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PRODUCTION OF PAPAYA FLAVORED ICE-CREAM WITH PUREE, AND SPRAY-DRIED PAPAYA POWDER

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ABSTRACT

Ice-cream is one of the most consumed dairy products. However, the commercial ice-cream product is low in natural antioxidants, dietary fibers, and minerals. Therefore, highly nutritious papaya can be incorporated into ice-cream. This study aims to produce ice-cream using papaya puree (20-80% w/v) and spray-dried papaya powder (20-80% w/v). The sensory properties (QDA and nine points hedonic scale), and physicochemical and proximate analysis of the ice-cream were performed. From sensory evaluation, ice-cream formulated with 20% (v/v) papaya puree gained the highest rate on overall acceptability and was most preferred among the formulated papaya ice-creams. Meanwhile, ice-cream formulated with 20% (v/v) papaya puree contains 23.53 ± 2.33% moisture, 2.30 ± 0.10% protein, 0.88 ± 0.06% ash, and 3.04 ± 0.81% fat. Therefore, ice-cream formulated with 20% (v/v) papaya puree might be suitable and more accepted by the consumers and may have a potential marketable value.

1.Introduction

Incorporation of fruits, dietary fibers, natural antioxidants into ice-cream to improve nutritional attributes has been one of the interests in recent years (Erkaya *et al.*, 2012). Based on a study conducted by Santana *et al.* (2003), the addition of papaya pulp into ice-cream showed higher averaging corresponding to the terms of the hedonic scale "liked moderately" for all attributes. The study showed that papaya ice-cream was considered as a nutritious dessert and also an excellent alternative to the use of fruit, thus opening new opportunities for a manufactured product of papaya.

However, in Malaysia, papaya ice-cream is not available in the market, although the production quantity of papaya was 50519 tonnes in the year 2018 (FAOSTAT, 2020). Papaya is commonly known for its nutritional values and is rich in antioxidants, vitamins, minerals, and fibers (Krishna *et al.*, 2008). Application of enzyme in juice is common, where it serves to increase extraction yield before processing. The juice yielded will have better color and aroma (Bhat, 2000). Conversion of fruit into powder form can reduce the increased product stability, reduce wastage, and cost from transportation and storage (Chew *et al.*, 2019). Spray drying is usually applied to produce fruit juice powder (Phisut, 2012). The spray-drying method was applied in the production of 'Terung Asam,' papaya, kuini mango, 'cempedak', 'Bintangor' orange, kedondong and pineapple powder (Chang *et al.*, 2020a; Chang *et al.*, 2020b; Loo and Pui, 2020; Pui *et al.*, 2020; Yu and Pui, 2021; Chang *et al.,* 2021; Wong *et al.*, 2015). The powder produced can serve as a functional ingredient or incorporated into food as a colorant or natural flavorings.

Hence, this study aims to incorporate papaya puree and papaya powder into ice-cream. The work includes the production of papaya puree using enzyme treatment and the production of papaya powder using a spray-dryer. Papaya ice-cream that is made of spray-dried papaya powder and papaya puree will be tested using sensory evaluation techniques, including Quantitative Descriptive Analysis (QDA) and Hedonic Test.

2. Materials and methods

2.1. Materials

Fresh "Sekaki" papaya was purchased from local fruits stall in Serdang, Selangor, Malaysia. The ingredients used to make ice-cream include whole milk powder (Brand: Nestlé), whipping cream (Brand: Emborg), egg yolk (Brand: Nutriplus), caster sugar, and salt.

2.2. Preparation of papaya puree and powder

Ripe papaya fruit was rinsed to remove dirt on its surface. The skin of papaya was peeled using a peeler, and the seed was removed using a spoon. The pulp was sliced and cut into smaller pieces with dimensions approximately 5 cm x 4 cm x 3 cm. The cut fruit pulps were subjected to a blender (Warring, USA) and blended at speed 3 for 1 minute until no observable solid form. Then, 200 g of blended papaya was poured into a 250 mL beaker and weighed using an electronic weighing balance (Mettler Toledo, Switzerland).

