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Optimizing Local Balinese Salacca Waste from Religious Ceremonies and Pitaya Peel into Innovative and Commercial Functional Food Products

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***Abstract*— Food waste is still the focus of intensive discussion of the global environmental issue. The largest sources of food waste in Bali come from households and traditional ceremonies, which often use local fruits such as dragon fruit and Balinese salacca that are frequently left unused and discarded. This study aims to develop and evaluate fruit leather made from Balinese salacca fruit combined with pitaya peel puree as an innovative and sustainable product. The design used in this study was a Randomized Group Design (RGD) with five treatment levels, containing 10–50% pitaya peel puree. The parameters observed were sensory characteristics, and the best treatment was followed by moisture content, antioxidant activity, total phenolic content, vitamin C, and total sugar. The results showed that fruit leather containing 40% pitaya peel puree achieved the highest overall acceptance. This formulation exhibited a moisture content of 11.74%, antioxidant activity of 50.07%, total phenolic content of 10.78 mg GAE/g, vitamin C content of 4.02 mg AAE/g, and total sugar of 50.39%, meeting the Indonesian National Standard for dried sweet products. The high antioxidant activity is attributed to the presence of phenolic compounds and vitamin C derived from both raw materials. Overall, salacca-pitaya peel fruit leather demonstrates strong potential as a local functional food that supports food waste valorization, environmental sustainability, and the utilization of local resources.**

Keywords—fruit leather, pitaya peel, Balinese salacca, antioxidant activity, functional food

I. INTRODUCTION

Food waste represents a significant global environmental issue and remains the focus of intensive discussion at various international forums. The growth of population, urbanization, economic development, and rapidly improving living standards can contribute to an increase in food waste production [1]. The issue of food waste management remains a significant challenge for most regions in Asia [2]. According to the 2024 Food Waste Index Report by the United Nations Environment Programme (UNEP), Indonesia produces 14,73 tons of household food waste per year, thereby positioning Indonesia as the leading contributor to household food-waste generation in Southeast Asia [3].

Both domestic and international tourists are attracted to Bali and be the most popular destinations. This makes Bali being one of the provinces with high mobility of population, resulting in higher urbanization rates and the potential for greater food waste. [4] reported, Bali has 3.9 million residents and receives more than 2 million tourists annually, leading to increased waste generation. Additionally, Hindu religious ceremonies, which incorporate various ritual components, also significantly contribute to overall waste production. According to [5], the average waste production from religious ceremonies in Bali is 0.8 kg on normal days and increases threefold on holy days to 2.4 kg/day. Common materials used in Balinese religious ceremonies include local fruits. Two local fruits often used are dragon fruit (pitaya) and Balinese salacca. Pitaya is generally only used for its flesh, and the skin is underutilized, despite its strong potential to be processed into innovative food products.

According to research conducted by [6], pitaya peel in its fresh condition has 140.12 ± 5.76 mg/ml of antioxidant activity and 252 mg of vitamin C per 100 g. Additionally [7] also reported that pitaya peel extract contains 6.118% pectin. Another local fruit chosen for Balinese traditional ceremonies is the salacca fruit, which is generally consumed directly and is not yet widely processed. The cause is that local Balinese salacca fruit has a unique sour taste and crunchy texture. The salacca fruit contains various excellent nutrients, including vitamin C, phenolic compounds, and antioxidants [8]. According to [9] Balinese salacca also has antibacterial properties that are beneficial to health. Based on this explanation, the combination of pitaya peel and Balinese salacca fruit has the potential to be used to develop an innovative product, such as fruit leather.

Fruit leather is a processed sweet product made with fruit as its main ingredient and has considerable potential for commercial development. It is widely consumed in several countries, including Europe, America, and India, but in Indonesia, fruit leather is still relatively rare and not yet commercially produced.

