Research Article

SENSORY VARIATION ANALYSIS IN ICE CREAM MADE BY PALMYRA (*BORASSUS FLABELLIFER*) PULP WITH JAGGERY AND SELECTED SPICES

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Abstract

Consumer acceptance of ice cream depends largely on its structure, textural quality, resistance to melting, nutritional composition and flavour. Incorporation of fruits and spices is one of the choices to increase consumer acceptance. The study was focused to develop a nutritional and flavour rich palmyra pulp ice cream with selected spices and jaggery. Eight sensory evaluation tests were carried out with 30 semi-trained panellist using 5 point hedonic scales. Initial sensory evaluation test results reveals pulp which is less bitter and added in overrun combination was selected for both natural and commercial pulp. Then 25% of pulp was selected for both type of pulp. By using the combination which is selected in previous sensory evaluation natural pulp ice cream and commercial pulp ice cream were developed. From that; natural pulp ice cream was preferred as best. Then for the selected ice cream, 125 ppm level of ginger and cinnamon oleoresins incorporated products were selected as best outputs. When comparing cinnamon natural pulp ice cream and ginger natural pulp ice cream, the first was preferred due to bitterness masking property of ginger. Finaly, jaggery added ginger flavoured natural palmyra ice cream was developed without adding artificial colours and preservatives.

Keywords: Ice cream, Borassus flabellifer, ginger, cinnamon, jiggery

1. INTRODUCTION

Ice cream is a frozen dairy product that has higher nutritive, biological and caloric value (Soad et al., 2014). Definition of ice cream is a frozen sweetened product made from a heat treated mix consisting of edible fat and milk solids with or without other ingredients and permitted additives. The product is intended for storage, sale and consumption in the frozen state (SLS 223 specification for ice cream, 2016).

Consumer acceptance of ice cream depends largely on its structure, textural quality, resistance to melting and flavour (Soad et al., 2014). Ice-creams are food products showing potential advantages being appreciated by people belonging to all age groups and social levels (Adriano et al., 2009). Incorporation of fruits and spices into ice creams are the one of the choices to increase the nutrition value, flavour and palatability of the product.

The consumer's trend has been towards foods with more natural antioxidants, dietary fibers, natural colorants, minerals, vitamins, low calories, low cholesterol, and low fat and free of synthetic additives. While ice cream could be poor in some of these characteristics (El-Samahy et al., 2009), Palmyra fruit pulp is nutritious and has a yellow colour due to carotenoids which are precursors of vitamin A, and giving attractive yellow colour to the food, rich in vitamin C, good source of pectin (Sangheetha et al., 2014), and potential source of antioxidant as carotenoids, vitamin C, poly phenols, anthocyanin and macro ions (Ca, Na, Mg & K), and Macro elements (Fe, Zn, Cr,

Mn, Cu, Ni, Co, Pb, and B) (Jansz et al., 2002).

The main flavouring substances for ice creams are vanilla, chocolate and cocoa, strawberry, fruits and fruit extracts and nuts.

Spices are the building blocks of flavour in food. Their primary functions are to provide aroma, texture and colour to food. In addition they also act as preservative, and provide nutritional, and health benefits.

Scientific name of ginger is *Zingiber officinale* Roscoe (Embuscado, 2015) is a member of the Zingiberaceae family of plants (Shukla & Singh, 2007; Sigletary, 2010). The consumed part of the plant of ginger is rhizome (White, 2007; Embuscado, 2015). This rhizome can be processed into a powder, syrup, volatile oil, and oleoresin (Sigletary, 2010). Ginger root does not have any side effects stated by Bone et al., (1990) and Fischeri- Rasmussen et al., (1991).

Ginger and its preparations are rich in antioxidant compounds (Butt & Sultan, 2011) due to the Free radical scavenger activity and allied health discrepancies (Butt & Sultan, 2011). The major biologically active compound found in ginger as Gingerol (Yashin et al., 2017). Ginger is used as a spice (Prakash, 2010), a condiment, flavouring agent (Shukla & Singh, 2007) and a natural food additive (White, 2007). 2007).

Genus *Cinnamomum* has two main varieties; *Cinnamomum zeylanicum* (CZ) and *Cinnamon cassia* (CC) (also known as *Cinnamomum aromaticum* (Qin et al., 2010; Ranasinghe et al., 2013). It is obtained from the inner bark of trees (Rao & Gan, 2014). The volatile oils obtained from the bark, leaf, and root barks. Primary constituents of cinnamon are such as; cinnamaldehyde (bark), eugenol (leaf) and camphor (root) (Ranasinghe et al., 2013).

Cinnamon has antioxidant activity (Gruenwald et al., 2010; Rao & Gan, 2014) due to the free radical scavenging properties (Ranasinghe et al., 2013). Cinnamon has natural antioxidants for improving human nutrition and health (Su et al., 2007). Cinnamon is used as a spice (Gruenwald et al., 2010), flavouring agents, preservatives (Qin et al., 2010). Cinnamon has a great antioxidant activity. That delay or prevent food spoilage (Rao & Gan, 2014), prevent lipid oxidation (Shobana & Naidu, 2000).

Therefore, producing an ice cream product incorporated with these selected spices, with great product consistency would not only provide sensory pleasure, but also delivers numerous health benefits that are absent in typical products.

2. MATERIALS AND METHODS

2.1 Preparation of raw materials and Quality tests
Selection and quality of raw materials are the major determinants of the quality of end products in a food processing. Therefore, raw materials were analysed prior to be subjected to the processing to ensure the production of good quality end product.

2.2 Raw Materials
Palmyra fruits were collected from kaithady and Allaipitti in Jaffna, Sri Lanka. Commercial Palmyra fruit pulp & Jaggery were collected from Katpaham, wellawatta. Spices were brought from HDDES extracts (PVT) ltd, No - 02, Police Park Avenue, Colombo 05, Sri Lanka. Milk, cream, full cream milk powder, glucose syrup, sugar & packaging materials were used from MILCO (PVT) LTD, No. 45, Nawala road, Narahenpita, Colombo 05.

2.3 Preparation of the pulp
For pulp extraction procedure followed the method of Sangheetha et al., (2016) & Jansz et al., (2002) with some modifications. Pest attack free, fresh, black skinned, well ripe fruits were selected. Palmyra fruit was peeled manually. Then nutlets were separated & dipped in warm water (45 - 50° C) for few seconds. Thereafter pulp was extracted with water (pulp: water =1:2 v/v) manually. Pulp was then strained. It was kept in deep freezer at -25° C for about 48 hours to reduce bitterness. Before adding the pulp into ice cream mix, pulp was heated up to 85°C for 30 minutes.

2.4 Tests for pulp

Quality of pulp was checked prior to be subjected to the ice cream processing. pH of natural pulp & commercial pulp were tested using a digital pH meter.

Total solids (Gravimetric method): Firstly empty dishes was heated and closed in the oven for 30 min. Then dish was cooled in a desiccator and weighed (m_0). Sample was added in to the dish for testing and weighed (m_1). Dish was placed into the oven and kept for 2 and half hours at 105°C. Then dish was removed, cooled in a desiccator for 30 min & reweighed (m_2). The process was repeated until the observed the constant weight. The residue represents the Total Solids (TS) content.