For the production of papaya puree, 2% (v/w) of enzyme pectinase, Pectinex® Ultra SP-L (Novozymes, Denmark) was added into 200 g of the blended papaya pulp. The mixture was placed into a small water bath at 50 °C and incubated for two hours with shaking at speed 4.5. It was then placed in a hot water bath (Memmert, Germany) at 90 °C for five minutes, followed by ice water for five minutes (Wong et al. 2015).

On the other hand, to produce spray-dried papaya powder, the papaya puree was added with 100 g of maltodextrin (Bronson and Jacobs, Australia) diluted in 500 g of warm filtered water. The concentration of maltodextrin added was 20% (w/v) of water weight, and the ratio of water to puree was 1:1 (Pui et al., 2020). The inlet temperature of the spray-dryer (Büchi, Switzerland) was preset at 160 °C. Compressed air was set to a level of 4 cm with gas spray flow at 600 L/h and a feed flow rate of 6 mL/min. The papaya powder was then collected in the product collection vessel and vacuum packed.

2.3. Preparation of papaya ice-cream

Table 1 shows the respective formulations with the number of ingredients used expressed in the form of a percentage. The mixture was stirred until fully solubilized and then pasteurized in a water bath at 74 °C for 10 minutes with shaking at speed 3. After pasteurization, the mixture was allowed to cool for 10 minutes.

Subsequently, the pasteurized mix was homogenized (Ika, Germany) at speed 13.8min×1000 for 5 minutes, followed by 3.4/min×1000 for 5 minutes. The mix was then cooled and undergone aging in a refrigerator at 4°C overnight. After that, the mix was removed from the refrigerator and poured into an ice-cream maker (Kenwood, Malaysia). Within 15 minutes, the ice-cream was set, and the ice-cream was removed from the ice-cream maker using a plastic spatula into a plastic container and stored in the freezer (Ardo, Belgium) at -18°C.

2.4. Properties of papaya puree and reconstituted powder

2.4.1 Total Soluble Solid (TSS) and pH

The TSS of papaya puree and reconstituted powder were evaluated using a portable Hand Refractometer (B+S, UK) with a scale of 0-32 °Brix (Wong *et al.*, 2015). The pH value of papaya puree and reconstituted powder were evaluated with pH meter (Mettler Toledo, Switzerland).

2.4.2 Color Determination

The color of papaya puree and reconstituted powders were evaluated by a colorimeter (ColorFlez EZ, Hunter Associates Laboratory Inc, USA). Results were expressed in L* (lightness), a* (redness), and b* (yellowness) values (Chang *et al.*, 2020b).

Table 1. Formulations of papaya ice-cream

Formulations	Ingredients in percentage (%) (w/w)							
	Whole milk powder	Sugar	Salt	Egg yolk	Whipping cream	Water	Papaya powder	Papaya puree
F0	7.8	5.9	0.2	7.1	20.2	58.8	-	-
F1	7.8	5.9	0.2	7.1	20.2	58.8	20	-
F2	7.8	5.9	0.2	7.1	20.2	58.8	50	-
F3	7.8	5.9	0.2	7.1	20.2	58.8	80	-
F4	7.8	5.9	0.2	7.1	20.2	58.8	-	20
F5	7.8	5.9	0.2	7.1	20.2	58.8	-	50
F6	7.8	5.9	0.2	7.1	20.2	58.8	-	80

F0 (Control) = ice-cream without addition neither papaya puree nor papaya powder; F1 = ice-cream added with 20% (w/v) of papaya powder; F2 = ice-cream added with 50% (w/v) of papaya powder; F3 = ice-cream added with 80% (w/v) of papaya powder; F4 = ice-cream added with 20% (v/v) of papaya puree; F5 = ice-cream added with 50% (v/v) of papaya puree; F6 = ice-cream added with 80% (v/v) of papaya puree