According to [10]fruit leather is made by pureeing fruit and drying it in a food dehydrator until the water content is less than

20%. The distinctive characteristics of fruit leather are its thin sheet-like shape and elastic properties, which prevent cracking when rolled. Based on this study, in addition to the utilization potential uses of pitaya peel and Balinese salacca, research focused on turning waste from local resources into innovative products remains very limited. Previous research has mainly examined the nutritional properties of pitaya peel or salacca fruit separately, while studies exploring their combined utilization in value-added food products are still scarce. Furthermore, research on integrating food waste valorization with local fruit resources in Bali to support sustainable food systems has not been widely reported.

The combination of utilizing pitaya peel puree (as a food waste byproduct) and Balinese salacca as the main ingredients is the novelty of this study. This approach not only enhances the use of local agricultural resources but also helps reduce food waste generated by religious ceremonies in Bali. In addition, incorporating pitaya peel, a natural source of antioxidants and pectin, is expected to improve the functional properties and textural characteristics of the fruit leather product.

II. MATERIALS AND METHODS

A. Materials

The materials included: Balinese salacca fruit and pitaya peel obtained from waste generated during Balinese Hindu religious ceremonies, water (aqua), sugar (Gulaku), and citric acid obtained from UD. Ayu, aquades (Rofa), methanol (Merck), 1,1-diphenyl-2-picrylhydrazyl (DPPH) (Sigma-Aldrich), HCl (Merck), indicator phenolphthalein (PP), reagent Nelson, arsenomolibdate, and filter paper.

The tools used in making fruit leather are blender (Philips), food dehydrator (Getra), digital scale (Shimadzu ATY 224), analytical scale (Pioneer), centrifuge (Corona), dropper pipette, vortex (Thermolyne), spectrophotometer (Genesys 10s UV-Vis), and water bath (Thermology).

This study was conducted between March and May 2025 at the Food Processing and Food Analysis Laboratories. Both facilities are part of the Food Technology Study Program within the Faculty of Agricultural Technology at Udayana University.

B. Fruit Leather Making Process

The production of fruit leather was carried out in several stages, as described by [10], with modifications. This study used a Randomized Group Design with five treatment levels of pitaya peel puree (10%, 20%, 30%, 40%, and 50%), each with three replications, resulting in a total of 15 experimental units. The fruit leather formulation is shown in Table I.

TABLE I. FRUIT LEATHER FORMULATION

Treatment	Composition				
	Balinese salacca (g)	Pitaya peel (g)	Water (ml)	Sugar (g)	Citric Acid
P1	100	10	50	20	0,25
P2	100	20	50	20	0,25
P3	100	30	50	20	0,25
P4	100	40	50	20	0,25
P5	100	50	50	20	0,25

Notes:
P1: Addition of 10% pitaya peel puree
P2: Addition of 20% pitaya peel puree
P3: Addition of 30% pitaya peel puree
P4: Addition of 40% pitaya peel puree
P5: Addition of 50% pitaya peel puree

Pitaya peel puree making process starts with steam blanching the peel at 60 °C for 2 minutes. This blanching process prevents discoloration, inactivates enzymes and microorganisms, and softens the tissue. The blanched pitaya peel is then blended into a puree.

The production of salacca fruit puree begins with peeling and washing the fruit, then blending until a smooth puree forms. The pitaya peel puree and salacca fruit puree are then mixed according to the designated formulation. Subsequently, 20 g of granulated sugar and 0.25 g of citric acid are added, and the mixture is heated at 70–80 °C for 2 minutes with continuous stirring. The mixture is then poured onto a baking tray lined with baking paper, evenly spread, and dried in a food dehydrator at 65 °C for 8 hours. Then, all fruit leather treatments were tested sensorily by 30 semi-trained panelists. The panelists' assessment of the sensory properties of fruit leather included evaluation of color, aroma, taste, texture, and overall acceptance. After sensory testing, the best treatment was selected, and the sample then proceeded to the chemical analysis stage, which included testing for antioxidant activity, phenols, vitamin C, total sugar, and moisture content.