2.5 Milk quality tests

Quality of milk was check prior to be subjected to the ice cream processing. Taste, colour and the smell of milk was tested before introduce into the process. PH of the milk was tested with the help of PH meter in R & D laboratory MILCO (PVT) ltd. Alcohol precipitation test (APT): Exactly 1 ml of milk sample was pipetted to a sterilized test tube. Then 1 ml 70% alcohol solution was added into it. It was shaken gently. Then presence of clots was checked to ensure the quality of milk.

Clot on boiling test (COB): Exactly 5 ml of milk was added in to a boiling tube. Then it was kept in a boiling water bath for 5 minutes. Then presence of clots was checked to ensure the quality of milk. Add 5 ml of milk in to a boiling tube.

Determination of Fat by Gerber method: Firstly, milk sample was heated to 40°C and cooled it to 20°C. Then 10 ml of Sulphuric acid was added into the Gerber tube. Then 10.94 ml of the well mixed and prepared milk was added along the wall of the tube (not to wet the neck of the tube). Then 1ml of Amyl alcohol was added & closed close the neck of the Gerber tube with a stopper. Gerber tube was shaked carefully until all the contents are dissolved. Gerber tube was centrifuged immediately after the mixing (Speed – 1100 rpm, Time – 4 min). Then tube was removed from centrifuge & observed the results by adjusting the stopper.

2.6 Preparation of the ice cream

First standardized milk (fat- 3.25 %) was heated up to 70°C and sugar, full cream milk powder, cream (40% fat), glucose syrup, stabilizer and emulsifier were added. After dissolving all ingredients, the mix was pasteurized at 95°C for 15 seconds. Then the mix was kept at room temperature. Then the mixture was aged at 4°C for overnight (12 hours). Finally the mix was overrun using laboratory scale overrun machine and filled in to ice cream containers. After that ice cream mix was hardened at -22°C overnight. Finally it was stored at -18 °C.

2.7 Manufacturing of palmyra pulp ice cream with spices (Figure 2).

Palmyra pulp ice cream with spices procedure was modified from simple ice cream process through the many trails and sensory evaluation.

Bitter pulp - After the extraction of Palmyra pulp from the fruit is usually bitter taste it is called as bitter pulp.

Less bitter pulp - If bitter pulp keeps at -25° C for about 48 hours it will reduce the bitterness. It is called as less bitter pulp. Before adding the pulp into ice cream mix, pulp was pasteurized up to 85°C for 30 minutes.

Natural pulp: Is extracted from the fruits by manually. It uses immediately after extraction without adding preservatives.

Commercial pulp - Which is packed into the bottles with preservatives and it produced by palmyra development board, Sri Lanka.

Final ice cream was developed as jaggery added ginger flavoured palmyra natural pulp ice cream. Natural palmyra pulp & ginger were added before the overrun process. Granulated jaggery was added during filling after overrun (Figure 1).
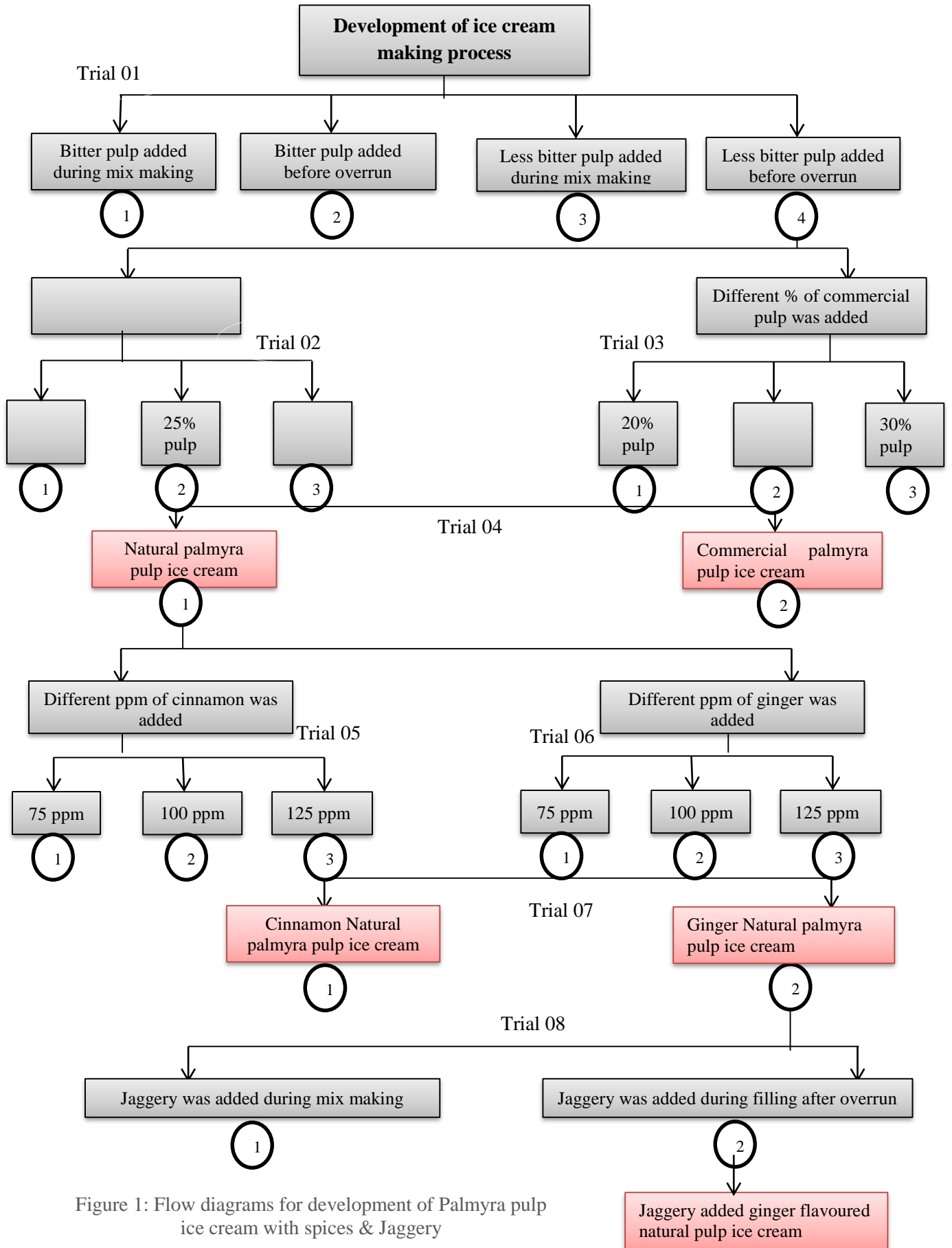
Figure 1: Flow diagrams for development of Palmyra pulp ice cream with spices & Jaggery

2.8 Sensory evaluation series

To determine the best treatments in each trial, a semi trained panel consisting 30 members were used with 5 point hedonic scale. Each member was given no of samples according to no of treatments in each trails and asked to rank sensory properties (aroma, taste, creaminess, colour, mouth feel and overall acceptability.

Sensory test 01: Sensory No 01 was conducted to determine the best treatment within four treatments in trial 01 based on pulp category (based on bitterness) & pulp adding stages in ice cream processing.

Sensory test 02: Sensory No 02 was conducted to determine the best treatment in trial 02 based on adding three different % of natural pulp for ice cream production.

Sensory test 03: Sensory No 03 was conducted to determine the best treatment in trial 03 based on adding three different % of commercial pulp for ice cream production.