2.5. Sensory evaluation of papaya ice-cream

8 trained panelists evaluated the ice-cream with Quantitative Descriptive Analysis (QDA). A total of seven samples, including control (ice-cream without papaya puree or powder), were given to panelists one at a time. Three formulations with the best result were used to conduct a hedonic test. The hedonic test was carried out with 100 untrained panelists from UCSI University. A total of four samples, including one commercial ice-cream and three best-formulated ice-creams based on QDA, were used in the testing. The ice cream's appearance, aroma, flavor, texture, and overall acceptability evaluation were evaluated. Participants are encouraged asked to rank their preferences on a nine-point hedonic scale and willingness to purchase the samples to examine the market potential.

2.6. Properties of selected papaya ice-cream

2.6.1. Total Solid Contents

The total solid contents of ice-cream were determined using the AOAC official method 941.08. The ice-cream test portion (2 g) was weighed into a round, flat-bottom porcelain dish with a diameter bigger than 5 cm. It was heated on a steam bath for 3.5 hours at 100 °C, cooled in a desiccator, and weighed. Repeat drying, cooling, and weighing samples until a constant weight was obtained. The percentage of total solid content in papaya ice-cream was expressed as in Equation 1.

$$\text{Total solid content, \%} = (A - B)/C \times 100 \qquad (1)$$

Where:

A = Total weight of porcelain dish, lid, and sample after drying in gram

B = Weight of porcelain dish, and lid in gram

C = Initial weight of sample in gram

2.6.2. Titratable Acidity

The titratable acidity of papaya ice-cream was evaluated using the method described by Pui *et al.* (2018). Ice-cream (9 g) was melted to room temperature and mixed thoroughly in a 100 mL beaker. Then, 18 g of distilled water was weighed and mixed with the melted ice-cream sample. A volume of 0.5 mL of phenolphthalein indicator was added into the beaker followed by titration with 0.1 N sodium hydroxide until a pink color was shown. The titratable acidity of ice-cream was calculated.

2.6.3. Meltdown Test

The meltdown test was performed, according to Goh *et al.* (2006). Ice-cream samples were stored at -18°C overnight before the meltdown test. A hardened ice-cream sample in block shape weight approximately 158 ± 5 g (11 cm x 8 cm x 2 cm) was placed on a metric text sieve suspended over a weighing balance. They were allowed to stand at ambient temperature (20°C ± 2°C). The dripped ice-cream was collected and weighed at every 5 minutes up to 60 minutes. Pictures of the ice-cream were taken every 20 minutes to see the effect on the rate of melting on the deformation of shape (Muse and Hartel, 2004). The time (min) was plotted against the weight of dripped ice-cream (g), and the slope is representing the melting rate.

2.7. Proximate analysis

The moisture content, protein, ash, and fat) of ice-cream added with 20% (v/v) of papaya puree, and control (ice-cream without addition neither papaya puree nor papaya powder) were analyzed according to the method stated in AOAC (2000).

2.8. Statistical Analysis

The analyses were conducted in triplicate. Results obtained from QDA, Hedonic test, and physicochemical analysis were analyzed by One-way ANOVA from statistical analyzing software, SPSS (Statistical Package for the Social Sciences 20). Post-Hoc tests were performed, significantly different at $p \leq 0.05$. Meanwhile, results obtained from the proximate analysis were analyzed with a T-test.

3.Results and discussions

3.1. Properties of papaya puree and reconstituted papaya powder

The reconstitution of spray-dried powder was evaluated to determine the potential of the juice powder in resembling the original juice as close as possible upon reconstitution (Simha *et al.*, 2012). Table 2 shows the properties of papaya puree and reconstituted papaya powder. In terms of pH value, there was no significant difference ($p > 0.05$) between papaya puree and reconstituted papaya powder. This may be explained by no further release or reduction of the carboxylic acids and galacturonic acid content upon spray-drying of papaya puree (Akesowan and Choonhahirun, 2013).

