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Physicochemical and sensory evaluation of ice cream formulated with sweet potato flour and sweetened with different sweeteners

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Ice cream is known as one of the popular and nutritious frozen dairy product that characterized by the delicious flavour, smooth texture and pleasing mouth feel while sweet potato has been discovered as a functional food containing high level of phytochemical and antioxidant content. The high consumption of sugar that contributed to health problems increased the consumers interest to find alternative sweeteners to sugar (sucrose) in ice cream. The objectives of this study was to determine the physicochemical properties, antioxidant activity and consumers' acceptability of the ice cream formulated using different type of sweeteners. In this study, three type of sweeteners were used in the formulations; sugar (F1), stingless bee honey (F2) and stevia powder (F3).The result showed that the use of stevia powder as a sweetener in the ice cream formulation (F3) significantly increased ($p \leq 0.05$) the ash content, protein content, fat content and fiber content meanwhile the moisture content of ice cream is highest in F2 that used stingless bee honey as a sweetener. Besides, the antioxidant value of DPPH and total phenolic content in F2 was the highest compared to F1 and F3 which indicates high antioxidant activity in the F2 sample of ice cream. Moreover, the use of stevia in the ice cream formulation (F3) slightly decreased the overall acceptability of ice cream in the sensory analysis due to the decrease in taste and bitter taste effect onto the ice cream meanwhile the most preferred ice cream in overall acceptability is F1 that used sugar as a sweetener.

Keywords: Ice cream, , sweetener, sugar, stingless bee honey, stevia powder

INTRODUCTION

Ice cream is a popular dairy dessert throughout the world that is characterized by delicious flavour, smooth texture and pleasing mouth feel. The global ice cream market size was valued at USD 54.80 billion in 2016 and expected to grow at annual growth rate of 4.1% over the forecast period. The development of new products is increasing with the consumers' awareness towards healthier foods (Dias et al., 2015). The introduction of innovative flavours and rise in the demand from the consumer above 50 years acts a major drive for the market. Besides, the consumption of functional food in diet among consumers also increasing as the rising health concern of ice cream consumption and the need to maintain the health. According to Aboulfazli et al. (2016), the demand towards the functional food has led to the production of ice cream that contains special ingredients with recognized nutritional and physiological properties.

Sweet potato has high content of starch, carbohydrates, fiber, vitamins and minerals. It rich in simple starches, complex carbohydrates, dietary fiber and vitamins content such as beta carotene which is pro-vitamin A carotenoid, vitamin B2, C and E (Ishida et al. 2000). Sweet potato also has high antioxidant content and antioxidant activity. It has proved its excellent bioactivities such as antioxidant activities (Kano et al. 2005). These high nutritional values and antioxidant content of sweet potato can provide benefits to human health. It is highly perishable and the need of processing required to enable it to be shelf stable (Sugumaran et al., 2019). A study conducted by Ho et al. (2017) reported that the substitution of sweet potato flour for self-rising flour in sponge cake formulation has improved the nutritional compositions of the final product. Thus, sweet potato is suitable to be used as one of the ingredients to produce a nutritious ice cream. Research conducted by Mohamad Faris (2018) showed that ice cream incorporated with sweet potato flour was more nutritious with higher antioxidant content as compared to ice cream without sweet potato flour and the increment of sweet potato flour incorporated in ice cream also increased the nutritional value and antioxidant content.

The most desirable of all flavours in ice cream is a sweet taste which affects our senses and often determines the acceptance or rejection of the food product. Ice cream is high amount in sugar, which makes up the majority of its carbohydrate content. The consumption of too much sugar may contribute to health problems such as weight gain, diabetes, cavities and cardiovascular disease. Therefore, consumers tend to choose an alternative in lowering the risk for high cholesterol and sugar-related problems by consuming ice cream in moderation or choosing a low-fat and low-sugar ice cream substitute. Increasing the sweetener level increases the creaminess of the ice cream as the result of the reduction size of ice crystals. The type and amount of sweetener used in the formulation also influence the melting rate of ice cream during consumption. Rate of melting increases at a lower freezing point (Muse &Hartel, 2014). Consequently, the quality of the ice cream will be affected. Thus, this study aims to determine the physicochemical properties, antioxidant activity and consumers' acceptability of the ice cream formulated using different type of sweeteners.