Sensory test 04: Sensory No 04 was conducted to determine the best treatment in trial 04 based on best pulp variety from natural & commercial pulp ice creams.

Sensory test 05: Sensory No 05 was conducted to determine the best treatment in trial 05 based on adding three different ppm of cinnamon for cinnamon flavoured natural palmyra pulp ice cream production.

Sensory test 06: Sensory No 06 was conducted to determine the best treatment in trial 06 based on adding three different ppm of Ginger for Ginger flavoured natural palmyra pulp ice cream production.

Sensory test 07: Sensory No 07 was conducted to determine the best treatments in trial 07 based on best spicy flavoured from Ginger flavoured natural palmyra pulp ice cream & cinnamon flavoured natural palmyra pulp ice cream.

Sensory test 08: Sensory No 08 was conducted to determine the best treatments in trial 08 based on granulated jaggery adding stages for production of jaggery added ginger flavoured palmyra natural pulp ice cream production.

2.9 Determination of overrun % of ice cream samples

Overrun % of ice cream samples was measured after air incorporation of each ice cream mix samples during ice cream manufacture. Before the overrun the weight of a known volume of ice cream mix was taken and after overrunning, the weight of the same volume of ice cream was taken. The overrun percentage of final product was calculated on a weight basis using a following formula,

$$\% \text{ Overrun} = \frac{\text{Vol. of ice cream produced} - \text{Vol. of mix used}}{\text{Vol. of mix used}} \times 100\%$$

(Source: Goff & Hartel, 2013)

2.10 Determination of the Texture profile

The texture profile of ice cream samples were measured after hardened the ice creams using a computer-controlled CT3 Texture Analyzer (50 kg, BROOKFIELD, USA) based on the TA-41 Cylinder, 6 mm D, & 35mm L probe. Initially the test run was done to locate the base. All analyses were conducted immediately after taken from freezer. After that each ice cream sample was placed on the base and the test was run. After doing the test, raw data were analysed by using Minitab 17.

2.11 Statistical analysis

Friedman non parametric analysis at 95% confidence level was used to analyze data from sensory evaluation (between ice cream sample made with pulp varieties (Natural & Commercial), ice cream sample made with pulp with oleoresins (Cinnamon & Ginger) and ice cream sample made with pulp, Ginger & Jaggery) in IBM SPSS statistics V21 software.

3. RESULTS

3.1 Quality test for Raw materials

Quality of pulp, milk and cream were checked prior to be subjected to the ice cream processing.

Table 1: Results for palmyra pulps' quality

	Natural pulp	Commercial pulp
Moisture	84.95	89.53
Brix	15.1	13.5
Bulk density	$1.144 gcm^{-3}$	$1.04 gcm^{-3}$
pH	4.65	4.15
Total solid	15.05	10.47
Ash	0.8617	0.859
Viscosity	$2114 mPs^{-1}$	$4682 mPs^{-1}$
Protein	0.357%	0.360%

Table 2: Results for milk quality

Organoleptic test	Aroma and taste accepted milk was used
pH	6.45
APT- alcohol precipitation test	Negative
COB- clot on boiling test	Negative
Fat %	3.5%

Quality parameters of raw materials were within the acceptable range. They were in compliance with the Sri Lanka Quality Standards (SLQS).

3.2 Results of sensory evaluation

3.2.1 Results of sensory evaluation 01

The four ice cream samples were developed according to bitterness of pulp & pulp adding stages in ice cream manufacture to select best combination.

Sample number 105 = ice cream made with bitter pulp added during mix making process.

Sample number 110 = ice cream made with bitter pulp added before Overrun process.

Sample number 115 = ice cream made with less bitter pulp added during mix making process.

Sample number 120 = ice cream made with less bitter pulp added before Overrun process.

Table 3: Mean value of tested parameters in sensory evaluation 01

Tested parameters	105	110	115	120	P value
Colour	1.63	1.63	3.03	3.07	0.000
Aroma	2.00	1.60	2.83	3.57	0.010
Appearance	1.13	2.40	2.80	3.67	0.000
Taste	1.27	2.27	2.83	3.63	0.020
Creaminess	1.80	2.10	2.30	3.80	0.010
Texture	1.23	2.27	2.83	3.67	0.000
After mouth feeling (feel less Bitterness)	1.23	2.23	3.00	3.53	0.000
Overall acceptability	1.83	2.37	2.80	3.00	0.006

According to the results p value of all the sensory attributes were less than 0.05. So there was significant difference between the samples 105, 110, 115 and 120 when considering colour, aroma, appearance, taste, creaminess, texture, after mouth feelings and overall acceptability.

The sample 120 (less bitter pulp was added before overrun process to prepare ice cream) has the highest mean value with all tested sensory attributes, it is the best sample. And also according to drawn web diagram the sample which was coded as 120 was selected as the best sample.

Samples 105 and 115 were prepared by adding the pulp during mix making. They were observed as high viscous after mix preparation and also appearance and texture were observed as not good. Prepared ice cream mix was seen as (like pudding) difficult to air incorporation process in overrun machine. So sample 105 & 115 was rejected by sensory evaluation. Sample no 110 was prepared by adding bitter pulp during overrun process. It was rejected due to the after mouth feeling as feel high bitter taste.

Palmyra pulp was added to ice cream to increase nutritional composition of ice cream and utilization of palmyra pulp. According to Jansz et al., (2002), palmyra pulp has carbohydrate, Amino acids, carotenoids, vitamin A, vitamin C, Dietary fibre and high amounts of mineral contents. Amount of pectin is reported as 4.4g and 6.7g per 100g PFP (Jansz et al., 2002). Due to the fibre content palmyra pulp added ice cream mix was shown higher viscous.

Utilization palmyra fruit pulp is less due to the bitter taste of pulp (Jansz et al., 2002). Bitterness was reduced by keeping the palmyra pulp in deep freezer at – 22 °C for 48 hours (Sangeetha et al., 2016).

3.2.2 Results of sensory evaluation 02

The three ice cream samples were prepared with 3 different Natural Palmyra pulp to select best percentage of natural palmyra pulp. It was added before overrun process & pulp is less bitterness according to sensory no 01.

Sample number 205 = ice cream made with 20 % Natural Palmyra pulp (less bitter) ice cream.

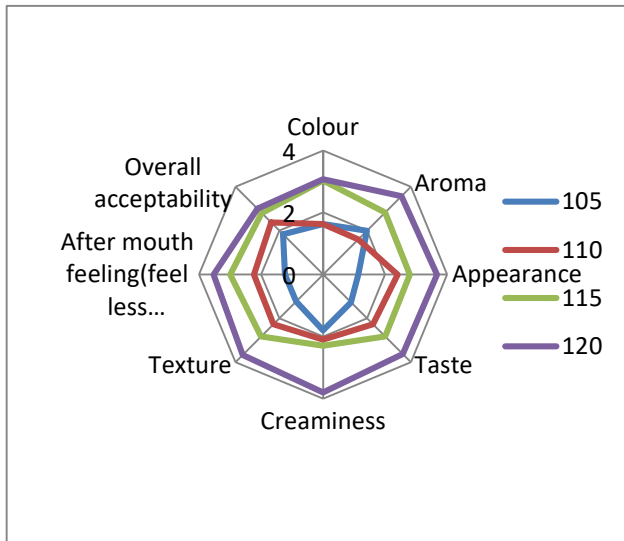Sample number 210 = ice cream made with 25 % Natural Palmyra pulp (less bitter) ice cream.

