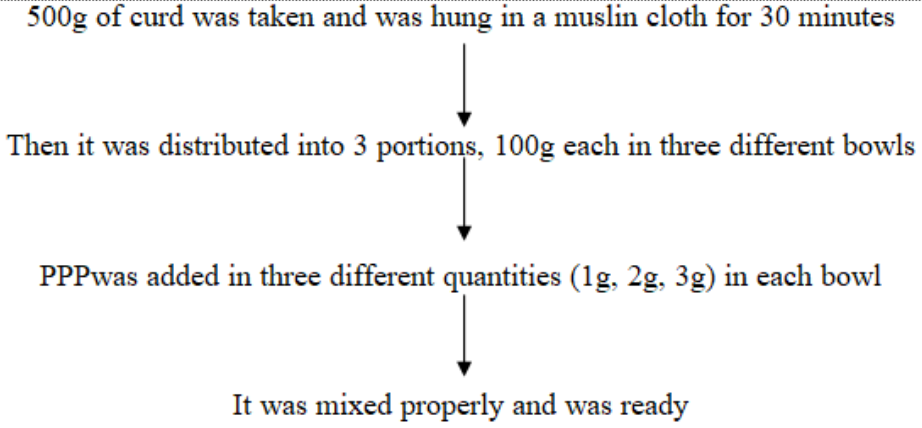

Figure6: Preparation of papaya peel powder-based yoghurt

Nutritional and proximate composition of papaya peel powder: The nutritional and proximate composition of papaya peel powder, including its moisture, protein, fat, fiber, ash, and carbohydrate content, was referenced from previously published studies.

Table 1: Average values of the proximate composition of papaya peel powder

S.no.	Proximate & Nutritional Composition (%)	Papaya peel powder
1.	Moisture	8.04±0.06
2.	Ash content	7.56±0.01
3.	Protein	5.31±0.03

4.	Fat	2.27±0.01
5.	Total carbohydrate	64.65±0.24
6.	Total dietary fiber	44.66
7.	Crude fiber	12.43
8.	Energy (kcal/100g)	300±0.10
9.	Antioxidant content (mg/100gm GA equivalent)	514.6
10.	Total phenolic	2.65±0.10
11.	Sodium (mg/100gm)	3.61
12.	Potassium (mg/100gm)	79.34
13.	Vitamin A (IU/Kg)	1795.00±211.54

According to (Pavithra*et al,* 2017), the proximate composition of papaya peel powder includes 8.04±0.06% moisture, 7.56±0.01% ash content, 5.31±0.03% protein,64.65±0.24% Total carbohydrates, 44.66% Total dietary fiber, 12.43% crude fiber and300±0.10 Energy [15]. Because papaya peel flour has a low moisture content and is resistant to mold growth, it can be readily stored for an extended amount of time [16].

Also, (Pavithra *et al,* 2017), mentioned in their study the amount of Sodium and Potassium (mg/100gm) present in powder peel powder, i.e. 3.61 mg/100gm and 79.34 mg/100gm, respectively and the fat content present was 2.27±0.01. However, the unripe Carica papaya peel had a much higher crude fat value (22.30%), suggesting that it is a rich source of oil and higher fatty acids and might potentially replace vegetable or palm oil in poultry diet [17].

Another study, reported that the antioxidant content of papaya peel powder is 514.6 mg/100gm GA equivalent [18] and (GFF Joy *et al,* 2022), stated that the total phenolic content is 2.65±0.10 [19]

Similarly, (Akintunde*et al,* 2022) reported that papaya peel powder contains1795.00±211.54 IU/Kg Vitamin A. These values indicate that papaya peel powder can serve as a functional ingredient in food formulations.

Sensory evaluation of papaya peel powder-based cookies and yoghurt of different formulations

Sensory properties of cookies and yoghurt with variants of PPP was carried out by a panel of semi trained judges (n=10). The 9-point hedonic scale was utilized to assess the various parameters of the premixes. Various criteria for assessment include color, texture, appearance, smell, flavor, and general approval. Assessors rate their opinions on a scale from 1 to 9, where 1 indicates very poor and 9 signifies exceptionally high quality. 9-Like Extremely, 8-Like Very Much, 7-Like Moderately, 6-Like a Little, 5-Neither Like nor Dislike, 4-Dislike a Little, 3-Dislike Moderately, 2-Dislike Very Much, 1-Dislike Extremely [20]. The overall acceptance was determined by averaging the scores assigned by each person across all attributes.