Based on Table 2, reconstituted papaya powder was (14.94 ± 1.09) lighter while showing a decrease in redness and yellowness in as compared to papaya puree (Table 4). This may result from pigment degradation, especially carotenoids, during spray-drying (Fratianni *et al.*, 2010).

3.2. Sensory evaluation of papaya ice-cream

The mean intensity ratings of papaya ice-cream's appearance, flavor, texture, and aroma (from QDA) were exhibited in Figure 1. According to the trained panelists, color is defined as the intensity of it from white to light yellow, followed by orange under white light. The intensity for the color attribute of ice-cream formulated with papaya puree and papaya powder ranged from 8.60 cm to 12.19 cm, with F2 (ice-cream formulated with 50% (w/v) papaya powder) having the highest intensity.

Trained panelists define glassiness as the number of sharp abrasive pieces in ice-cream. Ice-cream formulated with 80% (w/v) papaya powder (F3) showed to have the least intensity in glassy attributes, among the ice-cream, which has a glassy attribute from 1.48 cm to 8.20 cm. This may be due to its high mix viscosity. The addition of papaya powder increases the viscosity of the ice-cream mix and reduces the amount of free water to be frozen (Rincón *et al.*, 2006).

Separation is defined by trained panelists, as the cream appears on the top layer of ice-cream. With the separation attribute ranging from 2.74 cm to 4.98 cm, with both ice-cream formulated with 50% (v/v) papaya puree (F5) and 80% papaya puree (F6) showed to have the lowest degree of separation. This may be explained by the homogenization processing steps that cause a reduction in particle size and aggregation of fat globules (Sun-Waterhouse *et al.*, 2013).

Sweetness is defined as the fundamental taste sensation contributed by either sugar or sweeteners (Dooley *et al.*, 2010). Ice-cream formulated with papaya powder was found to have a higher intensity of sweetness than ice-cream formulated with papaya puree. This may be explained by the addition of papaya powder that increases the solid content in ice-cream, attributing to maltodextrin added (Abdallah *et al.*, 2017).

The sweetness of ice-cream formulated with 20% (w/v) of papaya powder (F2) showed to have the highest intensity. Based on the work done by Santana *et al.* (2003), papaya ice-cream found to have high sugar content indicated by total soluble solid (TSS) contents at above 31°Brix. There was no increasing trend of ice-cream samples for sweetness attributes. The reason could be due to the trained panelists' difficulty to distinguish between varying sugars concentrations at high overall sweetness level (Bolenz *et al.*, 2006).

Both ice-creams formulated with 50% (v/v) papaya puree (F5) and 80% papaya puree (F6) showed to have the highest intensity in the scoopability attribute. The force required to cut the sample with a spoon was known as scoopability (Dooley *et al.*, 2010). It was influenced by the microstructure of ice crystal (Wildmoser *et al.*, 2004). A smaller size of ice crystal can improve the scoopability of ice-cream.

Ice-cream mix formulated with papaya powder freeze faster than the ice-cream mix formulated with papaya puree because it has lower water content and lower freezing point (Li and Sun, 2001). Therefore, ice-cream formulated with papaya powder had a smaller size of ice crystal.

Table 2. Properties of papaya puree and reconstituted powder

Analysis	Papaya Puree	Reconstituted Papaya Powder
TSS (°Brix)	10.23 ± 0.80^{a}	10.17 ± 0.07^{a}
pH	4.42 ± 0.19^{a}	4.32 ± 0.32^{a}
Color (L*)	31.68 ± 1.72^{a}	14.94 ± 1.09^{b}
Color (a*)	27.95 ± 2.71^{a}	0.77 ± 0.76^{b}
Color (b*)	41.27 ± 1.71^{a}	14.19 ± 2.28^{b}

Data on TSS, pH, and color of reconstituted papaya powder are means ± standard deviations where n = 3. Different letters in the same row indicate a significant difference at $p \leq 0.05$. Abbreviations: TSS = total soluble solids, L* = degree of lightness, and darkness, a* = degree of redness or greenness, and b* = degree of yellowness or blueness.