MATERIALS AND METHODS

Materials of ice cream

Fresh milk, whipping cream, skim milk powder and sugar were purchased from the supermarket at Jerteh, Besut. The stabilizer carboxymethyl cellulose (CMC) and emulsifier glycerol monostearate (GMS) were obtained from the bakery laboratory in UniSZA. Besides, the raw sweet potato was purchased from a local farmer around Tembila area to produce sweet potato flour which was then incorporated in the ice cream formulation. Other than that, stingless bee honey was purchased from local supplier, while stevia powder was obtained from Stevia Sugar Corporation (M) Sdn. Bhd.

Preparation of sweet potato flour

The raw sweet potatoes was cleaned and washed with tap water to remove all dust and stain. Then, the skin of sweet potato was peeled manually to remove their skin. After that, the sweet potato was cut and sliced using semi-automated slicer to produce 0.5 cm of thickness of sweet potato slices. Then, the sliced sweet potato was washed in water and soaked in 2% of sodium metabisulfite solution for 15 minutes to inhibit enzymatic activity that might cause browning to the sweet potato slices (Sgroppo et al. 2010). The slices were dried for 24 hours in the lab drier at temperature of 50 ˚C to reduce the moisture content below than 7%. Next, the dried sweet potato slices was grounded by using grinding machine to become small granules of flour. The sweet potato granules was sieved by using sieving machine to achieve the smallest powder which is 75 µm. Finally, the sweet potato flour is ready to be analysed and used in ice cream production.

Ice Cream formulation

In this study, three formulations of ice cream were produced according to Mohamad Faris (2018) with some modifications. There were three types of sweeteners involved; sugar, stingless bee honey and stevia powder and labelled as F1, F2 and F3 respectively as shown in Table 1. The weight of sweetener used in these three formulations was measured according to the relative sweetness of the sweeteners while the amount of other ingredients was kept constant for all the formulations.

Table 1: Ice cream formulations

Ingredients	F1 (g)	F2 (g)	F3 (g)
Fresh cow's milk	1000	1000	1000
Whipping cream	270	270	270
Skim milk powder	62.5	62.5	62.5
Sweet potato flour	30.9	30.9	30.9
Carboxymethyl cellulose (CMC)	1.57	1.57	1.57
Glycerol monostearate (GMS)	3.4	3.4	3.4
Sugar	202.5	-	-
Stingless bee honey	-	135	-
Stevia powder	-	-	12.3

Production of Ice Cream

The preparation of the ice cream was started by weighing all the ingredients according to the formulation. The fresh milk was mixed with the whipping cream to become the milk sample. Next, the skimmed milk powder, sweetener (sugar, stingless bee honey or stevia powder), stabilizer and emulsifier were mixed into the milk sample. The sweet potato flour was added into the milk sample after it was stand at 65 ˚C. The final mixture was pasteurized at 85 ˚C for 20 minutes and aged at 4 ˚C for 24 hours. Then, the mixture was placed into a hard ice cream machine at -5 ˚C for 6 minutes for the churning and freezing process. Finally, it was placed in the freezer for 24 hours at -22 ˚C for hardening process.

Analyses

Proximate Analysis of Ice Cream

Moisture, ash contents, protein, fat, crude fiber and of the sample of ice cream with different sweeteners were analyzed using AOAC method (AOAC, 2000). Moisture was determined by oven drying method, ash by combustion, protein by Kjedahl method, fat by soxhlet method extraction, crude fiber by acid and alkali digestion method and carbohydrates was calculated by subtraction of the total sum of moisture, ash, protein, fiber and fat.

Physicochemical Analysis of Ice Cream pH

The pH of the ice cream for three different formulations was measured using a pH meter (Thermo Scientific Onion Star A200 Series Meter).

Total Soluble Solid (TSS)

Total soluble solid (TSS) of ice cream were measured by a refractometer. The readings were taken as °Brix.