Cookies Sensory Evaluation: Cookies samples were formulated with different substitution levels of PPP (2%, 4% and 10%) and the control cookies (100%all-purpose flour) was used as a reference. Each cookies sample was served to the panelists on white plates coded with experimental 1, 2 and 3. The sensory attributes evaluated for cookies included appearance, aroma, taste, texture, overall acceptability etc.

YoghurtSensory Evaluation: Yoghurtsamples were prepared with different PPP levels (1%, 2%, and 3%) and evaluated alongside a control yoghurt(without PPP). The yoghurtsamples were presented to the panelists in 30 mL servings in small plastic cups coded with experimental 1, 2 and 3. Panelists evaluated the following sensory attributes like color, appearance, texture, flavor, consistency, overall acceptability.

Results And Discussions

Sensory evaluation of papaya peel powder-based cookies:

Color: The Table 2, shows the results of sensory evaluation of PPP based cookies. In cookies, the appearance was affected as the color of the cookies became a little darker, when the amount of papaya peel powder was increased. The PPC3 which contains 10% of papaya peel powder had a little darker color. However, the variation in color wasn't very huge.

The overall acceptability, on the basis of color was 7.2± 1.31 in PPC2 (containing 4% PPP), which was the highest. PPC3 also showed good overall acceptability, on the basis of color. (Pavithra *et al,* 2018) had shown in their study that the highest rating for colour, taste, chewability and taste was for 15% PSP (papaya peel paste) incorporated chapathi [21]. The figure 7, shows the colour differences of different cookie formulations.

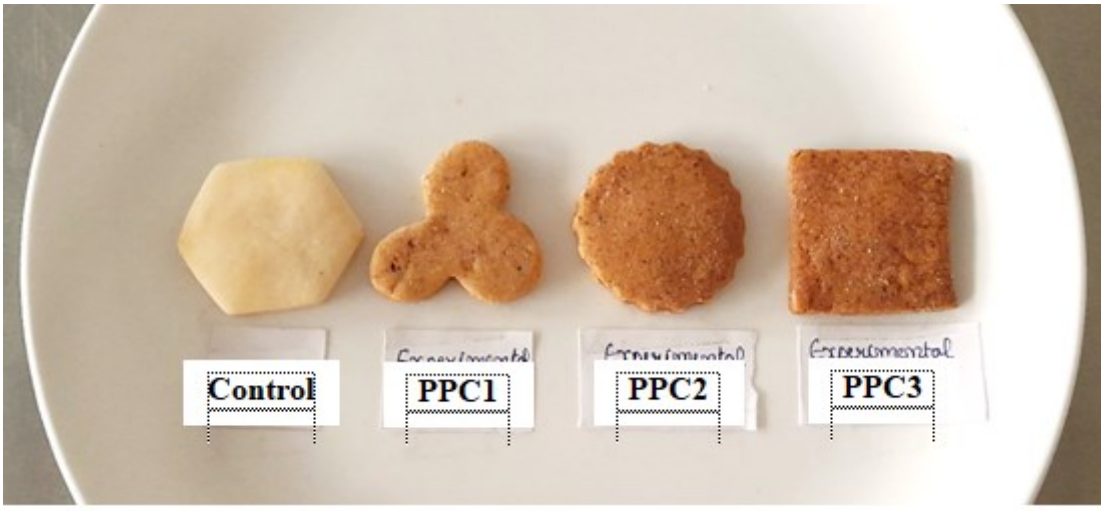

Figure 7: Color differences of different cookie formulations

Aroma and Taste:were also affected, as the aroma was stronger in the cookies containing the high levels of papaya peel powder. The overall acceptability was again higher, on the basis of aroma and taste in PPC2. The cookies with 10% of papaya peel powder (PPC3) had a mild bitterness in them, which in turn reduced the overall acceptability of those cookies. According to, (AB mate *et al*, 2021), the best blended cookies were made with 30 g of papaya peel powder and 970 g of maida, and their chemical composition remained very steady over storage [22].