C. Sensory Evaluation

Testing to determine sensory characteristics involves hedonic testing, also referred to as preference testing, as described by [11]. Hedonic testing aims to measure how much panelists like the various parameters being tested, including color, aroma, taste, texture, and overall acceptance. A total of 30 semi-trained panelists, from food technology students at Udayana University and had taken the Sensory Evaluation course, conducted sensory characteristic testing of fruit leather. In the test, panelists were asked to evaluate their liking for Balinese salacca fruit leather with added pitaya peel, using a 1-5 hedonic scale (1=dislike; 2= slightly dislike; 3=neutral; 4=slightly like; 5= like). The panelists received five fruit leather samples, each representing a different treatment variation, with varying numbers during testing.

D. Antioxidant Activity

Based on the procedure described by [12], antioxidant activity was evaluated via the DPPH method. The process involved mixing 1 mL of DPPH ethanolic solution with 2 mL of the fruit leather sample in a test tube. After vortexing, the mixture underwent a 30 minutes incubation in a dark environment at room temperature. A spectrophotometer was utilized to measure absorbance at 517 nm, using ethanol as a blank. For comparison, a control was prepared identically to the sample but omitted the fruit leather. The radical scavenging percentage was subsequently determined using the following equation:

$$Antioxidant\ Activity\ (\%) = \frac{control\ absorbance - Sample\ absorbance}{control\ absorbance}\ x\ 100\%$$

E. Total Phenol

The total phenolic content (TPC) was determined using the Folin-Ciocalteu method as described by [13]. Initially, 0.1 g of salacca peel was extracted in 5 mL of 70% ethanol. 0.1 mL aliquot of this extract was combined with 0.3 mL of 70% ethanol and 0.4 mL of Folin–Ciocalteu reagent. Following a 6-minute incubation, 4.2 mL of 5% Na_2CO_3 was introduced. The resulting mixture was vortexed and allowed to react for 90 minutes at room temperature in a dark environment. Absorbance was recorded at 760 nm, with TPC values quantified against a gallic acid standard curve using the following equation:

$$Total\ Phenol (mg\ GAE/g) = \frac{C\ x\ V\ x\ FP}{W}$$

Notes:
C = Sample concentration from linear regression results (mg/L)
V = Sample volume (L)
FP = Dilution factor
W = Weight (g)

F. Vitamin C

Vitamin C content was assessed using a spectrophotometer in accordance with the method of [14], with modifications. The reagent was prepared by dissolving 5.3218 g of sodium phosphate and 2.471 g of ammonium molybdate in 500 mL of 0.6 M sulfuric acid. For the assay, 0.1 g of fruit leather was extracted in 5 mL of citrate–phosphate buffer according to the experimental conditions. A 0.3 mL aliquot of this extract was combined with 3 mL of the reagent solution and incubated in a 95 °C water bath for 90 minutes. Following a 5-minute cooling period in water, absorbance was recorded at 695 nm. Vitamin C levels were expressed as ascorbic acid equivalents (mg AAE/g extract) using the following equation:

$$Total\ Vitamin\ C (mg\ AAE/g) = \frac{C\ x\ V\ x\ FP}{W}$$

Notes:
C = Sample concentration from linear regression results (mg/L)
V = Sample volume (L)
FP = Dilution factor
W = Weight (g)

