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Development of functional chocobar and sensorial analysis

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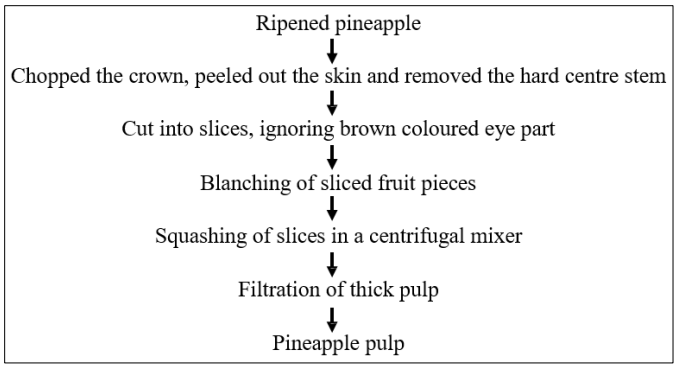
Abstract
The present research focusses on developing functional chocobar incorporating pineapple fruit pulp and natural sweeteners *viz*. jaggery and palm sugar as two different products. Based on the sensory evaluation of chocobar, 15 per cent inclusion level of pineapple pulp was found to be ideal. For incorporating jaggery as a natural sweetener, 7.5 per cent attained higher sensory scores compared to 5 and 10 per cent jaggery in chocobar. Similarly, the overall acceptability projected 7.5 per cent as an ideal level for palm sugar incorporated functional chocobar. On cost analysis, the control chocobar had lower cost (Rs. 125.52/litre) than the functional chocobar prepared. The functional chocobar containing jaggery had lower cost of production (Rs. 137.52/litre) than the palm sugar admixed chocobar (Rs. 148.02/litre) due to the higher cost of palm sugar in the market.

Keywords: Functional chocobar, natural sweetener, pineapple pulp, sensory evaluation

Introduction
Indian dairy industry is constantly exploring for the production of newer value-added dairy products. Milk, being a nutritious produce, serves as a protein rich product for the vegetarian population. Among the dairy products, ice cream is considered to be one of the wholesome products, as it contains opulent sources of vitamins, proteins and minerals such as calcium and phosphorous (Deosarkar *et al.*, 2016). The presence of mouth-watering flavours and colours along with the melting property makes the product acceptable for all age groups precisely children and younger generations. Owing to this, the present research initiated in developing healthy chocobar ice cream incorporated with pineapple fruit pulp and natural sweeteners *viz*. jaggery and palm sugar as natural flavouring and sweetening agents respectively.
Pineapple (*Ananas comosus*) has drawn much attention due to its excellent flavour and taste. It is a tropical and compound (multiple) fruit that has a juicy pulp, rich in health promoting sources of antioxidant vitamin C, vitamin B1, vitamin B6, copper and dietary fibre (Hossain *et al.*, 2015) [10].
Owing to increasing type-2-diabetes mellitus and juvenile diabetes, consumption of cane sugar which has 99% sucrose is being impeded by the consumers worldwide. Hence, natural sweeteners reoccurred in food and dairy industry due to its additional mineral contents. The prominent use of natural sweeteners dates back from our ancient Vedic times in India when Ayurveda was in use (Rajesh *et al.*, 2016) [16]. Jaggery is considered as a "Superfood sweetener" giving a healthy replacement of sugar. Similarly, palm sugar is also a nutrient rich, low glycemic crystalline sweetener produced from Palmyra. Being an iron rich natural sugar, it is also a good source of Vitamin B1, B2, B3, B6 and B12 and minerals such as potassium and phosphorous in minimal amounts (*https://www.avacare.in/blog/palm-candy/*). The phytonutrients such as polyphenols present in it also render much antioxidant benefits (*https://www.spiceography.com/palm-sugar/*).
Thus, the developed product possess functional attributes with nutritional and therapeutic properties apart from rendering an awful taste.

Materials and methods
Fresh cow milk was procured from the Model Dairy Plant, Department of Livestock Products Technology (Dairy science), Madras Veterinary College, Chennai. Skim milk powder (SMP), sugar, pineapple fruit, natural sweeteners *viz*. jaggery and palm sugar, stabilizer and emulsifier were purchased from super markets in Chennai.