Texture: Texture-wise, cookies with higher PPP levels were firmer due to the increased fiber content. The overall acceptability, on the basis of texture was more in PPC1 (containing 2% of PPP), as compared to others.

Overall Acceptability: The overall acceptability was highest in the PPC2 i.e. 7.06± 0.64, which means they were the most liked cookies, on the basis of color, appearance, aroma and taste. PPC1 also showed the overall acceptability of 6.71± 0.77, which was better as compared to PPC3 cookies. According to (Bokaria*et al*, 2016), the results of the sensory evaluation showed that the cookies made with wheat flour and papaya peel flour (95:5) had a higher overall acceptability of 7.6 compared to other formulations, such as 90:10 and 92.5:7.5, which had respective acceptability's of 6.8 and 6.4.

Table 2: Sensory evaluation of papaya peel powder-based cookies

Sample	Color	Texture	Appearance	Aroma	Taste	Overall Acceptability
Control	4.9± 2.51	6.4± 2.11	6.2± 2.34	6.5± 1.26	6.5± 1.26	6.1± 1.13
PPC1	6.7± 2.00	6.8± 1.68	7.1± 1.44	6.5± 1.77	6.45± 2.16	6.71± 0.77
PPC2	7.2± 1.31	6.5± 1.17	7.2± 1.54	7.4± 1.26	7± 1.63	7.06± 0.64
PPC3	7± 1.76	6.6± 1.50	6.9± 1.66	6.4± 1.34	5.7± 1.33	6.52± 0.74

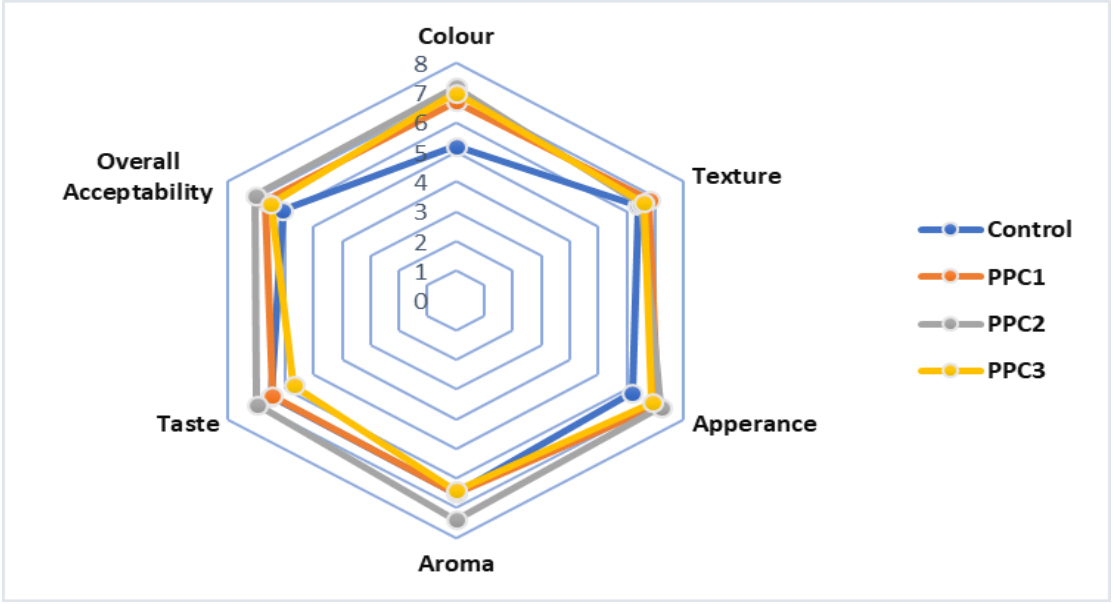

Figure 8: Papaya peel powder-based cookies sensory evaluation

Sensory evaluation of papaya peelpowder-basedyoghurt:

Color: In yogurt, the color differences can be seen, when the amount of PPP was increased. The PPY1 (containing 1% PPP) has shown the highest overall acceptability 8.2± 0.91, on the basis of color. PPY2 has also shown good results with ascore of 7.2± 0.91, as compared to PPY3 with an average score of 6± 1.33. (Manzoor *et al*, 2019), in their study stated that the addition of powder also had a substantial (P<0.05) impact on color characteristics, with fortified samples showing more yellowish (higher b* value) and darker (lower L* value) colors than the control sample [23]. The figure 9, shows the color differences in papaya peel powder-based yoghurt.

