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Study on development of pitaya fruit (Hylocereus undatus) incorporated ice cream; an alternative solution to the pitaya cultivators in Sri Lanka

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Abstract - Study was conducted to determine the composition of pitaya (*Hylocereus* sp.) pulp, to develop an ice-cream incorporated with pitaya pulp and to evaluate the shelf life of the pitaya pulp incorporated ice cream. Ice-cream samples were prepared with three different proportions of pitaya pulp, 12%, 15% and 18% (w/w). A sensory evaluation was done by seven-point Hedonic scale on 20 semi-trained panellists. Physico-chemical and microbial analyses were conducted during storage. The ice-cream with 12% (w/w) pulp yielded the highest consumer preference.

Keywords - Pitaya, Vitamin C, Ice-cream, value addition

Introduction

Pitaya is the fruit of climbing wine cactus species of the genus *Hylocereus* sp. (sweet pitayas) commonly referred to as dragon fruit. It has received worldwide recognition not only as an ornamental plant but also as a fruit crop. Currently, it is cultivated in at least 22 countries in the tropics including Australia, Cambodia, China, Malaysia, Thailand, Bangladesh and Sri Lanka (Mizrahi and Nerd, 1999; Nerd et al., 2002; Nobel and Barerra, 2002). A Pitaya fruit fetches a higher price than a durian, the "king of fruits" in Southeast Asia. The agronomic practices are easier and less expensive, with fewer pests and diseases. The biggest advantage however is that it will grow for about 20 years, and one hectare could accommodate about 800 dragon fruit plants. It is a fast return perennial fruit crop with full production after five years (Gunesena et al, 2006).

Pitaya fruit is perhaps most common as the red pitaya fruit (red flesh or red pulp), sweet pitaya fruit (with creamy pulp) and a delicate aroma. To prepare for consumption, the fruit is cut open to expose the flesh which is eaten raw. It is mildly sweet and is known to be low in calories. The seeds are eaten together with the flesh, have a nutty taste and are rich in lipids (Abdul Azis Ariffin et al., 2008).

Pitaya fruit is known to be rich in nutritive value (Taiwan Food Industry Development and Research Authorities, 2005) with the pulp containing 82.5-83% moisture, 0.16-0.23% protein, 0.21- 0.61% fat, 0.7-0.9% fiber, 6.3-8.8 mg calcium, 30.2-36.1 mg phosphorous, 0.5-0.61 mg iron and 8-9 mg vitamin C.

The shelf life of pitaya fruit is drastically reduced with the movement of fruits from in and out of cold storage (Gunasena et al, 2006). Evidence show that after harvesting the respiratory rate decreases and the weight loss increases showing visible shriveling within eight days of storage (Arevalo-Galarza and Ortiuz-Herrnandes, 2004) leading to post harvest losses, therefore, alternative methods are required to reduce the post harvest losses to extended the shelf-life as of the fresh fruit.

The main objectives of this research were (i) To analyze the proximate composition of pitaya fruit pulp and pitaya incorporated ice cream. (ii) To assess the nutritional quality, sensory attributes and storage stability of the prepared ice cream. (iii) Reduce the post harvest economical losses of pitaya fruit and to

motivate the cultivators to produce more to reach shelf sufficient stage.

Methodology

Collection of Samples

Eighty fresh ripened pitaya fruits were purchased from Makandura farm located 1.5 km from department of Food Science and Technology and transported to Food Processing laboratory of Department of Food Science and Technology, Faculty of Livestock Fisheries and Nutrition, Wayamba University of Sri Lanka where it kept for a day under the refrigeration condition.

Chemical analysis of dragon fruit pulp

The Moisture of pitaya pulp was determined by drying at 100-105ºC for 24 hours (AOAC 2004,). The acidity was expressed as anhydrous citric acid after titrating with 0.1M NaOH and the pH was measured by a pH meter (metrohm, mode 780, Dutchland) The ascorbic acid content in the product was estimated by a titrimetic method (Brody, 1994). An AOAC method (2004) was used to determine ash content of the sample. Total soluble solids (TSS) were determined by using a refrectometer (N-4E, Japan).

Processing of pitaya pulp incorporated ice cream

Pitaya pulp was separated from the skin by peeling or scooping out the fruity flesh. They were cut into (1x1cm) small pieces, and were blended for 2 minutes to obtain a homogenous mixture. All pulp thus collected was bundled into a muslin cloth and the content was immersed in hot water at 63ºC for 2 minutes. Three different formulations of ice cream were made (Table 1) by mixing of fresh milk, whipping cream and sugar and then adding egg yolk and beating to obtain a homogenized liquid mixture meanwhile different proportion of fruit pulp was added to the three formulations. Ice cream mix was kept under refrigeration condition at 4ºC for 3 hours for aging, stabilizer (cremodan) was added to the mix and beating was continued to incorporate air. Creaming was continued in an ice cream maker (CICM, mode 1700, Italy) for around one hour. The final product was dispensed into 300 small cups (150mL) and was kept under frozen condition (-14ºC).