Antioxidant Activity of Ice Cream

DPPH (2, 2- diphenyl-1-picryhydrazyl) Assay

Determination of DPPH radicals scavenging activity was estimated with the method described by Rahman et al. (2015). DPPH reagent of 0.4mM was prepared in ethanol and 4 mL of this reagent was added to 1 mL of ice cream sample in the test tube. Then, the test tube was vortexed for 2 minutes before it was allowed to incubate in the dark at room temperature for 30 minutes. The reduction of colour was measured by using spectrophotometer at 517 nm. The percentage of scavenging was evaluated by comparing with the 4 mL of ethanol and 1 mL of DPPH that acts as a control. The calculation of radical scavenging activity was determined by using the equation:

Scavenging in DPPH (%) =

$$\frac{\textbf{absorbance of control} - \textbf{absorbance of sample}}{\textbf{absorbance of control}} \times \mathbf{100}$$

The Total Phenolic Content Assay

The total phenolic content of the extracts were determined by Folin- Ciocalteau reagent method. Ice cream sample of 1 g was dissolved in 5 mL of distilled water. Then, it was mixed with 1 mL of Folin-Ciocalteu reagent. After 3 minutes, 2 mL of 7 % sodium carbonate was added and the mixture was incubated for 10 minutes. The absorbance value of the mixture sample was measured at 760 nm by using Gallic acid and spectrophotometer as the standard. The total phenolic content was expressed using calibration curve (R2 = 0.973) and reported as mg of gallic acid equivalents (GAE)/mL. The unit of total phenolic content is mg/mL (GAE). From the GAE graph, the total phenolic content was determined using the formulation from equation:

$$\text{Amount of phenolic, } \mathrm{C} = \mathrm{c} \times \mathrm{V}/\mathrm{M}$$

where;
c = concentration obtained from gallic acid
V = volume of extract used
M = mass of ice cream sample

Sensory Evaluation

For the sensory evaluation, consumer acceptance test was conducted for seventy (n=70) untrained panellists. Each panellist was given three different samples of ice creams that were randomly coded for the test and water to cleanse their palate in between each sample. Then, each

panellist was asked to evaluate and rank the samples for the acceptability in terms of colour, aroma, taste, sweetness, after taste, iciness and overall acceptance using 7-point of hedonic scale whereby score 1=dislike much to score 7=like very much.

Statistical Analysis

All the analysis was conducted in triplicates. The results obtained from this study were expressed as mean ± standard deviation (SD). The data was statistically analysed by analysis of variance (ANOVA) using SPSS. The calculated mean value was compared using Tukey's test with a significant level of $p \leq 0.05$.

RESULTS AND DISCUSSION

Proximate analysis of ice cream

Table 2 shows the moisture content of the three ice cream samples. From the result, F2 contains the highest moisture content which is at 63.81%, followed by F3 and F1 at 61.11% and 58.37% respectively and there were significant differences between these formulations at $p \leq 0.05$. Generally, ice cream mix containing high water content has proportionately more water to freeze than the ice cream containing a low water content when hardened at the same storage temperature (El Owni & Zeinab, 2009). According to USDA National Nutrients Database for Standard Reference 2009 the range of standard moisture content of ice cream is about 61.0% (Robert & Bradley, 2010). The moisture content of F2 that used stingless bee honey as a sweetener is slightly increased compared to standard range of moisture content due to the contribution of moisture from the stingless bee honeys itself (14.74 g/100 g of honey). According to Suntiparapap et al. (2012) the behaviour of stingless bee that does not vaporize their honey may increase the water content of the honey. Moreover, the higher the amount of fat in the ice cream may lower the moisture content (Pinheiro & Penna, 2004). Other than that, moisture content also indicates and relates directly to the total solid content in food where total solid content was equal to 100 % minus the percentage of moisture content (AOAC, 2000).

Ash content indicates the contents of other minerals and inorganic compounds such as calcium, sodium and potassium in the ice cream sample. Table 2 presents the ash content of the three ice cream formulations and there were no significance differences between F2 and F3 at $p > 0.05$. From the result, the ash content in F3 is the highest compared to F2 and F1. The high amounts of ashes in stevia ranging from 7.82 - 11.93% dry basis (Segura-Campos et al. 2014) may contributes to the increasing ash content in F3. Besides, honey from stingless bee species presented ash contents ranging from 0.22 to 3.1 g/100 of honey (Chuttong et al. 2016) also increase the ash content in F2. The ash content of stingless bee honey is influenced by the amount of minerals present in the nectar. Other than that, physical separation in the processing may cause the removing or loss of mineral from the food sample (Manju& Mark, 2009).