Figure 2: Web diagram for sensory evaluation 01

Sample number 215 = ice cream made with 30 %Natural Palmyra pulp (less bitter) ice cream.
Significant difference was observed for colour, aroma, taste, creaminess, after mouth feelings and overall acceptability (p value <0.05) between three samples. But for appearance and texture there was no significant difference.

is the best sample. And also according to drawn web diagram the sample which was coded as 210 was selected as the best sample. But for the after mouth feeling (feel less bitterness) most of the panellists were preferred for sample no 205 (ice cream made with 20% (less) natural pulp). Sample no 215 was prepared with high (30%) percentage of natural pulp. Due to that it was given high bitter taste. Hence it was rejected. Sample no 205 was prepared with low (20%) percentage of natural pulp. Due to that it was given milky taste, than pulp taste. Hence it was rejected.
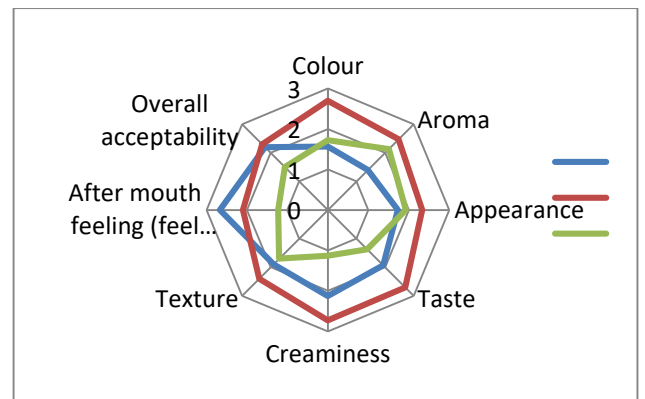

Figure 3: Web diagram for sensory evaluation 02

Table 4: Mean value of tested parameters in sensory evaluation 02

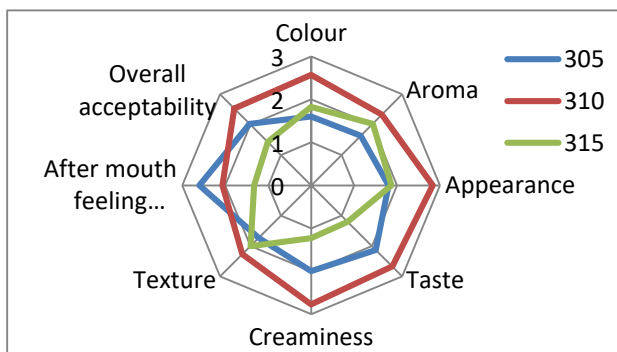| Tested parameters	205	210	215	P value
Colour	1.57	2.70	1.73	0.010
Aroma	1.40	2.47	2.13	0.010
Appearance	1.73	2.33	1.93	0.135
Taste	1.93	2.70	1.37	0.000
Creaminess	2.13	2.73	1.13	0.000
Texture	1.90	2.40	1.70	0.110
After mouth feeling (feel less bitterness)	2.67	2.10	1.23	0.000
Overall acceptability	2.20	2.30	1.50	0.015

Figure 4: Web diagram for sensory evaluation 03

The sample 210 (ice cream made with 25% Natural Palmyra Pulp Ice cream) has the highest mean value with all tested sensory attributes, it

3.2.3 Results of sensory evaluation 03

The three ice cream samples were prepared with 3 different commercial Palmyra pulp to select best percentage of Palmyra pulp. It was added before overrun process & pulp is less bitterness according to sensory no 01.

Sample number 305 = ice cream made with 20 % Commercial Palmyra pulp (less bitter) ice cream.
Sample number 310 = ice cream made with 25 % Commercial Palmyra pulp (less bitter) ice cream.
Sample number 315 = ice cream made with 30 % Commercial Palmyra pulp (less bitter) ice cream.
Significant difference was observed for colour, taste, creaminess, after mouth feelings and

Table 5: Mean value of tested parameters in sensory evaluation 03

Tested parameters	305	310	315	P value
Colour	1.60	2.57	1.83	0.005
Aroma	1.63	2.33	2.03	0.460
Appearance	1.80	2.83	1.87	0.192
Taste	2.13	2.67	1.20	0.000
Creaminess	2.00	2.77	1.23	0.000
Texture	1.73	2.27	2.00	0.280
After mouth feeling (feel less Bitterness)	2.60	2.07	1.33	0.000
Overall acceptability	2.03	2.53	1.43	0.020

overall acceptability (p value <0.05) between three samples. But for aroma, appearance and texture there was no significant difference.
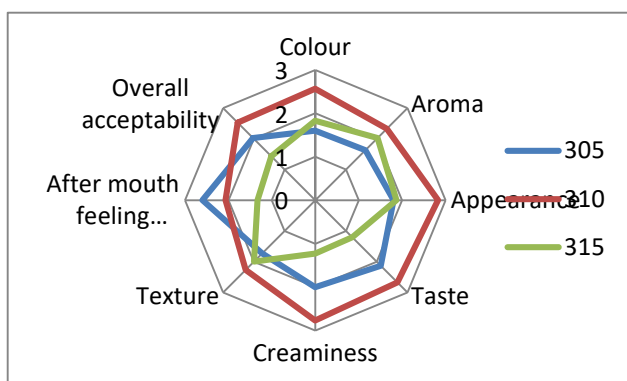

Figure 5: Web diagram for sensory evaluation 03

The sample 310 (ice cream made with 25% Commercial Palmyra Pulp Ice cream) has the highest mean value with most of the tested sensory attributes, it is the best sample. And also according to drawn web diagram the

sample which was coded as 310 was selected as the best sample. Although for the after mouth

Table 6: Mean values of tested parameters in sensory evaluation 04

Tested parameters	405	410	P value
Colour	1.13	1.87	0.020
Aroma	1.67	1.33	0.096
Appearance	1.83	1.17	0.040
Taste	1.80	1.20	0.003
Creaminess	1.50	1.50	1.000
Texture	1.63	1.37	0.060
After mouth feeling (feel less Bitterness)	1.83	1.17	0.020
Overall acceptability	1.80	1.20	0.007

feeling (feel less bitterness) most of the panellists were preferred for sample no 305 (ice

cream made with 20% (less) commercial pulp). Sample no 315 was prepared with high (30%) percentage of commercial pulp. Due to that it was given high bitter taste. Hence it was rejected. Sample no 305 was prepared with low (20%) percentage of commercial pulp. Due to that it was given milky taste, than pulp taste. Hence it was rejected.

3.2.4 Results of sensory evaluation 04
The two ice cream samples were prepared with 25% commercial and natural Palmyra pulp to select best Palmyra pulp. Pulp was added before overrun process & pulp is less bitterness according to sensory no 01.

Sample number 405 = Natural Palmyra pulp ice cream
Sample number 410 = Commercial Palmyra pulp ice cream
Significant difference was observed for colour, taste, appearance, after mouth feelings and overall acceptability (p value <0.05) between three samples. But for aroma, creaminess and texture there was no significant difference.