G. Total Sugar

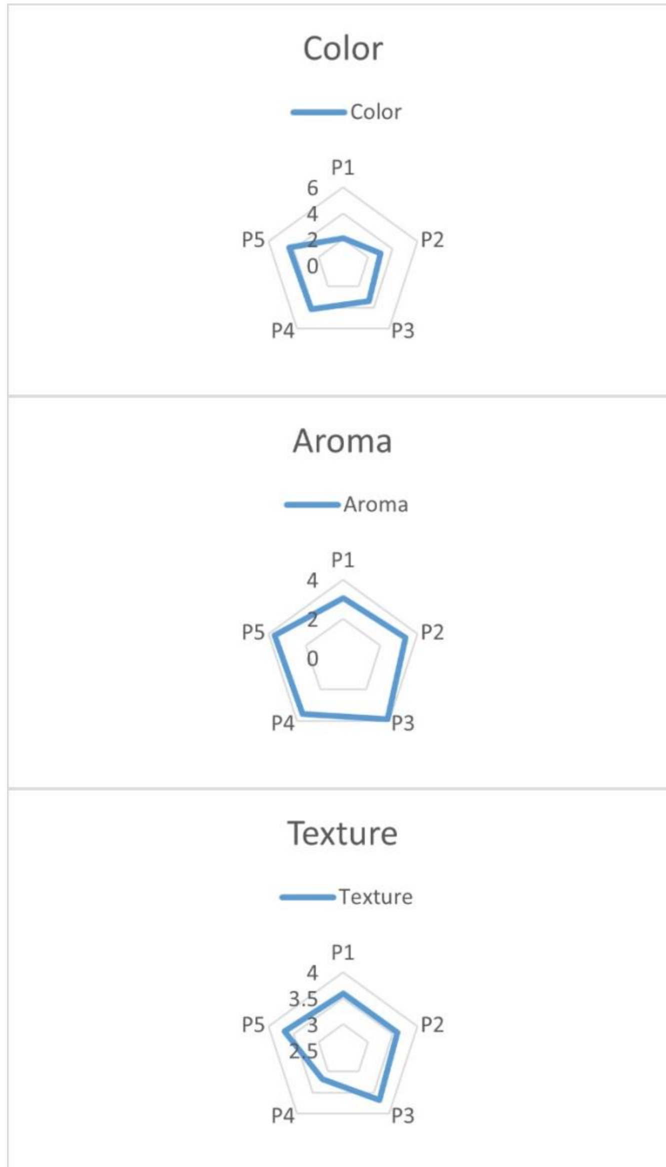
Total sugar was assessed using a spectrophotometer in accordance with the method of [15]. A total of 0.2 g of the sample was weighed and transferred into a test tube. Hydrolysis was initiated by adding 10 mL of HCl and 25 mL of distilled water, followed by heating in an 80 °C water bath for 2 hours. Once cooled to room temperature, the mixture was treated with three drops of phenolphthalein indicator and neutralized via NaOH titration. The resulting solution was then diluted to 100 mL in a volumetric flask and filtered. A 1 mL aliquot of the filtrate was combined with 1 mL of Nelson reagent and heated for 12 minutes. Finally, 1 mL of arsenomolybdate reagent and 7 mL of distilled water were added, and after a 30 minute incubation, the absorbance was recorded at 540 nm using a UV–Vis spectrophotometer.

H. Statistical Analysis

Statistical analysis of the sensory evaluation data was performed using Analysis of Variance (ANOVA) via Minitab 22. If the treatment showed a significant effect on the variables ($P<0.05$ or $P<0.01$), the analysis was followed by Tukey's Difference Test to determine differences among treatments.

III. RESULT AND DISCUSSION

The sensory characteristics of fruit leather and the further analysis of optimal sensory acceptance are shown in Figure 1 and Table II.



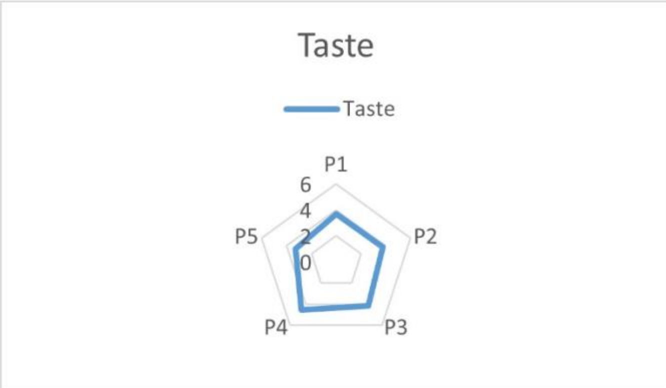


Fig. 1. Sensory Characteristics

Notes: P1 : Addition of 10% pitaya peel puree; P2 : Addition of 20% pitaya peel puree; P3 : Addition of 30% pitaya peel puree; P4 : Addition of 40% pitaya peel puree; P5 : Addition of 50% pitaya peel puree