Protein is an essential ingredient in ice cream as it functions to stabilize the emulsion after homogenization and affects the formation of the product structure. Besides, protein content also important in water-holding capacity that helps to improves the viscosity of the mixtures, reduces ice formation, and increases the melting resistance of the product (Souza et al. 2010) and milk used as the major ingredients in ice cream formulation is protein source in the ice cream. The result in Table 2 shows a gradually increase in protein content in the ice cream formulations from F1 to F3 and there were significant differences between the formulations at $p \leq 0.05$. Based on the result, the highest protein content of the ice cream was from F3 that used stevia powder as a sweetener which valued 13.77% compared to 12.61% and 11.33% from F2 and F1 that used stingless bee honey and sugar, respectively in the ice cream formulation. A study stated that the increasing use of stevia in the ice cream may increase the content of crude fiber, protein and carbohydrates while lower crude fat in the ice cream sample (Clarke, 2012). Besides, according to Shih et al. (2007) the addition of sweet potato flour in the ice cream formulation influenced the protein content in ice cream as the sweet potato contained higher amount of protein compared to other vegetables. Moreover, a study found that the use of purple sweet potato flour in the ice cream has lower protein content which is at 6.49% (Dian & Handajani, 2011) compared to the orange sweet potato. Furthermore, the substitution of sugar with non-nutritive sweeteners such as stevia showed non-significant effect on protein content of ice cream (Asghar et al. 2013) and storage period does not influence the protein level in ice cream samples (Murtaza et al. 2004).

Fat content contributes to the creaminess and smoothness of the ice cream while increasing its viscosity and melting resistance (Pinheiro&Penna,

2004; Souza et al. 2010). According to Sun-Waterhouse et al. (2013) a higher overrun is caused by a higher fat content due to the existence of greater amount of coalesced fat droplets to trap air bubbles in the ice cream. Besides, fat plays a crucial role in the ice cream as it promotes the incorporation and dispersion of air, imparts aroma and promotes the formation of ice crystals (Bolliger et al. 2000; Chung et al. 2003; Clarke, 2012; Granger et al. 2005).

In this study, the ingredients that used in the formulation that mainly contribute to fat content in the ice cream were milk and whipping cream. Based on the Table 2, there were significant differences between these three formulations at $p \leq 0.05$ and F3 has the highest percentage of fat content (13.13%) while F1 contain lowest percentage of fat content (5.91%) in the ice cream formulation. According to Arbuckle (2013) the fat content in a standard ice cream formulation that used sugar as a sweetener is about 12%. A study found that increasing the percentage of stevia powder in ice formulation may increase fat content until 12% (Clarke, 2012). However according to Limus- Mondaca (2012) the stevia may contain little or no calories and has been proven that it does not contain glucose, sucrose, maltose, or fructose level with zero glycemic index.

Fiber is an essential ingredient in ice creams as it is important to the stabilization of the emulsion after homogenization and the formation of the product structure. The result in Table 3 showsd a gradually increase in fiber content in the ice cream formulations from F1 to F3 and there were no significant differences between F1 and F2 at $p>0.05$. Based on the result, the highest fiber content of the ice cream was from F3 that used stevia powder as a sweetener which valued 4.18% compared to 2.26% and 1.99% from F2 and F1 that used stingless bee honey and sugar respectively in the ice cream formulation.

According to USDA from website usda.gov referred to National Nutrient Database for Standard Reference Legacy (2018), the standard fiber content in ice cream is 0.7%. A study stated that the increasing use of stevia in the ice cream may increase the content of crude fiber, protein and carbohydrates while lower crude fat in the ice cream sample (Goyal et al. 2010). Other than that, the *stevia rebaudiana* leaves may provide a good source of fiber (5.92-9.52% dry basis in the ice cream formulation (Segura-Campos et al. 2014). Besides, according to Shih et al. (2007) the addition of sweet potato flour in the ice cream formulation influence the fiber content in ice cream formulation increases due to the addition of sweet potato flour.