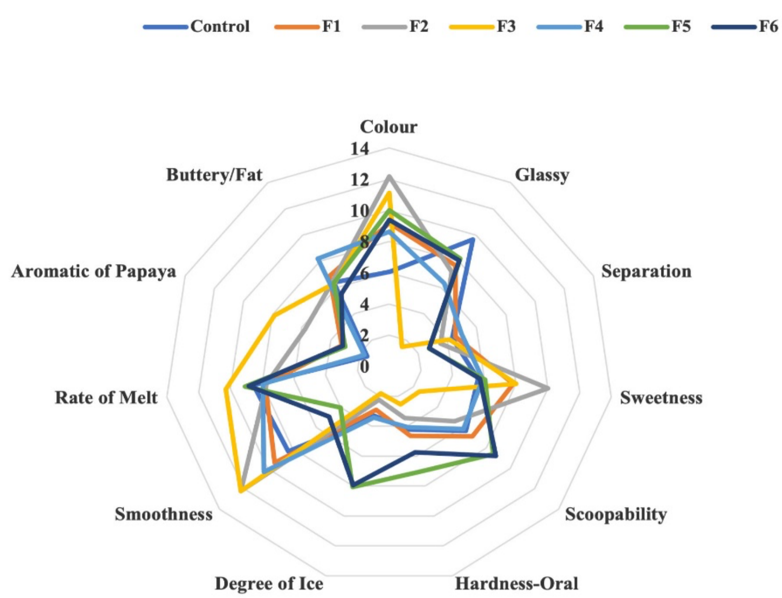

Figure 1. Spider diagram of the mean intensity ratings for the sensory attributes of the formulated papaya ice-cream samples

Other than that, ice-cream formulated with 50% (v/v) papaya puree (F4) has the highest intensity in the hardness-oral attribute. This means that more force is needed to compress the ice-cream between the tongue and mouth roof (Dooley *et al.*, 2010). Ice-cream formulated with papaya puree had higher intensity for hardness-oral attribute than ice-cream formulated with papaya powder. The water content of puree is more. Hence when frozen, the ice crystals network is more compact, hence harder (Wildmoser *et al.*, 2004).

The intensity of the degree of ice was lowest in ice-cream formulated with 80% (w/v) papaya powder (F6). The degree of ice is defined as the number of ice crystals felt in the mouth when the ice-cream is chewed (Dooley *et al.*, 2010). Ice-cream formulated with papaya puree freeze slower will lead to the formation of a larger size of ice crystal. Hence, the degree of ice was higher in the ice-creams formulated with papaya puree than ice-creams formulated with papaya powder.

Both ice-creams formulated with 50% (w/v) papaya powder (F3) and 80% (w/v) papaya powder (F4) showed to have high intensity in smoothness attributes. According to Li and Sun (2001), the fine ice crystal present in ice-cream is crucial in maintaining its smooth and creamy texture. Ice-creams formulated with papaya powder were smoother than ice-cream formulated with papaya puree.

On the other hand, ice-cream formulated 50% (w/v) papaya puree (F2) has the least intensity in the rate of melt attribute. The rate of the melt is defined as the rate in which the ice-cream change forms from solid to liquid state (Dooley *et al.*, 2010). Ice-cream formulated with 80% (w/v) papaya powder (F6) melts fastest among the ice-cream samples. The melting rate is influenced by the difference in air cell and size of ice crystal (Wildmoser *et al.*, 2004; Temiz and Yeşilsu, 2010). The addition of papaya powder potentially increases the sugars and organic acids contents, leading to an impact on the depression of freezing point, which causes the increase in unfrozen liquid in ice-cream, causing it to melt faster.