Table II. Further Analysis of The Optimal Acceptance

Treatment	Moisture Content (%)	Antioxidant (%)	Total Phenollic (mg GAE/g)	Vitamin C (mg AAE/g)	Total Sugar (%)
P4	11.74±0.07	50.07±1.89	10.78±0.10	4.02±0.18	50.39±0.89

A. Sensory Evaluation

Color

The results of the analysis of variance (ANOVA) revealed that an augmentation in the concentration of pitaya peel puree exhibited a substantial impact ($P < 0.05$) on the hedonic evaluation of the color of salacca fruit leather. As presented in Figure 1, the mean hedonic test scores for color ranged from 2.09 (disliked) to 4.36 (slightly liked). The highest score was obtained in treatment P5 (50% pitaya peel puree addition), while the lowest score was obtained in treatment P1 (10% pitaya peel puree addition). This finding suggests that there was an increase in the panelists preferences as the concentration of pitaya peel puree increased. The heightened predilection exhibited by the panelists for the salacca fruit leather in treatment P5 (which involved the incorporation of 50% pitaya peel puree) was attributable to the color produced, which was the most intense when compared to the other treatments. The color produced is influenced by anthocyanin pigments that are naturally present in the peel of the pitaya. Pitaya peel has been shown to contain a higher level of anthocyanins when compared to the fruit flesh, with a recorded content of 45.15 mg per 100 g of the peel [16]. Consequently, an increase in the concentration of added pitaya peel puree results in a more intense color, which can influence the panelists preference for salacca fruit leather.

Aroma

The results of the analysis of variance (ANOVA) test demonstrated that an increase in the concentration of dragon fruit peel puree had a significant effect ($P < 0.05$) on the hedonic evaluation of the aroma of salacca fruit leather. As presented in Figure 1, the mean hedonic test scores for aroma ranged from 3.05 (neutral) to 3.86 (slightly liked). The highest score was obtained in treatment P3, which involved the addition of 30% pitaya peel puree, while the lowest score was obtained in treatment P1, which involved the addition of 10% pitaya peel puree. This finding suggests that there was an increase in panelists preference up to a 30% concentration of pitaya peel puree, however, at higher concentrations, there was a tendency for a decrease in preference. Pitaya peel contains volatile compounds, including aldehydes, esters, alkanes, and ketones, which contribute to the peel's distinctive aroma. The addition of pitaya peel puree to a mixture has been shown to enhance this aroma [17]. Consequently, the panelists acceptance of the salacca fruit leather aroma exhibited a downward trend in treatments that incorporated 40% and 50% pitaya peel puree additions. A similar finding was reported in a study [18], which indicated that the aroma of pitaya fruit peel becomes stronger as the amount of added pitaya fruit peel pulp increases.

Texture

The results of the analysis of variance (ANOVA) test demonstrated that an increase in the concentration of pitaya peel puree had no significant effect ($P > 0.05$) on the hedonic evaluation of the texture of salacca fruit leather. As presented in Figure 1, the mean hedonic test scores for texture ranged from 3.18 (neutral) to 3.68 (slightly liked). This finding suggests that an increase in pitaya peel puree concentration does not affect the texture of salacca fruit leather. Salacca fruit leather is characterized by a firm and chewy texture. The chewiness of the fruit is attributable to the pectin content of the pitaya peel. As indicated in study [19], the peel of the pitaya (Psidium guajava) contains 5.47% pectin. These pectin molecules form a three-dimensional network by binding sugars, water, and dissolved solids, thereby forming a gel [20] (Permatasari et al., 2017). The formation of a gel is an indication of successful fruit leather, which is characterized by a flexible texture, ease of roll-up, and resistance to breakage.