The sample 405 (ice cream made with 25% Natural Palmyra Pulp Ice cream) has the highest mean value with most of the tested sensory attributes, it is the best sample. And also according to drawn web diagram the sample which was coded as 405 was selected as the best sample. But for the colour most of the panellists were preferred for sample no 410 (ice cream made with Commercial Palmyra pulp). The sample no 410 was prepared with 25% commercial Palmyra pulp ice cream was rejected by sensory evaluation. Due to due to the presence of added preservatives such as citric acid and sodium Meta bisulphite (SMS) in commercial pulp.
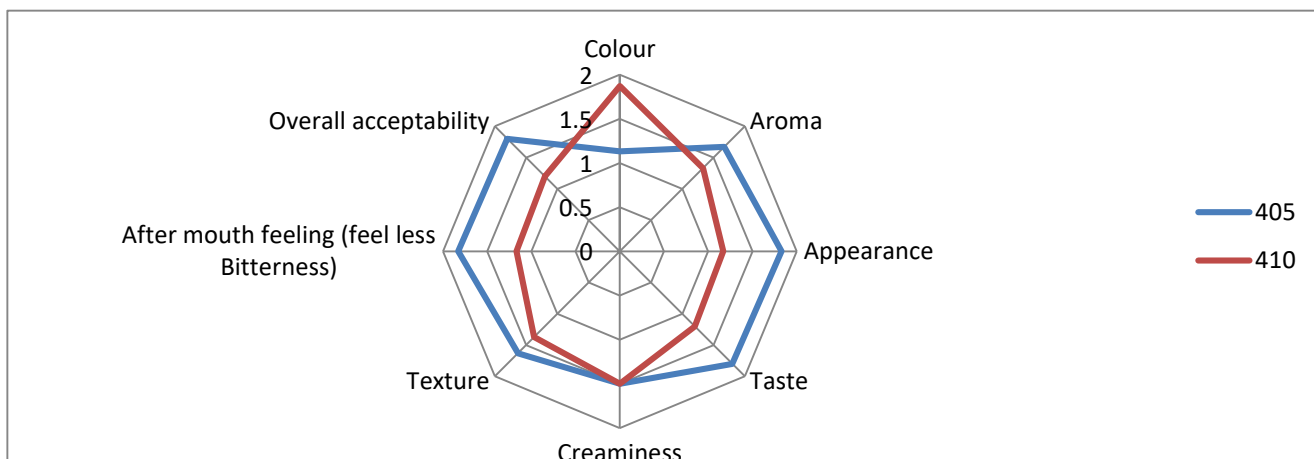
Figure 6: Web diagram for sensory evaluation 04

3.2.5 Results of sensory evaluation 05

Three ice creams were prepared with three different concentration of cinnamon oleoresin to select the best ppm level of oleoresin. Natural Palmyra pulp was used according to sensory 04. Pulp was added before overrun process & pulp is less bitterness according to sensory no 01.

Table 7: Mean values of tested parameters in sensory evaluation 05

Tested parameters	505	510	515	P value
Colour	1.90	2.00	2.10	0.789
Aroma	1.33	2.07	2.60	0.000
Appearance	1.80	2.00	2.20	0.358
Taste	1.43	1.90	2.67	0.001
Creaminess	1.93	1.93	2.13	0.766
Texture	1.73	2.03	2.23	0.178
After mouth feeling (feel less Bitterness)	1.47	2.03	2.50	0.003
Overall acceptability	1.43	2.00	2.57	0.004

505 = Cinnamon flavoured Natural Palmyra pulp ice cream made with 75 ppm cinnamon oleoresin.
510 = Cinnamon flavoured Natural Palmyra pulp ice cream made with 100 ppm cinnamon oleoresin.
515 = Cinnamon flavoured Natural Palmyra pulp ice cream made with 125 ppm cinnamon oleoresin.

Significant difference was observed for arma, taste, after mouth feelings and overall acceptability (p value <0.05) between three samples. However, for colour, appearance, creaminess and texture there was no significant difference. The sample 515 (125 ppm of cinnamon oleoresin) has the highest mean value with most of the tested sensory attributes, it is the best sample. And also according to drawn web diagram the sample which was coded as 515 was selected as the best sample.

The samples 505 and 510 were prepared with lesser cinnamon ppm level than sample no 515. There were not resulting acceptable flavour profiles as the latter. Due to that they were excluded after sensory evaluation. Cinnamon was added to ice cream to develop flavour profile of ice cream with palmyra flavour and to
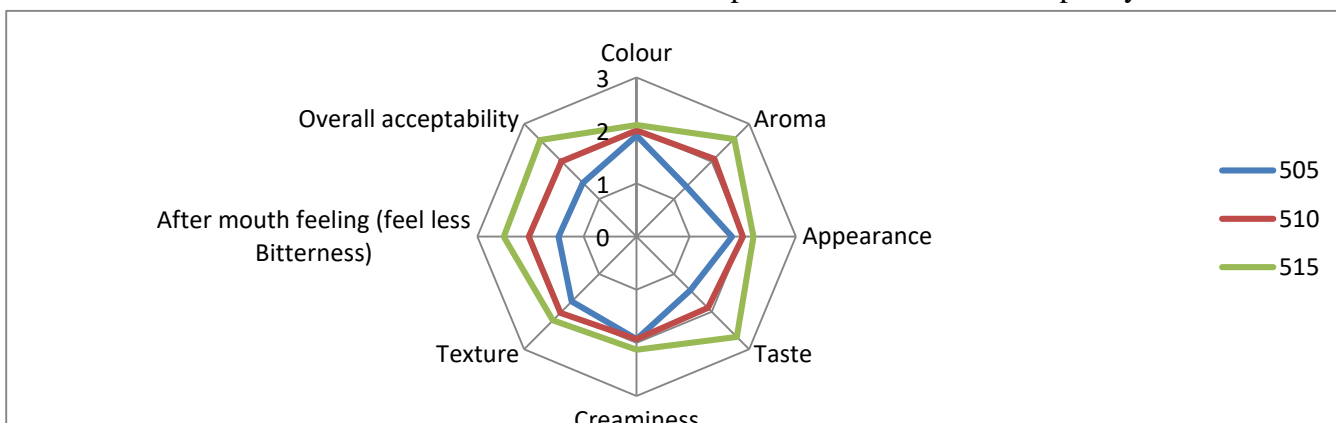

Figure 7: Web diagram for sensory evaluation 05

increase the antioxidant activity of ice cream. Cinnamon oleoresin doesn't have high contribution on behalf of major nutrients.

3.2.6 Results of sensory evaluation 06

Three ice creams were prepared with three different concentration of Ginger oleoresin to select the best ppm level of oleoresin. Natural Palmyra pulp was used according to sensory 04. Pulp was added before overrun process & pulp is less bitterness according to sensory no 01.

Table 8: Mean values of tested parameters in sensory evaluation 06

Tested parameters	605	610	615	P value
Colour	1.77	1.93	2.30	0.115
Aroma	1.57	1.93	2.50	0.010
Appearance	1.93	1.93	2.13	0.729
Taste	1.43	2.00	2.30	0.002
Creaminess	1.90	1.93	2.17	0.649
Texture	1.77	1.93	2.30	0.139
After mouth feeling (feel less Bitterness)	1.53	2.00	2.47	0.007
Overall acceptability	1.37	2.10	2.53	0.001

samples. Though for colour, appearance, creaminess and texture there was no significant difference.