For aromatic of papaya, ice-cream formulated with 80% (w/v) papaya powder (F3) has the highest intensity, where it was found to have pleasant, sweet, and mellow flavor (Fuggate *et al.*, 2010). The addition of a high concentration of papaya powder increases the soluble solids of papaya in the ice-cream (Abdallah *et al.*, 2017). Ice-creams formulated with papaya puree have lower intensity than ice-creams formulated with papaya powder. This may due to the ice-cream mix is diluted by a high amount of free water despite its high amount of solid contents in papaya puree.

Ice-cream formulated with 20% (v/v) papaya puree (F1) was found to have a higher intensity of buttery/fat than other ice cream samples. From the different attributes, the three best-formulated ice-creams (F2, F3, and F4) were chosen for further investigation in the Hedonic test for the determination of consumer affectiveness. They appeared to have a smoother texture as compared to other ice-cream samples. However, sensory attributes such as color, glassy, separation, sweetness, scoopability, hardness-oral, degree of ice, rate of melt, aromatic of papaya, and buttery/fat were taken into consideration as well. Other than the three formulations, a commercial ice-cream was also included in the nine-point hedonic scale test.

Table 3 shows the mean of hedonic ratings for consumer's acceptance of formulated papaya ice-cream samples. Based on the scores showed in Table 3, consumers liked the less intense color as F4 has a lighter color compared with F2, and F3. Less intense color in ice-cream formulated with papaya puree may change due to the dilution of solids content in papaya puree. According to Patel *et al.* (2010), the ideal color of the ice-cream should be neither too pale, not too intense.

Table 3. Mean of hedonic ratings for consumer's acceptance of formulated papaya ice-cream samples

Attributes	Sample[2]			
	F2	F3	F4	Commercial
Appearance	5.66 ± 1.55^a	4.70 ± 1.70^b	6.46 ± 1.34^c	6.49 ± 1.57^c
Aroma	4.85 ± 1.71^a	4.25 ± 1.73^b	5.39 ± 1.39^a	7.22 ± 1.28^c
Flavor	4.10 ± 1.98^a	3.38 ± 1.92^b	5.09 ± 1.75^c	7.16 ± 1.24^d
Texture	5.24 ± 1.73^a	4.35 ± 1.90^b	5.73 ± 1.53^a	6.95 ± 1.26^c
Overall Acceptability	4.52 ± 1.76^a	3.73 ± 1.63^b	5.29 ± 1.57^c	7.17 ± 1.12^d
Preference	2.20 ± 0.89^a	1.61 ± 0.89^b	2.64 ± 0.80^c	3.54 ± 0.92^d

Values represent means ± standard deviation; n = 100

Hedonic ratings are based on 9-point hedonic scales with descriptors: 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, and 1 = dislike extremely.

[2] Commercial – 'Corn flavor; F2 – ice-cream added with 50% (w/v) of papaya powder; F3 – ice-cream added with 80% (w/v) of papaya powder; F4 – ice-cream added with 20% (v/v) of papaya puree

[a-c] Different letters in same row indicate a significance difference at $p \leq 0.05$

In terms of aroma, the commercial sample got the highest scores for aroma attribute followed by ice-cream formulated with 20% (v/v) papaya puree F4. This is similar to flavor. Table 3 showed consumers liked the flavor of ice-cream formulated with 20% (v/v) papaya puree among the papaya ice-cream formulations. According to Kilara and Chandan (2007), the flavor of ice-cream will be more apparent when it undergoes melting. The serving temperature should not be too cold, which may lead to a deadened palate.

The texture is defined as how an ice-cream sample reacts in the mouth (Yilsay *et al.*, 2006). The commercial sample got the highest scores for texture attribute followed by ice-cream formulated with 20% (v/v) papaya puree (F4), while ice-cream formulated with 50% (w/v) papaya powder (F2) got the score more than average. Meanwhile, ice-cream formulated with 80% (w/v) papaya powder (F3) got the least scores. There was no significant difference ($p > 0.05$) for the appearance attribute existed between F2 and F4 (Table 3). The texture of ice-cream is affected by overrun and fat content (Muse and Hartel, 2004; Murtaza *et al.*, 2004). The commercial product got the highest scores because the fat content is high in the commercialized product.