Taste

The results of the analysis of variance (ANOVA) test demonstrated that an increase in the concentration of dragon fruit peel puree had a significant effect ($P < 0.05$) on the hedonic evaluation of the taste of salacca fruit leather. As presented in Figure 1, the mean hedonic taste test scores ranged from 3.27 (neutral) to 4.55 (liked). The highest score was obtained in treatment P4 (40% pitaya peel puree addition), while the lowest score was obtained in treatment P5 (50% pitaya peel puree addition). This finding suggests that there was an increase in panelists preference up to a 40% concentration of pitaya peel puree; however, at higher concentrations, there was a tendency for a decrease in preference. The increase in panelists' preferences, which reached a 40% addition of pitaya peel puree, was attributed to a balanced sweet and sour taste. As stated in [21], the sweetness of pitaya is attributed to its inherent sugar content, which ranges from 7.66 mg per 100 g of edible portion. However, in addition to its sweet taste, the peel of the pitaya (Hylocereus undatus) has been shown to produce a bitter aftertaste due to its high tannin content of 1.628 mg per g of dry weight [22]. Consequently, there was a decline in the panelists preference for the P5 condition (which involved the addition of 50% pitaya peel puree). This decline was attributed to the emergence of a bitter taste after consumption.

Overall Acceptance

The results of the analysis of variance (ANOVA) test demonstrated that an increase in the concentration of pitaya peel puree had no significant effect ($P > 0.05$) on the hedonic evaluation of the overall acceptability of salacca fruit leather. As presented in Figure 1, the mean hedonic test scores for overall acceptability ranged from 3.55 (slightly liked) to 4.14 (slightly liked). This finding suggests that an increase in pitaya peel puree concentration up to 50% is generally acceptable to the panelists.

The optimal salacca fruit leather was produced with the incorporation of 40% pitaya peel puree, as determined by sensory evaluations encompassing color, aroma, texture, taste, and overall acceptability. Subsequently, the fruit leather with this optimal formulation was subjected to a series of analytical tests to ascertain its chemical characteristics, including moisture content, antioxidant activity, phenolic content, vitamin C, and total sugar. The findings of the chemical characteristic tests indicate that the salacca fruit leather that underwent the most optimal treatment exhibited an average moisture content of 11.74%, an antioxidant activity of 50.07%, a phenolic content of 10.78 mg GAE/g, a vitamin C content of 4.02 mg AAE/g, and a total sugar content of 50.39%. The moisture and total sugar content values of the salacca fruit leather met the quality standards established in SNI 01-4443-1998 for dried candies, namely a maximum moisture content of 44% and a minimum total sugar content of 25%. Research on salacca fruit leather has been extensively developed using various types of raw materials.

B. *Moisture Content*

As indicated in Table II, the moisture content of the salacca fruit leather was found to be 11.74%. As stated in [23], the moisture content of fruit leather, a thin sheet-like dried sweet product, ranges from 10% to 20%. This phenomenon can be attributed to the varying moisture content present in the raw materials utilized during the manufacturing process. In this study, the raw materials employed were Balinese salacca fruit and pitaya peel. Salacca is classified as a fruit with a relatively high water content, approximately 78% when fresh [24]. Furthermore, the incorporation of 40% pitaya peel puree exerts a significant impact on the moisture content, attributable to its notably high fiber content. A study by [25]Jamilah et al. (2011) found that red pitaya peel contains a total fiber content of 69.3%, with a soluble dietary fiber content of 14.82%. As indicated by the findings reported in [26], the high moisture content observed in dragon fruit leather is attributable to the high fiber content present in the dragon fruit peel, particularly the insoluble dietary fiber component. This fiber is capable of binding water due to the presence of negatively charged oxygen or nitrogen atoms within the fiber, which can form bonds with the positively charged hydrogen atoms present in water [27]. The findings of this study indicate a lower moisture content in comparison to the results reported in [28]. The latter study documented a moisture content range of 16.66% to 24.70% in red dragon fruit leather.