The sample 615 (125 ppm of Ginger oleoresin) has the highest mean value with most of the tested sensory attributes, it is the best sample. And also according to drawn web diagram the sample which was coded as 615 was selected as the best sample. The samples 605 and 610 were prepared with less ginger ppm level than sample no 615. There were not given good flavour profile as combination of ginger and palmyra flavour. Due to that they were rejected by sensory evaluation. Ginger was added to ice cream to develop flavour profile of ice cream with palmyra flavour and to increase the antioxidant activity of ice cream. Ginger oleoresin doesn't have high nutritional components.

3.2.7 Results of sensory evaluation 07

The two ice cream samples were prepared with 125 ppm Cinnamon and ginger oleoresin to select best oleoresin to natural palmyra pulp ice cream. Natural palmyra pulp was used according to sensory no 04. Pulp was added
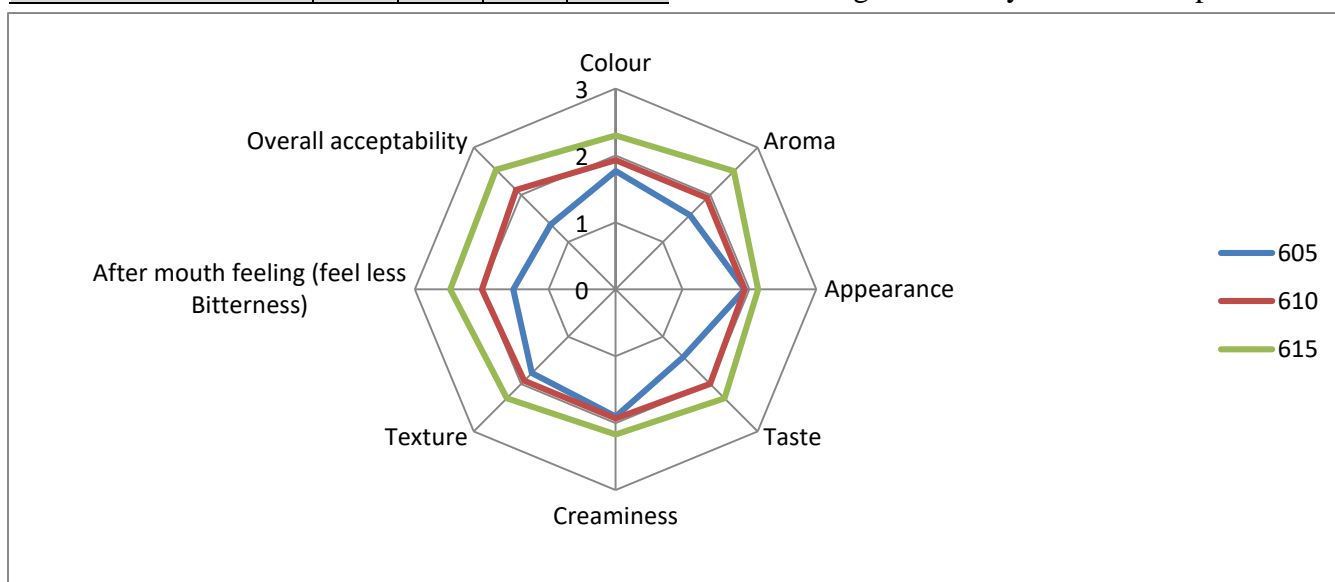

Figure 8: Web diagram for sensory evaluation 06

605 = Ginger flavoured Natural Palmyra pulp ice cream made with 75 ppm Ginger oleoresin.
610 = Ginger flavoured Natural Palmyra pulp ice cream made with 100 ppm Ginger oleoresin.
615 = Ginger flavoured Natural Palmyra pulp ice cream made with 125 ppm Ginger oleoresin.
Significant difference was observed for aroma, taste, after mouth feelings and overall acceptability (p value <0.05) between three

before overrun process & pulp is less bitterness according to sensory no 01.

Sample number 705 = Cinnamon Flavoured Natural Palmyra pulp ice cream
Sample number 710 = Ginger Flavoured Natural Palmyra pulp ice cream
Significant difference was observed for aroma, taste, after mouth feelings and overall acceptability (p value <0.05) between three

samples. For colour, appearance, creaminess and texture; there was no significant difference.

Table 9: Mean values of tested parameters in sensory evaluation 07

Tested parameters	705	710	P value
Colour	1.67	1.33	0.096
Aroma	1.13	1.87	0.005
Appearance	1.63	1.37	0.102
Taste	1.17	1.83	0.004
Creaminess	1.53	1.47	0.705
Texture	1.53	1.47	0.739
After mouth feeling (feel less Bitterness)	1.20	1.80	0.007
Overall acceptability	1.07	1.93	0.000

The sample 710 (ice cream made with Ginger Oleoresin) has the highest mean value with most of the tested sensory attributes, it is the best sample. And also according to drawn web diagram the sample which was coded as 710 was selected as the best sample. But for the colour and appearance most of the panellists were preferred for sample no 705 (ice cream made with Cinnamon oleoresin).

3.2.8 Results of sensory evaluation 08

Granulated Jaggery was added to select ice cream in sensory no 07 (Ginger flavoured Natural Palmyra Pulp ice cream) without adding sugar with 2 different stages (during mix making and during ice cream filling).

805 = Granulated Jaggery was added during mix making to prepare Jaggery added Ginger Flavoured Natural Palmyra pulp ice cream

810 = Granulated Jaggery was added during filling process to prepare Jaggery added Ginger Flavoured Natural Palmyra pulp ice cream.

Significant difference was observed for colour, taste, appearance, creaminess, texture after mouth feelings and overall acceptability (p value <0.05) between three samples. For aroma, there was no significant difference.

The sample 810 (Granulated Jaggery was added during filling) has the highest mean value with most of the tested sensory attributes, it is the best sample. And also according to drawn web diagram the sample which was coded as 810
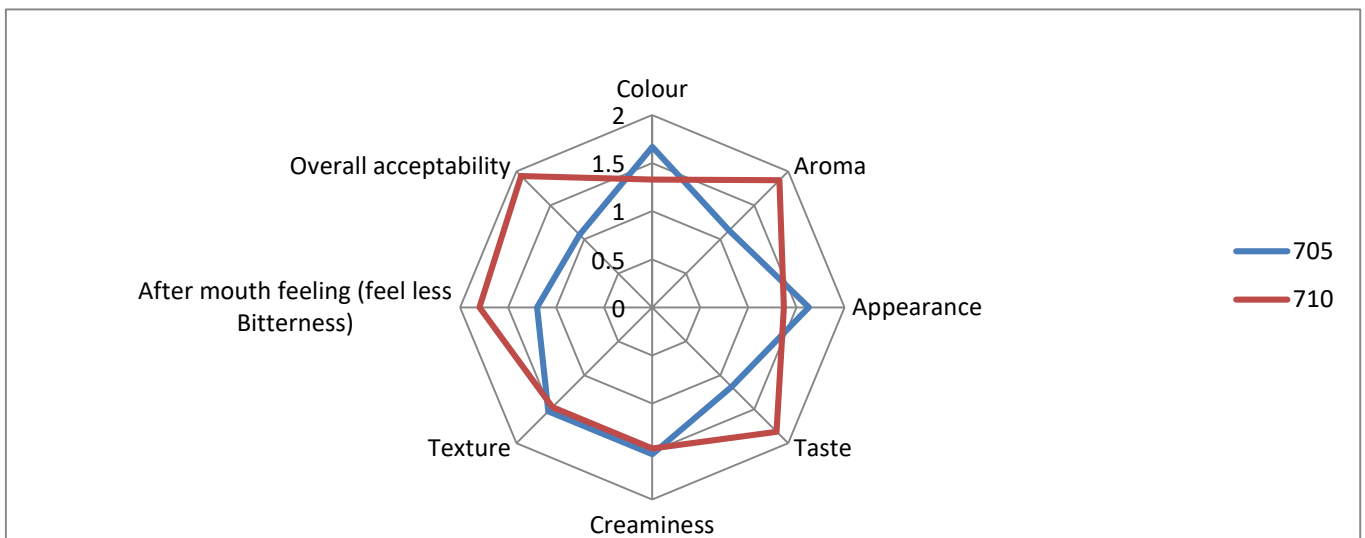