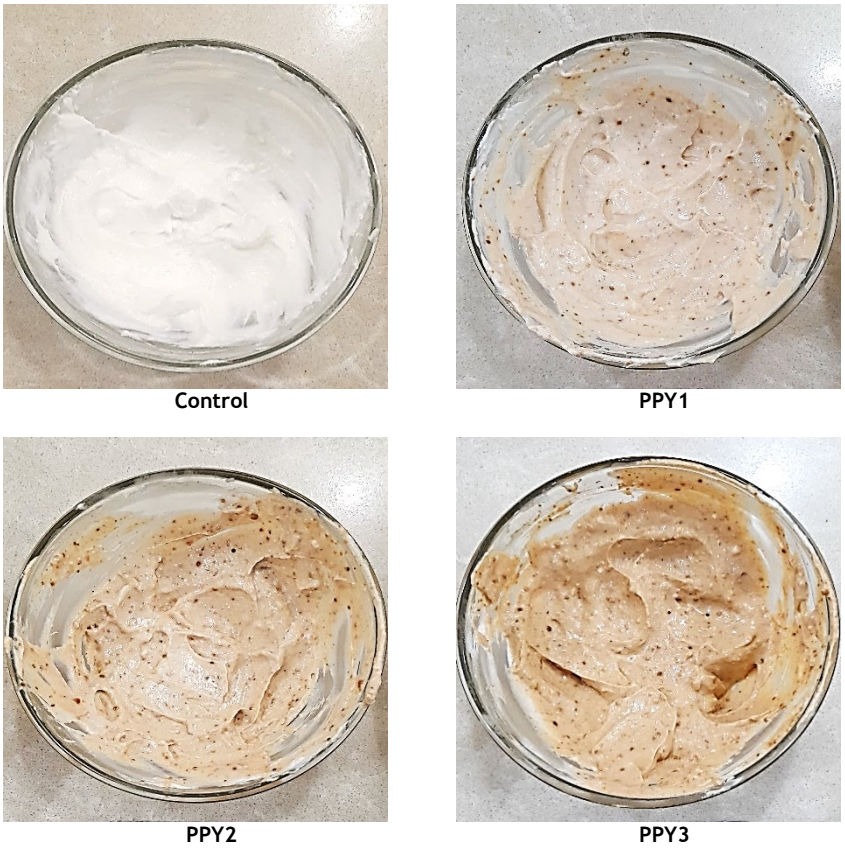

Figure 9: Color differences of papaya peel powder-based yoghurts

Aroma and Taste: The aroma and taste were more liked at lower PPP levels (1% and 2%). However, the yoghurt with high PPP level (3%) has shown a mild bitterness, due to which the overall acceptability was reduced. PPY1 and PPY2 scored 7.4± 0.69 and 6.5± 0.84 in taste and 7.5± 0.52 and 6.9± 0.87 in aroma, respectively. The score was much better in comparison with PPY3.

Texture:PPY1 has scored in texture, 7.7± 0.82. However, PPY3 has shown less overall acceptability, on the basis of texture because of its fibrous texture. Thus, it is less liked by the judges. According to, (Cao *et al*, 2024), because of its firm and smooth texture and subtle mango-sweet flavor, Treatment 2, which was fortified with mango powder, received the highest overall approval score [24].

Overall Acceptability: The overall acceptability of PPY1 was the highest 7.76± 0.56, which means it is the most liked one. PPY2 has also shown an overall acceptability of 6.94± 0.74. So, PPY1 and PPY2were positively received, with the panel appreciating the thicker texture and slight enhancement in flavor. However, PPY3 scored 5.84± 0.78, which makes it the least liked one, amongst the three. The table 3, shows the results of sensory evaluation of papaya peel powder-based yoghurt.