C. *Antioxidant Activity*

The potential for utilizing local fruits, namely Balinese salacca and pitaya peel waste, can be seen from the antioxidant content percentages shown in Table II. The total antioxidant percentage in the salacca fruit leather product is 50.07%. This phenomenon can be attributed to the high antioxidant content present in pitaya peel, which contributes to an increase in the antioxidant content of the salacca fruit leather. Research conducted by [19] on fruit leather made from jujube (Ziziphus mauritiana) and red pitaya peel yielded an antioxidant activity of 31.80%. A comparable study was conducted by [28] on red pitaya leather using cobia fish skin gelatin (Rachycentron canadum), which yielded an antioxidant activity of 41.21%. The antioxidant activity in salacca fruit leather was found to be higher than in similar studies. The high antioxidant activity observed in salacca fruit leather is influenced by the raw materials utilized, specifically Balinese salacca and pitaya peel. Balinese salacca contains vitamin C and phenolic compounds that can act as antioxidants [7]. Antioxidant activity is strongly influenced by the presence of phenolic compounds, which act as electron donors through hydroxyl groups to neutralize free radicals [29] (Janarny et al., 2023). Furthermore, [8] reported that Balinese salacca possesses antibacterial activity with the potential to provide health benefits. Pitaya peel contains active compounds such as alkaloids, flavonoids, tannins, and steroids, with an antioxidant activity of 46.3% and an anthocyanin content of 77.57 mg/L [30](Amrinola & Sekarningrum 2025). Furthermore, [31] reported that pitaya peel exhibits antioxidant activity of 87.30%. Antioxidant activity has been shown to be directly proportional to total phenolic content, which is attributable to the presence of hydroxyl groups (-OH) that are capable of donating electrons to neutralize ABTS free radicals, thereby stabilizing the radical reaction [32] (Rustan et al., 2025).

D. *Total Phenol*

Furthermore, the total phenolic content of salacca fruit leather was determined to be 10.78 mg GAE/g, which exceeds the levels reported by [33] for kiwi fruit leather, with total phenolic contents ranging from 1.41 to 1.77 mg GAE/g. As stated in [34], the total phenolic content of dragon fruit peel is 11.6 mg GAE/g. This suggests that the total phenolic content of the fruit leather is higher. This phenomenon is attributed to the phenolic compound profile of red-fleshed dragon fruit, which indicates the presence of six compounds namely catechins, vanillin, gallic acid, caffeic acid, chlorogenic acid, and ferulic acid out of the eleven phenolic compounds evaluated. Catechins were identified as the most dominant phenolic compound throughout the developmental stages of the fruit. However, as the fruit ripens, its concentration decreases from 11.92 ± 0.19 mg/100 g fresh material 30 days after anthesis to 8.31 ± 0.12 mg/100 g fresh material 42 days after anthesis [35].

Phenolic compounds are secondary metabolites that are derived from plants and are characterized by the presence of aromatic rings containing hydroxyl groups. Phenolic compounds have been demonstrated to possess antioxidant properties, antibacterial activity, cardioprotective effects, anticancer properties, immune-boosting characteristics, and anti-inflammatory effects [36](Sun & Shahrajabian, 2023). Phenolic compounds have been demonstrated to exhibit higher antioxidant activity in comparison to other groups of compounds. This activity is associated with the presence of a conjugated bond system in the benzene aromatic ring, as well as the number of hydroxyl groups (OH) they possess [37](Sedjati et al., 2018). In their capacity as antioxidants, phenolic compounds have the ability to reduce the amount of ROS (reactive oxygen species) due to their abundance of hydroxyl groups, which are characteristic of polyphenols. These hydroxyl groups (-OH) have been demonstrated to play a role in neutralizing free radicals by breaking the radical reaction chain [38](Mahardani & Yuanita, 2021).