Figure 9: Web diagram for sensory evaluation 07

Sample 705 (cinnamon flavoured) was rejected by sensory evaluation when comparing with sample no 710 (ginger flavoured). Because ginger oleoresin was masked the bitter taste of palmyra in GIinger flavoured natural palmyra pulp ice cream and bitter taste did not exist at after mouth feelings. But in cinnamon flavoured ice cream was given bitter taste at after mouth

was selected as the best sample. But for the colour most of the panellists were preferred for sample no 805 (Jaggery was added during mix making).

Granulated Jaggery was added to increase the usage of palmyra jaggery and reduce the usage of sugar content. And also increase the nutritional composition of ice cream. According

to Ravindra babu, (2012), Jaggery has moisture content- 8.5 %, fat- 0.17 %, protein- 0.98 %, ash- 4.5 % and carbohydrates- 90.60 %.

Table 10: Mean values of tested parameters in sensory evaluation 08

Tested parameters	805	810	P value
Colour	1.10	0.90	0.000
Aroma	1.43	1.57	0.527
Appearance	1.10	1.90	0.001
Taste	1.13	1.87	0.002
Creaminess	1.27	1.73	0.020
Texture	1.23	1.77	0.011
After mouth feeling (feel less Bitterness)	1.07	1.93	0.001
Overall acceptability	1.00	2.00	0.000

Sample no 805 was prepared ice cream and jaggery was added during mix preparation. That ice cream mix was existed as high viscous and it was shown difficult to air incorporation in overrun machine. So sample no 805 was rejected by sensory evaluation. Sample no 810, Granulated Jaggery was added during filling at three layers like fruit and nut ice cream. It was highly accepted.

between ice cream mix samples in Adhesiveness (p value > 0.05).

Figure 11: Graph for Hardness with ice cream variety

According to the TUKEY pair wise comparison there was significant different was observed in

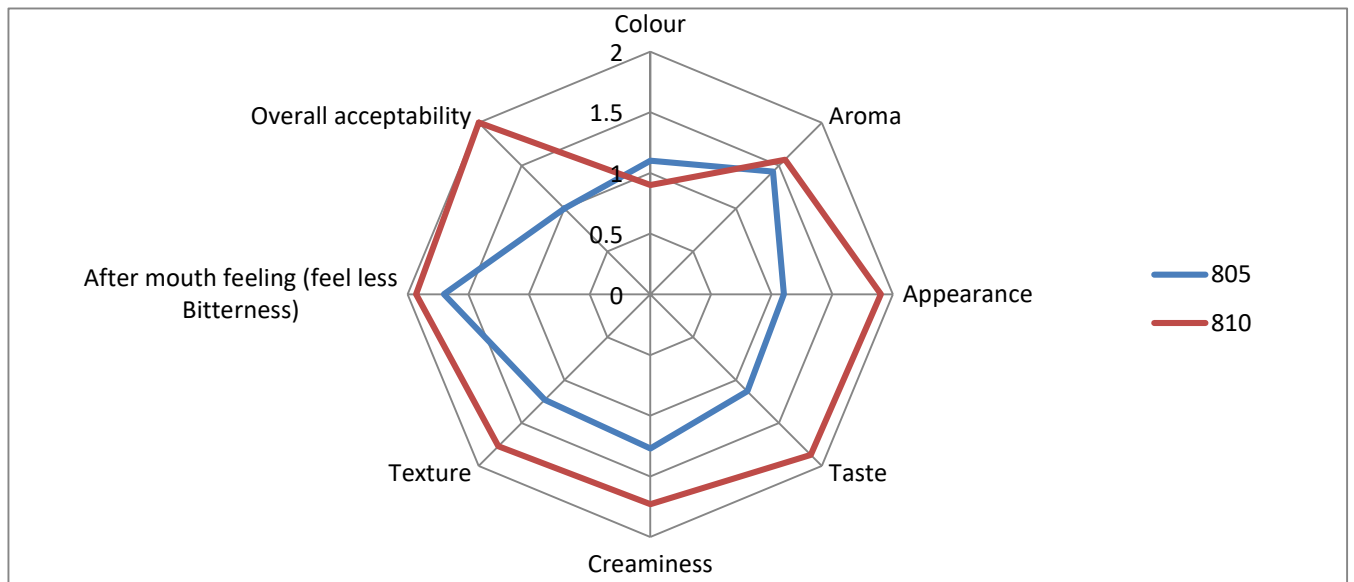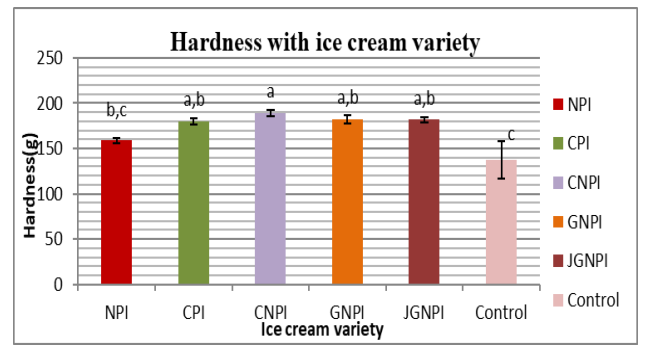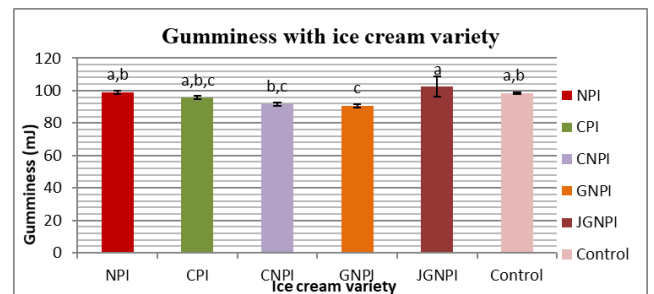Figure 12: Graph for gumminess with ice cream variety

Figure 10: Web diagram for sensory evaluation 08

3.3 Results for texture profile

According to the results obtained from one-way ANOVA for texture profile analysis, there was no significant different was observed between ice cream mix samples in hardness, Gumminess, Chewiness and Cohesiveness (p value < 0.05). But there was significant different was observed

hardness of ice cream samples. CNPI was observed as higher and control sample was showed lower hardness than other ice cream variety.