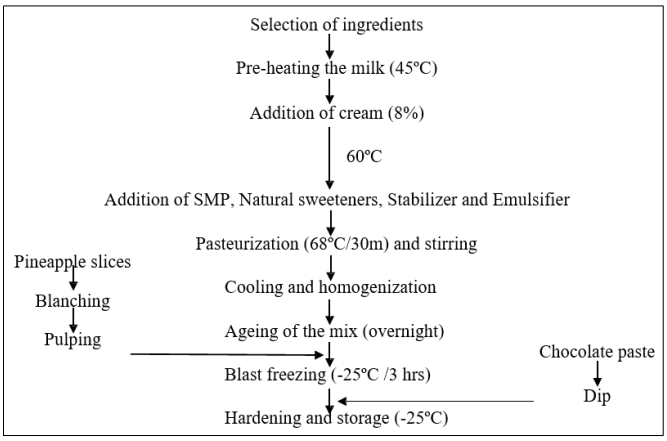
Preparation of pineapple fruit pulp



Blanching is done to inactivate the bromelain enzyme and to eradicate the contamination of yeasts which affects the shelf life of chocobar. The simple blanching process is performed by adding pineapple slices in hot water at 60-80°C and leaving it for about 3-5 minutes. The slices are then immersed in cold water immediately to achieve complete elimination of yeast (Agarry *et al.*, 2013) [1].

Preparation of functional chocobar

Chocobar was prepared as per the protocol outlined by De *et al.* (1980) [5] with slight modification.



Sensory evaluation of functional chocobar was carried out using 9-point hedonic scale as per Amerine *et al.* (1965) [2]. Cost of production of control and functional chocobar prepared from one litre of ice cream mix was obtained by calculating the quantity and cost of the ingredients required for chocobar preparation.

Statistical analysis

All the data were statistically analysed as mean ± standard deviation (SD) using SPSS software by applying one way ANOVA and Duncan multiple test as per Snedecor and Cochran (1994) [18].

Results and Discussion

The average sensory scores for the prepared functional chocobar incorporated with pineapple fruit pulp at different levels (5, 10, 15 and 20 per cent) and natural sweeteners *viz*. jaggery and palm sugar individually at 5, 7.5 and 10 per cent levels were tabulated.

Sensory analysis for standardizing the level of pineapple fruit pulp incorporation in functional chocobar

The sensory evaluation of chocobar with pineapple fruit pulp was given in Table 1.

Table 1: Sensory evaluation of chocobar with pineapple fruit pulp using 9 point hedonic scale (Mean# ± SE)

Sensory Attributes	Types of chocobar					F value
	Control	PCT1	PCT2	PCT3	PCT4	
Colour & Appearance	8.83±0.17	8.83±0.17	8.83±0.17	8.83±0.17	8.83±0.17	0.00^{NS}
Flavour	$9.00±0.00^{c}$	$4.83±0.17^{a}$	$5.67±0.21^{b}$	$8.83±0.17^{c}$	$5.17±0.17^{a}$	163.80**
Body & Texture	8.83±0.17	8.83±0.17	8.83±0.17	9.00±0.00	9.00±0.00	0.50^{NS}
Melting Resistance	7.67±0.21	7.50±0.22	7.50±0.22	7.50±0.22	7.33±0.21	0.29^{NS}
Overall Acceptability	$8.50±0.22^{b}$	$7.83±0.17^{a}$	$8.00±0.00^{ab}$	$8.50±0.22^{b}$	$7.83±0.17^{a}$	3.75*

Mean of six observations

Control – Plain chocobar without pineapple pulp

PCT1, PCT2, PCT3, PCT4 – Chocobar with 5, 10, 15 and 20 per cent pineapple pulp respectively NS – Non-significant (p>0.05);

* - Significant at (p≤0.05)

** - Highly significant at (p≤0.01)

Means bearing different superscripts within rows differ significantly

From the statistical analysis, it has been concluded that there was no significant difference between the control and functional chocobar with regard to colour and appearance, body and texture and melting resistance. There was not much difference in colour and appearance as the chocolate covering was found over the chocobar ice cream. For body and texture, similar results were interpreted by Hassan and Barakat (2018) [8], where significant difference in texture was observed only on increasing incorporation levels of pumpkin and carrot pulp in ice cream.

Admixing pineapple pulp at 15 per cent level (PCT3) showed highly significant ($p<0.01$) difference in flavour. On further increasing the pineapple pulp concentration, flavour decreased drastically as the fruit imparted a bitter taste. These results were in accordance with Makwana *et al.* (2016) and Bajwa *et al.* (2003) [4]. Makwana *et al.* (2016) observed highest sensory scores for 15 per cent sapota pulp in the ice cream among the other treatments containing 5, 10, 20, 25 and 30 per cent sapota pulp concentrations. Bajwa *et al.* (2003) [4] developed ice cream by incorporating different levels of strawberry pulp, where, 15 per cent strawberry pulp was awarded the highest score for organoleptic property.