Table 3: Sensory evaluation of papaya peel powder-based yoghurt

Sample	Color	Texture	Appearance	Aroma	Taste	Overall Acceptability
Control	7.8± 0.63	7.4± 1.07	7.5±1.08	6.7± 0.48	7.2± 0.78	7.32± 0.63
PPY1	8.2± 0.91	7.7± 0.82	8± 0.47	7.5± 0.52	7.4± 0.69	7.76± 0.56
PPY2	7.2± 0.91	6.6± 0.96	7.5± 0.84	6.9± 0.87	6.5± 0.84	6.94± 0.74
PPY3	6± 1.33	5.5± 1.26	6.8± 1.03	5.7± 1.15	5.2± 1.31	5.84± 0.78

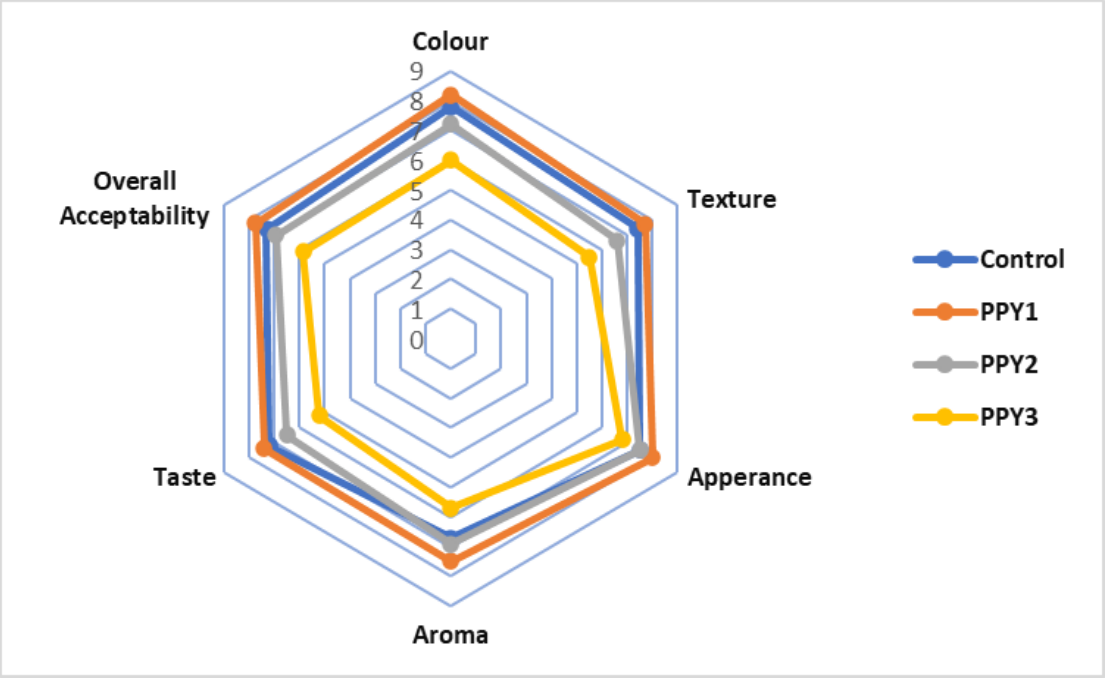

Figure 10: Papaya peel powder-based yoghurt sensory evaluation

CONCLUSION

The incorporation of papaya peel powder (PPP) into cookies and yoghurtformulations demonstrated its potential as a functional food ingredient, offering significant nutritional and health benefits. In both cookies and yogurt, PPP increased the amount of dietary fiber, total phenolic content, and antioxidant activity, which helped create healthier food products. The cookies formulated with PPP showed increased fiber content and antioxidant capacity, while the yoghurtexhibited improved viscosity, with enhanced functional properties.This study confirms that papaya peel, often considered a waste byproduct, can be repurposed into a valuable ingredient for functional foods, contributing to sustainable food production and addressing nutritional deficiencies.