Physicochemical properties of ice cream

Table 3 shows the pH and total soluble solid (TSS) in different formulation of ice cream sample using different sweeteners. In general, the pH of ice cream is in the range of 6.3-6.5 and varies with the composition of the product (Marshall et al. 2003). The pH value relates to the composition of the ice creams, especially milk proteins, mineral salts and dissolved gases. Production of lactic acid bacteria results in a high acidity of ice creams which contributes to the increase in viscosity, decrease in the rate of whipping and reduces the less stable mix. This will cause coagulation to occur during the processing procedure. Based on the result in Table 3, F2 shows the lowest pH which is at 6.28 compared to F1 and F3 at pH 6.84 and 6.76 respectively. However, the pH of all formulation do not differ significantly at $p>0.05$. The fluid milk used to make ice cream had a pH of 6.8. The low pH of honey had slightly decreased the pH of the ice cream as the honey usually has a pH at range 3.2 - 4.5 (Muruke, 2014). Low pH value usually indicates more acidity and more hydrogen ion that involved in the formation of other compounds in stingless bee honey (Silva et al. 2013). The lower the pH of the honey, the higher ability of the honey to inhibit the presence and growth of microorganisms. Besides, the acidity can change the sensory characteristics of the product resulting in a lower acceptance by consumers (Cruz et al. 2009; Pimentel et al. 2015; Costa et al., 2017). Other than that, according to Ali et al. (2015) the addition of stevia extract do not affect the pH values of the ice cream.

The control of total soluble solids in ice cream is important as it is an indicator of the balance among the ingredients. It is also important in determining the quality of ice cream and influences the lactose crystallization (Tamime, 2007). The solids may derived from sugars, milk-solids-non-fat (SNF) and additional ingredients, such as stabilizers and emulsifiers in the ingredients of the ice cream. The total soluble solid of the three different samples of ice creams in Table 3 are at 29.93˚, 30.03˚ and 30.93˚ Brix for F1, F2 and F3, respectively and showed no significant difference at $p>0.05$ between all samples. According to Tamime (2007) the adequate values the amount of total soluble solids in the ice cream is in the range between 28.9° Brix to 30.5° Brix. A study found that the decrease of total solids of stevia ice milk occurred when stevia

extract was added (Ali et al. 2015). Besides, the use of honey in the ice cream have caused a decrease in the total solids content (Januario, et al. 2018). Moreover, the solid contents in the ice cream is gradually increase with longer period of storage as the decreasing in moisture level in the ice cream samples.

Table2: Proximate analysis of ice cream samples with three different sweeteners in ice cream formulation

Parameter	Formulation		
	F1	F2	F3
Moisture	58.37 ± 0.46[a]	63.81 ± 0.26[b]	61.11 ± 0.42[c]
Ash	1.67 ± 0.03[a]	2.64 ± 0.35[b]	3.19 ± 0.19[b]
Protein	11.33 ± 0.15[a]	12.61 ± 0.35[b]	13.77 ± 0.26[c]
Fat	5.91 ± 0.37[a]	10.13 ± 0.12[b]	13.13 ± 0.61[c]
Fibre	1.99 ± 0.55[a]	2.26 ± 0.26[a]	4.18 ± 0.41[b]

Means with the same lowercase letter at different formulation do not differ significantly at p >0.05.

Table 3: pH and Total Soluble Solid in three different samples of ice cream

Parameter	Formulation		
	F1	F2	F3
pH	6.84 ± 0.08[a]	6.28 ± 0.03[a]	6.76 ± 0.18[a]
Total Soluble Solid (˚ Brix)	29.93 ± 0.42[a]	30.03 ± 0.46[a]	30.93 ± 0.25[a]

Means with the same lowercase letter at different formulation do not differ significantly at p >0.05.