The significant difference in overall acceptability indicated in table 1 was due to the flavour exposed by 15 per cent pineapple pulp. The PCT3 shown a statistical value of 8.50±0.22 which was equivalent to the value of control chocobar. Similar results were also depicted in a study by Hassan and Barakat (2018) [8] and Singh *et al.* (2017). Hassan and Barakat (2018) [8] resolved that overall acceptability was the highest for 15 per cent pumpkin and carrot pulp incorporated ice cream among the other treatments.

Sensory analysis for standardizing the level of jaggery incorporation in functional chocobar

The sensory evaluation of chocobar with pineapple fruit pulp and jaggery was presented in Table 2.

Table 2: Sensory evaluation of chocobar with pineapple fruit pulp and jaggery using 9 point hedonic scale (Mean# ±SE)

Sensory Attributes	Types of chocobar				F value
	Control	PJCT1	PJCT2	PJCT3	
Colour & Appearance	8.83±0.17	8.83±0.17	8.83±0.17	8.83±0.17	0.00^{NS}
Flavour	$8.83±0.17^{c}$	$4.66±0.21^{a}$	$8.50±0.22^{c}$	$6.50±0.22^{b}$	87.04**
Body & Texture	9.00±0.00	8.83±0.17	8.67±0.21	8.50±0.22	1.51^{NS}
Melting Resistance	7.50±0.22	7.50±0.22	7.67±0.21	7.67±0.21	0.19^{NS}
Overall Acceptability	$8.50±0.22^{b}$	$7.50±0.22^{a}$	$8.17±0.17^{b}$	$8.00±0.00^{ab}$	5.43**

Mean of six observations
Control – Chocobar with 15 per cent pineapple pulp
PJCT1, PJCT2, PJCT3 – Chocobar with 15 per cent pineapple pulp and 5, 7.5 and 10 per cent jaggery respectively
NS – Non-significant ($p>0.05$);
** - Highly significant at ($p\leq0.01$)
Means bearing different superscripts within rows differ significantly

As per the statistical values illustrated in table 2, there was no significant difference between the control and the prepared functional chocobar with regard to colour and appearance, body and texture and melting resistance. There was not much difference in colour and appearance because of the chocolate coating found over the chocobar ice cream. The statistical values for body and texture and melting resistance did not depict any significant variation at ($p>0.05$). Also, similar sensory score range of 8.40 for 6 per cent jaggery incorporated basundi was obtained by Ayare *et al.* (2020) [3] in their study.

There was a high significant variation at ($p\leq0.01$) in flavour between the control and the treatments. The chocobar with 15 per cent pineapple pulp and 7.5 per cent jaggery was almost equal to that of the control chocobar containing 15 percent refined sugar. This reveals that jaggery can render required sweetness even when incorporated at low level (7.5 per cent). A similar study was also carried out by Ubale *et al.* (2014) [19] who prepared kulfi with sapota pulp at 16, 25 and 40 per cent and jaggery at 7, 8 and 9 per cent.

Based on statistical analysis, the overall acceptability between the control and the treatments showed a high significant difference at ($p\leq0.01$). In contrary, Ayare *et al.* (2020) [3] who made basundi using jaggery as a natural sweetener and concluded that 6 per cent jaggery had significantly higher sensory scores than the other treatments containing 5 and 7 per cent jaggery in basundi.

Gartaula and Bhattarai (2014) [10] formulated a traditional heat desiccated dairy product, "Bomboyson" using jaggery as a natural sweetener and revealed that jaggery was a rich replacement of refined sugar as it did not alter the overall acceptability of the dairy product.

Sensory analysis for standardizing the level of palm sugar incorporation in functional chocobar

The sensory evaluation of chocobar with pineapple fruit pulp and palm sugar was illustrated in table 3.

Table 3: Sensory evaluation of chocobar with pineapple fruit pulp and palm sugar using 9 point hedonic scale (Mean# ±SE)

Sensory Attributes	Types of chocobar				F value
	Control	PPCT1	PPCT2	PPCT3	
Colour & Appearance	8.83±0.17	8.83±0.17	8.83±0.17	8.83±0.17	0.00^{NS}
Flavour	$8.83±0.17^{c}$	$4.50±0.22^{a}$	$8.5±0.22^{c}$	$6.50±0.00^{b}$	75.385**
Body & Texture	9.00±0.00	8.83±0.17	8.67±0.21	8.50±0.22	1.51^{NS}
Melting Resistance	7.50±0.22	7.50±0.22	7.67±0.21	7.67±0.21	0.14^{NS}
Overall Acceptability	$8.50±0.22^{b}$	$7.50±0.22^{a}$	$8.16±0.17^{b}$	$8.00±0.00^{ab}$	5.43**