Based on Table 3, the scores for overall acceptability varied from 3.73 to 7.17, with the commercial sample was rated superior to the other formulated samples. However, ice-cream formulated with 20% (v/v) papaya puree (F4) was found to have well-accepted compared with ice-cream formulated with 50% (w/v) papaya powder (F2) and 80% (w/v) papaya powder (F3). This demonstrates that papaya puree was more preferred for the production of ice-cream, although the rating was lower compared to the commercial sample.

The commercial sample got the highest scores for appearance attribute, while F4 (ice-cream formulated with 20% (v/v) papaya puree) was the only one rated similar to the commercial sample, thus indicating that 20% (v/v) papaya puree can be used in the ice-cream production without any appearance defect (Temiz and Yeşilsu, 2010).

3.3. Physicochemical properties of papaya ice-cream

Table 4 shows the total solid contents and titratable acidity for the chosen papaya ice-cream as compared to the control ice-cream. Based on Table 4, there was no significant difference in the percentage of total solid content between F4 (ice-cream added with 20% (v/v) of papaya puree) and F0 (without the addition of papaya puree). This could be explained by the addition of 20% (v/v) of papaya puree that did not increase the total solids in ice-cream. In terms of percentage of titratable acidity, ice-cream added with 20% (v/v) papaya puree was higher (0.153 ± 0.006%) than control (0.113 ± 0.006%).

Figure 2 shows the meltdown characteristics of ice-cream, where the melting rate of ice-cream added with 20% (v/v) of papaya puree (F4) was faster than ice-cream without the addition of papaya puree (control, F0). Schmidt (2004) reported that the addition of purees of kiwifruit with green, gold, and red flesh into ice-cream altered the physical form of proteins in ice-cream and causes a change in melting properties. Moreover, the addition of papaya puree increases the sugars and organic acid contents, which eventually increase the amount of unfrozen liquid (Temiz and Yeşilsu, 2010). Therefore, ice-cream added with purees melts faster. Besides, the melting rate can be reduced by high overrun (higher air volume) (Muse and Hartel, 2004). Meanwhile, ice-cream added with 20% (v/v) of papaya puree retained their shape well during melting, which parallels to control ice-cream.

3.4. Proximate analysis of papaya ice-cream

Proximate composition of control ice-cream (F0) and ice-cream formulated with 20% (v/v) papaya puree (F4) were shown in Table 5. The moisture content of control, F0 ice-cream (27.93 ± 0.16%), was found to be higher than the ice-cream formulated with 20% (v/v) papaya puree, F4 (23.53 ± 2.33%). Meanwhile, the increase in total solids in ice-cream reduces the amount of free water that is present in the ice-cream, thus decreasing its moisture content (Rincón *et al.*, 2006). From Table 5, there was no significant difference ($p > 0.05$) found in protein, ash and fat content in both ice-cream.

Table 4. Mean of total solid contents and titratable acidity for the chosen papaya ice-cream samples

Analysis	Control	F4
Total Solid Content (%)	25.28 ± 0.53^a	25.31 ± 0.26^a
Titratable Acidity (%)	0.113 ± 0.006^a	0.153 ± 0.006^b

Data on total solid content and titratable acidity are means ± standard deviations where n = 3. Different letters in the same row indicate a significant difference at $p \leq 0.05$. Abbreviations: Control = ice-cream without addition neither papaya puree nor papaya powder F4 = ice-cream added with 20% (v/v) of papaya puree.