Table 11: Results of texture profile for final ice creams

	NPI	CPI	CNPI	GNPI	JGNPI	Control	p
Hardness(g)	158.56±2.83	179.69±3.72	188.77±3.46	182.24±4.56	181.66±2.55	137.20±20.5	0.000
Gumminess(mJ)	98.79±0.96	95.61±1.06	91.66±1.05	90.59±1.19	102.39±6.35	98.49±0.60	0.001
Chewiness (mJ)	13.11±0.18	14.50±0.28	14.85±0.71	15.40±0.36	15.33±0.37	12.03±0.40	0.000
Adhesiveness (mJ)	2.20±0.32	1.20±0.18	2.05±0.10	1.94±0.15	1.95±0.10	1.80±0.05	0.160
Cohesiveness	0.12±0.00	0.14±0.01	0.15±0.004	0.13±0.03	0.18±0.01	0.11±0.00	0.002

According to the TUKEY pair wise comparison there was significant different was observed in Gumminess of ice cream samples. JGNPI was observed as higher and GNPI was showed lower Gumminess than other ice cream variety.
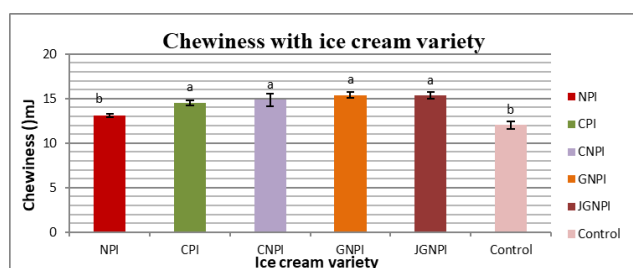

Figure 13: Graph for chewiness with ice cream variety

According to the TUKEY pair wise comparison there was significant different was observed in Chewiness of ice cream samples. GNPI was observed as higher and control sample was showed lower Chewiness than other ice cream variety.
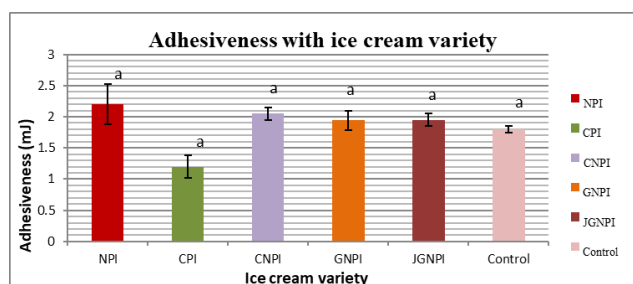

Figure 14: Graph for Adhesiveness with ice cream variety

According to the TUKEY pair wise comparison there was significant different was observed in Adhesiveness of ice cream samples. NPI was observed as higher and CPI was showed lower Adhesiveness than other ice cream variety.
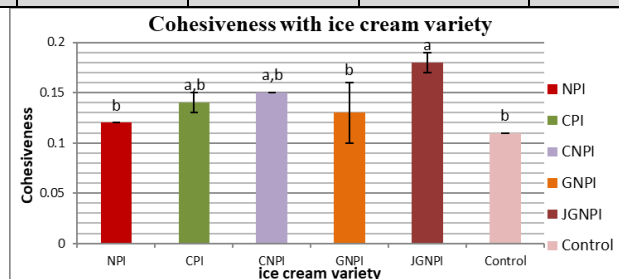

Figure 15: Graph for cohesiveness with ice cream variety

According to the TUKEY pair wise comparison there was significant different was observed in Adhesiveness of ice cream samples. JGNPI was observed as higher and control sample was showed lower Adhesiveness than other ice cream variety.

3.4 Results of the "overrun"

According to the results obtained from one-way ANOVA overrun % results, there was significant different was observed between ice cream mix samples in Overrun percentage (p value > 0.05).

Table 12: Overrun % Mean with standard deviation

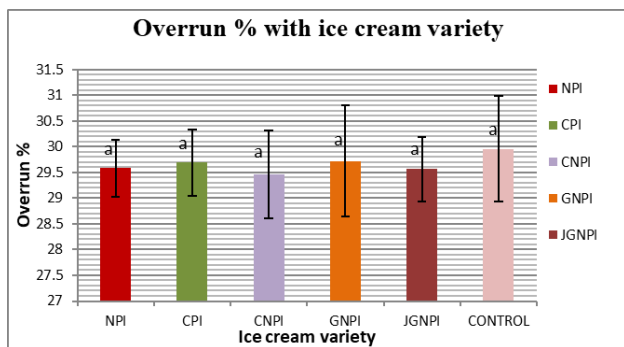| Types of ice creams	Overrun % Mean with standard deviation
NPI	29.58± 0.55 [a]
CPI	29.67 ± 0.65 [a]
CNPI	29.47 ± 0.85 [a]
GNPI	29.72 ± 1.08 [a]
JGNPI	29.57 ± 0.63 [a]
CONTROL	29.96 ± 1.02 [a]

Figure 16: Graph for overrun % with ice cream variety

According to TUKEY pairwise comparison there was no significant different was observed in overrun percentage of NPI, CPI, CNPI, GNPI, JNPI and control ice cream samples.

4. DISCUSSION

Jaggery added ginger flavoured palmyra pulp based ice cream was a success with respect to its sensory properties and overall product qualities. It is also commercially feasible due to availability of raw materials in the tropics. Improvement and diversification of flavour in typical ice creams can be obtained by using a palmyra pulp; as have revealed by the results. Ginger elicits to have greater marking properties of bitterness that makes its oleoresin a viable ingredient in ice cream processing.

Ideal amounts of pulps to be used can be pointed out as; 25% of natural pulp and commercial pulp. Amongst the two, the natural pulp revealed to be the best one. The best concentrations of cinnamon and ginger were 125 ppm. Ginger can be recommended as best spices according to masking properties of bitterness. Altogether, we can conclusively determine that development of jaggery added natural palmyra pulp ice cream is feasible.

Figure 17: Appearance of the rejected high viscous ice cream mix

Figure 18: Appearance of the accepted ice cream mix (less viscous)

Figure 19: Selected best product- jaggery added ginger flavoured natural palmyra pulp ice cream

Ice cream texture is major parameter for ice cream. Texture is results from ice cream's structure (Goff, 1997) as contributed by water, fat, milk solids-not-fat (casein micelles, whey proteins, lactose, and milk salts), sugars, stabilizers, and emulsifiers and air (Goff & Hartel, 2013). Structure formation of ice cream is highly complex, that resulting from various stages, including pasteurization, homogenization, ageing, whipping, freezing and hardening (Goff, 1997).

Potter & Hotchkiss, (2012), reported as the normal range of overrun is 70% to 100%. Overrun percentage of ice cream results were observed as range between 29 to 30%. It is due to the overrun machine in research and development laboratory in MILCO (PVT) LTD. That machine was given maximum overrun percentage as 30%. Overrun % was reduced below 30 % when increase viscosity of ice cream mix in that machine.

5. CONCLUSION

Organoleptic properties of dairy ice creams can be improved by using a palmyra pulp as a base, jaggery as a sweetener and tropical spices as flavour enhancers/ maskers. Ideal formulations of these ingredients could result in an acceptable product without damaging their overrun or the textural characteristics.

6. ACKNOWLEDGEMENT

7. CONFLICTS OF INTERESTS

All authors confirm that they don't have any conflict of interests.

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