Mean of six observations
Control – Chocobar with 15 per cent pineapple pulp
PPCT1, PPCT2, PPCT3 – Chocobar with 15 per cent pineapple pulp and 5, 7.5 and 10 per cent palm sugar respectively
NS – Non-significant ($p>0.05$)
** - Highly significant at ($p\leq0.01$)
Means bearing different superscripts within rows differ significantly

The statistical values indicated no significant difference with regard to colour and appearance, body and texture and melting resistance. The colour and appearance of the prepared chocobar did not have any significant difference at (p>0.05) because of the chocolate coating found over the chocobar. The body and texture result was in accordance with Low *et al.* (2015) [13] who developed probiotic ice cream using different levels of coconut palm sugar (15, 18 and 21 per cent). There was a slight increase in melting resistance in higher levels of palm sugar than the control is due to high moisture content and hygroscopic nature of glucose and fructose sugars present in palm sugar (Nafingah *et al.*, 2019) [15].

A high significant difference in flavour was observed between the control and the treatments due to the addition of palm sugar at different proportions. The flavour of 7.5 per cent palm sugar added chocobar was almost similar to that of control chocobar. On further increasing the percentage level, palm sugar exhibited higher sweetness which might be due to the presence combination of sugars *viz*. sucrose, fructose and glucose.

The overall acceptability was superior for 7.5 per cent palm sugar when compared to 5 and 10 per cent palm sugar incorporated functional chocobar, which was similar to Saputro *et al.* (2016) [17] who formulated dark chocolates with palm sugar.

Cost economics of functional chocobar

As elucidated in table 4, the functional chocobar projected higher cost (Rs. 137.52 and Rs. 148.02/litre) than the control chocobar (Rs. 125.52/litre). Among the functional chocobar, jaggery admixed functional chocobar had lower cost than the palm sugar incorporated functional chocobar. This high cost of palm sugar is due to its low recovery percentage from the sap (Hebbar *et al.*, 2013) [9].

Table 4: Cost of production per litre of functional chocobar

Ingredients (Quantity/litre)	Cost of Ingredients (Rs.)	Cost per litre of chocobar (Rs.)		
		Control	PJCT2	PPCT2
Whole milk (750ml)	43/L	32.25	32.25	32.25
Skim milk powder (50g)	337/Kg	16.85	16.85	16.85
Cream (80g)	63/250g	20.16	20.16	20.16
Glycerol Monosterate (GMS) (3g)	38/100g	1.14	1.14	1.14
Pectin (2g)	161/100g	3.22	3.22	3.22
Pineapple pulp (150g)	60/Kg	-	9	9
Sugar (150g)	40/Kg	6	-	-
Jaggery (75g)	60/500g	-	9	-
Palm sugar (75g)	130/500g	-	-	19.5
Choco paste (200g)	140/Kg	28	28	28
Vegetable oil (50 ml)	158/L	7.9	7.9	7.9
Processing cost	10	10	10	10
Cost per litre of chocobar ice cream (Rs.)		125.52	137.52	148.02

Control – Chocobar without pineapple pulp and with refined sugar

PJCT2– Chocobar with 15 per cent pineapple pulp and 7.5 per cent jaggery PPCT2– Chocobar with 15 per cent pineapple pulp and 7.5 per cent palm sugar

Though the cost of production of functional chocobar were high than the control, it was concluded that functional chocobar are found to be good owing to their healthiness and other functional attributes.

Conclusion

Concern on developing value added dairy products is tremendously growing due to the nutritional and therapeutic ingredients present in the dairy products. The current research focussed on admixing pineapple pulp and natural sweeteners *viz*. jaggery and palm sugar in chocobar to increase the healthfulness of the developed dairy product. As frozen desserts are desired by people of all ages around the world, incorporating natural ingredients in them would render a healthy dairy product overall. Based on the sensory evaluation of functional chocobar prepared in this study, pineapple pulp at 15 per cent and jaggery and palm sugar at 7.5 per cent level individually were the most liked by the sensory panellists. Despite the fact that the cost of functional chocobar is high, it is considered to be a healthful solution to the consumer for reducing the onset of *diabetes mellitus* and other metabolic disorders. This proved that commixture of fruit pulp and natural sweeteners like jaggery and palm sugar added taste and nutritive value to the chocobar, thus posing a health conscious decision.

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