Table 1:
Formulation of pitaya fruit incorporated ice cream.

Ingredients	T1	T2	T3
Fresh milk (g)	400	400	400
Whipping cream (g)	300	300	300
Sugar (g)	120	120	120
Pitaya pulp (%)	12	15	18
Stabilizer	10	10	10
Egg yolk (g)	80	80	80
Lime juice (mL)	5	5	5

Sensory analysis

Sensory evaluation for each ice cream sample was carried out with 20 semi-trained panelists after two days of preparation of ice cream on texture, flavor, appearance and overall acceptability, Flavor and color were determined during storage up to 16 weeks in biweekly intervals. The scores were analyzed by Friedman ranking test ($p<0.05$) and mean separation (Meilgaurd, 1999) using MINITAB 11.

Microbiological analysis

Total plate counts were determined in serial dilutions for each ice cream sample in weeks by using poured plate method (FDA, 2004).

Physical analysis

Complete melting time was measured according to Guven and Karaca (2002) method . 25 g of tempered samples were left to melt (at room temperature, 20ºC) on a 0.2 cm wire mesh screen above a beaker and the complete melting time of the ice cream was determined. TSS of ice cream was estimated using a handheld refrectrometer (N-4E, Japan). The overrun of the final product was calculated using Eq. 1 as described in (Akin, 1990).

$$\text{Overrun} = \frac{\text{Weight of unit mix-weight of Equal volume of ice-cream}}{\text{Weight of equal volume of ice-cream}} \times 100\% \quad (1)$$

Chemical analysis

pH, titratable acidity, fat content and protein content of ice cream samples were measured using different laboratory techniques recommended by AOAC (1995). The samples were analyzed weekly for 16 weeks of storage at -14°C. The pH of ice cream was measured by using a laboratory pH meter and titratable acidity was measured by titrating 10.0 mL of filtered ice cream with 0.1 M NaOH using phenolphthalein as an indicator. The dry matter of milk samples was determined by exposing to 100±1°C for 3.5 h using an air oven (Akin, 1990), fat content in dry basis was determined by using soxlet method and for the estimation of protein, kjeldahl analysis was conducted on dry ice cream sample.

Results and discussion

The proximate compositions of pitaya pulp and pitaya incorporated ice cream is tabulated as below. The composition of fresh dragon fruit pulp such as moisture, TSS, reducing sugar, non-reducing sugar, total sugar, and ash, pH, acidity and vitamin C contents recorded in Table 2. The results obtained are in good agreement with those of ICBF (1992) and Morton (1987). The result of vitamin C content 10.90 mg/100g supported by Teddy (2008) who reported 9 mg/100 gm, beside this pH (4.20) and acidity (0.45) also closely related.

Table 2:
Sensory evaluation results - Mean scores given by panelists for different treatments with Standard deviation.

Character	p value	mean	±SD
Texture	0.005	5.48	0.718
Flavor	0.002	5.53	0.671
Appearance	0.000	5.58	1.041
Overall Acceptability	0.000	5.51	1.073

There was significant difference between the sensory characters ($p < 0.05$). When the pitaya pulp content was increased, the overall acceptability was reduced it may be due to the increased level of pectin present in pitaya pulp and the change in the texture of pitaya ice cream: "fig1". According to the sensory evaluation results, formula of 12% of pitaya pulp was selected as most acceptable for final product. Although the freezing temperature reduces the total microbial count to a lower level since the chemical reaction is continued, it cannot be completely stopped thus resulted the changes in pH, titratable acidity and brix value.

There was no significant difference ($p > 0.05$) between the pH of pitaya ice cream during storage time up to 12 weeks (table 4) But thereafter, the changes were significant. There was slight increase in the pH probably due to oxidation reaction of antioxidants, chemical and bio chemical mechanism (Hui, 2006).

Table 3:
Comparison of the composition of pitaya fruit pulp and pitaya incorporated ice cream

Parameters	Pitaya fruit pulp	Pitaya incorporated ice cream
Moisture (%)	81.20±0.05	60.42±0.04
Ash (%)	0.41±0.03	3.7±0.16
Reducing sugar (%)	4.20±0.06	*
Non-reducing sugar (%)	3.60±0.03	*
Total sugar (%)	7.80±0.01	*
TSS	10.5±0.02	31.5±0.01
pH	4.50±0.01	6.56 ±0.03
Titratable Acidity (%)	0.43±0.04	0.15±0.01
Vitamin-C (mg/100g)	8.30±0.04	*
Dry matter content (%)	11.80±0.04	39.58±0.28
Protein (%)	*	7.73±0.34
Fat (%)	*	45.37±0.99
Moisture (%)	81.20±0.05	60.42±0.04