DPPH

DPPH (2, 2-diphenyl-1-picryl-hydrazyl-hydrate) is a stable organic free radical method that used as a substrate to evaluate the antioxidant activity. According to Marcocci et al., 1994) the free radical scavenging activity DPPH of all the samples were measured by DPPH assay. In other words the antioxidant scavenging the free radical DPPH by donating electron to DPPH. The decrease in absorbance of DPPH radical is caused by antioxidants, because of the reaction between antioxidant molecules and radicals which results in the scavenging of the radical by hydrogen donation and it is visually noticeable as a change in colour from the purple to yellow. The results shown that the DPPH free radical scavenging activity the sample F1 was 77.42%, F2 was 90.58% and F3 was 85.95% and there were a significant differences between each of the formulation at p ≤0.05 as shown in Figure 1.

The higher of DPPH free radical scavenging activities in the ice cream indicates the higher antioxidant activity in the ice cream. From the previous study the use of purple sweet potato as an ingredients in the ice cream formulation increases the antioxidant activity in the ice cream (Dian & Handajani, 2011).

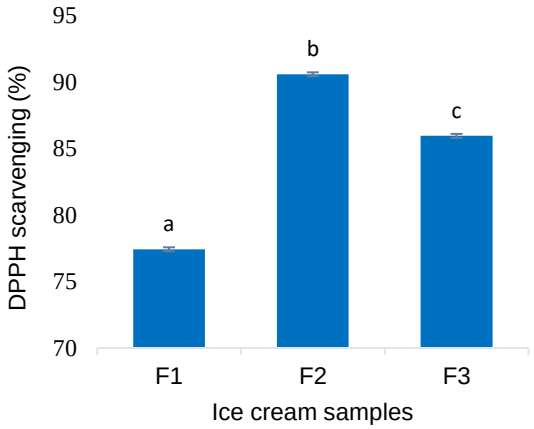

Figure 1: Percentage of DPPH scavenging of ice cream samples in three different formulations.

F2 that used stingless bee honey have the highest percentage of DPPH free radical scavenging activities compared F1 and F3 that used sugar and stevia powder in the formulation

of ice cream and the highest correlation of total phenolic content in F2 compared to F1 and F3 indicates high antioxidant activity in F2.

Means with the same lower letter at different formulation do not differ significantly at p > 0.05.

Total Phenolic Content

Total phenolic content assay was used to determine the phenolic content as the phenolic compound containing anthocyanin showing the presence of antioxidant activity. Gallic acid standard curve was used to determine the concentration of total phenolic and the absorbance of gallic acid standard that directly proportional to the concentration shows the higher concentration of gallic acid resulted in a higher absorbance reading at 760 nm. From the observation of the experiment the standard sample with more intensity blue color have higher absorbance value and higher amount of phenolic compound. Figure 2 shows the concentration of total phenolic content in ice cream samples. It can be seen that the concentration of total phenolic in F1, F2 and F3 were 0.26 ± 0.02, 0.40 ± 0.02 and 0.35 ± 0.03 mg/mL GAE respectively. This shows that F2 have the highest antioxidant activity in the ice cream.

A study by Oddo et al. (2008) reported the phenolic contents of stingless bee honey averaged 55.74 mg GAE/ 100 g of honey. Moreover, Almeida da Silva *et al*. (2013) reported that honey sample which displayed the highest total phenolic content have slightly highest ABTS+ cation radical scavenging capacity. This indicates that there is a correlation between phenolic content and antioxidant activity in the stingless bee's honey (Duarte et al. 2012; De Sousa et al. 2016).

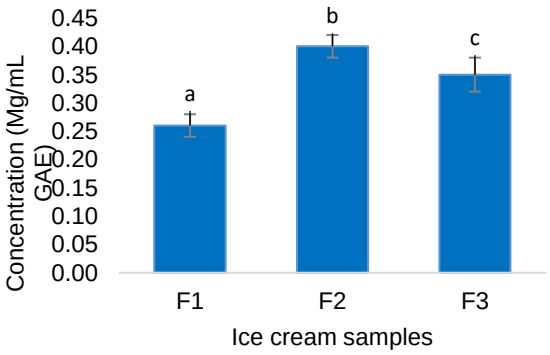

Figure 2: Total phenolic content of ice cream samples in three different formulations.

Means with the same lower same letter at different formulation do not differ significantly at p > 0.05.