E. Vitamin C

In comparison to the study conducted by [39] on pineapple fruit leather with added apple peel puree, which yielded a vitamin C content of 3.03 mg AAE/g, the vitamin C content in salacca fruit leather is higher. [19] reported that dragon fruit peel contains 8.71 milligrams of vitamin C per 100 grams, resulting in a higher vitamin C content in the fruit leather. Furthermore, the incorporation of citric acid during the fabrication of salacca fruit leather, in conjunction with the composition of each utilized raw material, exerts a substantial influence on the final vitamin C content. A study by [40] reported that fresh salacca fruit from various varieties contains 0.86–1.58 milligrams of ascorbic acid per gram. Furthermore, red dragon fruit is also reported to contain 32.65 milligrams of vitamin C per gram [35]. As stated by [41]Wardana et al. (2025), the high vitamin C content of salacca fruit is attributable to its dense cellular structure, which contains a high phenolic content, thereby protecting the vitamin C within the fruit.

F. Total Sugar

As demonstrated in Table II, the total sugar content of the salacca fruit leather was found to be 50.39%. This phenomenon can be attributed to the incorporation of sucrose during the manufacturing process of the salacca fruit leather. As indicated by the findings of [42], an increase in the quantity of sugar added to a given substance was observed to result in a corresponding increase in the total sugar content of the mixture. Furthermore, pitaya peel, a constituent raw material in the production of salacca fruit leather, exhibits a total sugar content of 11.5% [43]. Another factor influencing the resulting total sugar content is the addition of citric acid during the production process of salacca fruit leather. As reported by [43], the incorporation of citric acid during the fruit leather production process results in a product with a reduced total sugar content. This phenomenon occurs due to the ability of citric acid to catalyze the hydrolysis of sucrose, a process in which sucrose is converted into glucose and fructose, also referred to as reducing sugars.

G. The Potency of Salacca-Pitaya Peel Leather as Local-Functional Food

Salacca fruit leather demonstrates considerable promise in its potential for development as a local functional food, as evidenced by its sensory characteristics, chemical composition, and high sustainability value. The product under consideration contains bioactive compounds, particularly phenolic compounds and vitamin C, which contribute significantly to its antioxidant activity. Phenolic compounds act as natural antioxidants through a hydrogen-donation mechanism, while vitamin C neutralizes oxidative stress through an electron-transfer mechanism, thereby supporting the product's functional health benefits. Sensory and chemical evaluations indicate that the optimal formulation is fruit leather with 40% dragon fruit peel puree added, which meets consumer acceptance criteria for color, aroma, texture, taste, and overall acceptability. This formulation exhibits a low moisture content (11.74%), high antioxidant activity (50.07%), a relatively high phenolic content (10.78 mg GAE/g), vitamin C content (4.02 mg AAE/g), and a total sugar content of 50.39%.

In addition to its functional properties, salacca fruit leather also supports sustainable food system practices through the utilization of pitaya peel. This peel is an underutilized organic waste product generated in large quantities from household consumption and religious activities in Bali. The product's ease of production, broad appeal, and economic viability are evident in a comprehensive production cost analysis that indicates a competitive selling price. The development of salacca fruit leather represents a promising innovation in the field of functional food, integrating the benefits of functional health, environmental sustainability, and economic value. This potential local functional food product merits further development.

IV. CONCLUSIONS

Salacca-pitaya peel fruit leather shows strong potential as a local functional food, given its sensory acceptability, antioxidant, and sustainability value. Phenolic compounds and vitamin C contribute to its antioxidant activity, supporting its functional food characteristics. The optimal formulation containing 40% pitaya peel puree met sensory acceptance criteria and exhibited favorable chemical properties, including low moisture content (11.74%), antioxidant activity of 50.07%, total phenolic content of 10.78 mg GAE/g, vitamin C content of 4.02 mg AAE/g, and total sugar of 50.39%. Its cranberry-red color attributes (L* 34.07; a* 56.73; b* 27.03) resulted in boosted acceptability of the product. Acceptability of pitaya peel as the primary raw material approach supports of organic waste valorization, particularly from household and ceremonial sources in Bali. Combined with a competitive production cost, these findings indicate that salacca-pitaya peel fruit leather is a viable functional food innovation with environmental and economic relevance.

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