*** Not Determined**

Table 4:
Chemical and physical characteristics of pitaya incorporated ice cream during the storage

Period of storage (Weeks)	Flavor	color	pH	Over run value (%)	Complete melting time(s)	Microbial count (log cfu/mL)	Remarks
0	fresh	Light yellow	6.56^{a}	22.84^{a}	4572 ± 20^{a}	4.75	Good
2	fresh	Light yellow	6.56^{a}	22.82^{a}	4585 ± 12^{a}	4.48	Good
4	fresh	Light yellow	6.55^{a}	22.79^{a}	4596 ± 22^{a}	4.23	Good
6	fresh	Light yellow	6.55^{a}	22.78^{a}	4610 ± 20^{a}	4.18	Good
8	fresh	Light yellow	6.55^{a}	22.76^{a}	4615 ± 31^{a}	3.62	Good
10	fresh	Light yellow	6.54^{a}	22.73^{a}	4635 ± 15^{b}	3.45	Good
12	fresh	Light yellow	6.54^{a}	22.54^{b}	4640 ± 16^{b}	3.26	Good
14	fresh	Light yellow	6.48^{b}	22.51^{b}	4648 ± 12^{b}	3.14	Good
16	off flavor	Light yellow	6.49^{b}	21.49^{b}	4679 ± 23^{c}	3.04	Not good

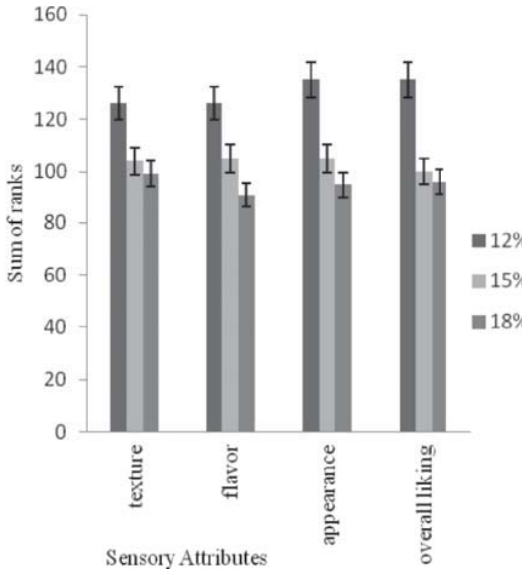
The values are means of three independent determinations. The means with different superscripts in a column differ significantly ($p< 0.05$).

Complete melting time was slightly reduced but there was no significant difference until 8 weeks but after that the changes were significance ($p<0.05$). After 14 weeks changes were higher. The brix value of pitaya ice cream was slightly changing with the storage time. In pitaya fruit malic acid is produced through the chemical reaction during storage period (Nomura et al, 2005) it may have led to the pectin to be hydrolyzed during storage (Diaz et al, 2007). There was no significant difference between the total soluble solid ($p>0.05$). It reveals that the shelf life of this product is confined to 3 months according to the physical and chemical characteristics (Table 4).

According to the Frozen Confections Regulation, any frozen confection for sale should not contain more than50, 000 bacteria per gram. According to the microbial evaluation for the pitaya ice cream sample, the initial microbial population was less than 50,000 /ml and it was in the acceptable microbial range. Even in the storage period of pitaya ice cream, there was only a slight reduction in bacterial counts. The decline in bacterial counts, as a result of freezing, was likely due to the freeze injury of cells, leading eventually to the death of cells. However, the mechanical stresses of the mixing and freezing process and also the incorporation of oxygen into the mix may have resulted in a further decrease in bacterial count. Similar results were reported by Ravula and Shah (1998); Haynes and Playne (2002); Mufas and Perera (2012).

In this study artificial colorings or preservatives were not added. The shelf life of the product may be increased by such additives. It is expected that the lime juice added, could provide some additional vitamin C to replace the loss during processing and storage of pitaya incorporated ice cream. Egg yolk is added for difference purposes: to provide light yellow color so it could be preferred by consumers, to provide higher whipping property to ice cream which could satisfy the overrun value and complete melting time of standard ice cream and to provide higher nutritional value because of its richness in some essential vitamins and minerals (Nau, 2010).

Fig. 1: Panelist preference for different sensory attributes



Conclusion

The proximate composition of pitaya fruit pulp and pitaya incorporated ice cream was found out. Study concluded the feasibility for valuable venture of producing ice cream using 12% of pitaya fruit pulp with higher acceptability to fulfill the market requirements. The shelf life of the pitaya incorporated ice-cream is three months. As the fruit has some special, medicinal and nutritive value (Taiwan Food Industry Development and Research Authorities, 2005), it is assumed that it could fetch a good economical value from the consumers. Therefore, the present study is a sign of bright prospect of processing of pitaya fruit into value added ice-cream. In this value addition process, the post harvest loss of pitaya is minimized. Further investigation is necessary to study the economic aspects of the products before recommending for commercial level.

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