Sensory Analysis

According to Yangilar (2015) the ice cream was evaluated for acceptability for certain attributes such as flavour, body and texture, color, appearance, resistance to melting and overall acceptability. Besides, sensory conducted is based on consumer acceptance test where the panelist chosen the preferable scale to the attributes such as appearance, color, texture, flavour and taste with hedonic scale provided (Fernandes, 2017).

Ice cream is a product that appeals to the most varied taste of all ages and understanding the characteristic and acceptability towards the costumer of the ice cream is possible by using sensory product testing. Table 5 shows the sensory evaluation of the ice cream formulation with all parameter analyzed. The sensory analysis demonstrated that the aroma, taste, after taste and overall acceptability of ice cream sample have a significant differences at p ≤ 0.05 while the color of all ice cream samples shown nosignificant different between the mean of the ice cream samples at different formulation at p >0.05. Other than that, the score of F3 in the formulation of ice cream is lowest in aroma, taste and iciness compared F1 and F2. From the result, the substitution of sugar with stevia powder in F3 decreased the overall acceptabilities and taste of the ice cream. The use of stevia powder in F3 also increased the bitter after taste parameter in the ice cream.

Besides, the mean of sweetness and iciness of the ice cream do not shown the significance different between F1 and F2 at p >0.05. The sweetening power and persistence of sweet taste by stevia powder in ice cream formulation are affected by several factors such as concentration, ingredients and temperature of ice cream (Odzemir et al. 2008). It has been described that the addition of very high concentrations of stevia to many food products negatively provide bitter aftertaste to the food products and it is a major problem associated with many sweeteners which limits their use at high concentrations. Further, the bitter aftertaste of stevia powder is more persistent than other natural and synthetic sweeteners and the increasing of stevia amountadded to ice-cream samples may decrease the sensory quality (Yogiraj et al. 2014). Moreover, a study found that the addition of orange fiber into the ice cream formulation to

replace fat reduced the overall acceptability (Crizel et al. 2014).

Table 4: Sensory evaluation of ice cream formulations

Parameter	Formulation		
	F1	F2	F3
Color	6.51 ± 0.46[a]	6.3 ± 0.26[a]	6.5 ± 0.42[a]
Aroma	5.43 ± 0.03[a]	5.62 ± 0.35[b]	4.79 ± 0.19[c]
Taste	6.33 ± 0.15[a]	6.62 ± 0.35[b]	5.48 ± 0.26[c]
Sweetness	5.89 ± 0.37[a]	6.12 ± 0.12[a]	6.34 ± 0.61[b]
After taste	6.22 ± 0.55[a]	5.88 ± 0.26[b]	4.95 ± 0.41[c]
Iciness	5.23 ± 0.08[a]	5.54 ± 0.03[a]	4.89 ± 0.18[b]
Overall acceptabilites	6.25 ± 0.42[a]	6.04 ± 0.46[b]	5.31 ± 0.25[c]

Means with the same lower letter at different formulation do not differ significantly at $p > 0.05$.

CONCLUSION

In conclusion, sweeteners play an important role in providing sweetness and develop the pleasing smooth and creamy texture while maintaining the nutritional values of the ice cream. The result had shown the use of stevia powder as a sweetener in the ice cream formulation (F3) significantly increased the ash content, protein content, fat content and fiber content meanwhile the moisture content is highest in F2 that used stingless bee honey as a sweetener of the ice cream. Besides, the antioxidant value of DPPH and total phenolic content in F2 was the highest compared to F1 and F3 which indicates high antioxidant activity in the F2 sample. Moreover, the use of stevia in the F3 decreased the overall acceptability of ice cream in the sensory analysis due to the decrease in taste and bitter taste effect onto the ice cream. The most preferred ice cream by overall acceptability is F1 which used sugar as a sweetener.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Ainin Sofiya, A. performed the experiments, run data analysis and drafted this manuscript, while Nurul Zaizuliana, R. A. and Zarinah, Z. supervised the experiments and reviewed the manuscript. Che Abdullah A. B. contributed the opinions for improvement. Nurul Zaizuliana, R. A. is also the project leader for this research grant.

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