REFERENCES

- John, Jenny A., and Fereidoon Shahidi. "Phenolic compounds and antioxidant activity of Brazil nut (Bertholletia excelsa)." *Journal of functional foods* 2.3 (2010): 196-209.
- Mello, Vanessa J., et al. "The gastric ulcer protective and healing role of cysteine proteinases from Caricacandamarcensis." *Phytomedicine* 15.4 (2008): 237-244.
- Pathak, Pranav D., Sachin A. Mandavgane, and Bhaskar D. Kulkarni. "Waste to wealth: a case study of papaya peel." *Waste and Biomass Valorization* 10 (2019): 1755-1766.
- Ali, Amanat, et al. "Nutritional and medicinal value of papaya (Carica papaya L.)." *Natural products and bioactive compounds in disease prevention* (2011): 34-42.
- Dutta, Upma. "Antimicrobial and antioxidant properties of peel and seed extract of Carica papaya L.: Antimicrobial and antioxidant potential of papaya." *Indian Journal of Experimental Biology (IJEB)* 62.08 (2024): 660-669.
- Lydia, Esther, et al. "Investigation on the phytochemicals present in the fruit peel of Carica papaya and evaluation of its antioxidant properties." *Int J Health Allied Sci* 5 (2016): 247-52.
- Sharma, Ashutosh, et al. "Phytochemistry, pharmacological activities, nanoparticle fabrication, commercial products and waste utilization of Carica papaya L.: A comprehensive review." *Current Research in Biotechnology* 2 (2020): 145-160.
- Joy, Gbenga-FabusiwaFunmilayo, et al. "Waste-to-wealth; nutritional potential of five selected fruit peels and their health benefits: A review." *African Journal of Food Science* 16.7 (2022): 172-183.
- Abul-Fadl, M. M. "Nutritional and chemical evaluation of white cauliflower by-products flour and the effect of its addition on beef sausage quality." *Journal of Applied Sciences Research* 8.2 (2012): 693-704.
- Castro-Vargas, Henry I., et al. "Valorization of papaya (Carica papaya L.) agroindustrial waste through the recovery of phenolic antioxidants by supercritical fluid extraction." *Journal of food science and technology* 56 (2019): 3055-3066.
- Martial-Didier, AdingraKouassi, et al. "Phytochemical properties and proximate composition of papaya (Carica papaya L. var solo 8) peels." *Turkish Journal of Agriculture-Food Science and Technology* 5.6 (2017): 676-680.
- Bokaria, Kanta, and Subhajit Ray. "Development of papaya peelpowderbased cookies and evaluation of its quality." *Development* 3.12 (2016): 6393-6396.
- Pavithra, C. S., et al. "Development and evaluation of papaya peel powder and paste incorporated chapathis." *Journal of Pharmaceutical Research International* 24.1 (2018): 1-5.
- Dabarera, MelaniChathurika, Lohini V. Athiththan, and Rasika P. Perera. "Antihypertensive peptides from curd." *AYU (An International Quarterly Journal of Research in Ayurveda)* 36.2 (2015): 214-219.
- Pavithra, C. S., et al. "Nutritional properties of papaya peel." *The Pharma Innovation Journal* 6.7 (2017): 170-173.
- Werthera J, Saengera M, Hartgea E.-U, Ogadab T, Siagib Z. 2000. Combustion of agricultural residues. Prog Energy Combust Sci, 26: 1–27
- Akintunde, AdeyinkaOye, et al. "Evaluation of the nutritive values of Carica papaya fruit peels as a potential ingredient in livestock nutrition." (2022): 104-113.
- Bokaria, Kanta, and Subhajit Ray. "Development of papaya peelpowderbased cookies and evaluation of its quality." *Development* 3.12 (2016): 6393-6396.
- Joy, Gbenga-FabusiwaFunmilayo, et al. "Waste-to-wealth; nutritional potential of five selected fruit peels

and their health benefits: A review." *African Journal of Food Science* 16.7 (2022): 172-183.

- Wichchukit, Sukanya, and Michael O'Mahony. "The 9-point hedonic scale and hedonic ranking in food science: some reappraisals and alternatives." *Journal of the Science of Food and Agriculture* 95.11 (2015): 2167-2178.
- Pavithra, C. S., et al. "Development and evaluation of papaya peel powder and paste incorporated chapathis." *Journal of Pharmaceutical Research International* 24.1 (2018): 1-5.
- Mate, A. B., et al. "Studies on utilization of papaya peel powder in the preparation of cookies." (2021).
- Manzoor, Sama, et al. "Quality Characteristics and Sensory Profile of Stirred YoghurtEnriched with Papaya Peel Powder." *Pertanika Journal of Tropical Agricultural Science* 42.2 (2019).
- Cao, Yukun, Yuanxin Fang, and Sharareh Hekmat. "Impact of fruit powders incorporation on probiotic viability and sensory properties of yogurt." *Nutrition & Food Science* (2024).