Table 5. Mean of moisture content, protein content, ash content, and fat content for the chosen papaya ice-cream samples

Analysis	Control	F4
Moisture Content (%)	27.93 ± 0.16^a	23.53 ± 2.33^b
Protein Content (%)	2.32 ± 0.25^a	2.30 ± 0.10^a
Ash Content (%)	0.51 ± 0.09^a	0.88 ± 0.06^a
Fat Content (%)	3.71 ± 0.76^a	3.04 ± 0.81^a

Data on total solid content and titratable acidity are means ± standard deviations where n = 3. Different letters in the same row indicate a significant difference at $p \leq 0.05$. Abbreviations: Control = ice-cream without addition neither papaya puree nor papaya powder F4 = ice-cream added with 20% (v/v) of papaya puree.

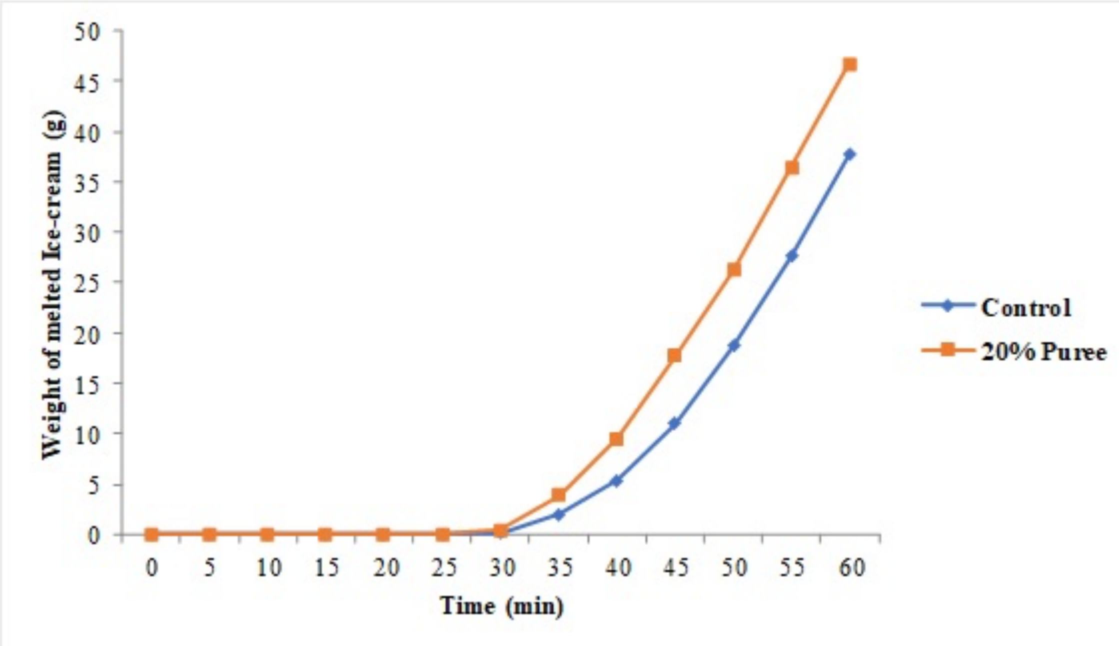

Figure 2. Meltdown characteristics of ice-cream samples, ( ) control, and ( ) ice-cream added with 20% (v/v) papaya puree. Each data point is an average value obtained from three samples.

4. Conclusions

Papaya ice-creams were produced with incorporation of papaya purees and papaya powder at 20%, 50%, and 80% concentrations. QDA panelists selected F2 (ice-cream with 20% papaya powder), F3 (ice-cream with 50% papaya powder) and F4 (ice-cream with 20% papaya powder). Among the 3 formulations, when conducted with 100 panelists for the Hedonic test, F4 was found to be 2nd most preferable, after commercial ice-cream. The ice-cream formulated with 20% (v/v) papaya puree (F4) can be produced commercially and has a high potential marketable value because papaya flavored ice-cream is not available in the market. When compared with F0 (without papaya puree), F4 (ice-cream with 20% papaya puree) is higher in titratable acidity and lower in moisture content.

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