



# IMPACT OF PROBIOTICS AND SUGAR SUBSTITUTES ON THE SENSORY QUALITY AND CONSUMER ACCEPTANCE OF SOY ICE CREAM

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## Abstract

Ice cream is a nutritious food because it contains ingredients responsible for supplying energy to the body. Soy has a high nutritional value and functional properties which make it to be an alternative ingredient to replace cow's milk. The purpose of this paper was to formulate an ice cream with soy milk and cow milk & banana powder, is also used and submitted to a sensory evaluation. Three formulations of ice cream were prepared: one soy-based (containing soy milk 70% , cow milk 30%) and this is control sample, the other with soy-based probiotic ice cream (containing soy milk 70% , cow milk 30%) and last one is sugar free (containing 100 % cows milk only) & for the sugar replacement here we added dextrose, fructo-oligosaccharide & oligofructose) & for all the three types of ice creams here we used ripened banana powder as it is a good source of dietary fibre, which promotes the healthy digestion, supports weight management. All these ice creams were submitted to a sensory evaluation in order to evaluate the appearance, flavor and texture attributes, mouthfeel, sweetness and overall acceptance, for this examination it was used the hedonic scale of five points. With regard to **colour & appearance** control ice cream obtained rating of 3.8 remaining between the terms "Good" & "Very good", while the probiotic with sugar ice cream got 3.71 remaining between the terms "Good" & "Very good" and where as the probiotic sugar free ice cream obtained 4.0 remaining between the terms "Good" & "Very good". For the attribute **flavour & taste** control ice cream obtained rating of 4.1 remaining between the terms "Excellent" & "Very good", while the probiotic with sugar ice cream also got the result of 4.01 whose term is as same the control sample and where as the probiotic sugar free ice cream obtained 3.2 remaining between the terms "Good" & "Very good". For the attribute **mouthfeel**, control ice cream obtained rating of 4.16 which corresponds between the terms "Excellent" & "Very good", while the probiotic with sugar ice cream got 3.6 remaining between the terms "Good" & "Very good" and where as the probiotic sugar free ice cream obtained 3.4 remaining between the terms "Good" & "Very good". For the attribute **sweetness** control ice cream obtained rating of 4.0 which corresponds to the terms between "Very good" & "Excellent", while the probiotic with sugar ice cream got 3.93 remaining between the terms "Good" & "Very good", where as the probiotic sugar free ice cream obtained 3.0 which corresponds to the "good". The sensory parameters evaluated showed that the control ice cream i.e soy-based dietary ice cream had a good acceptance compared to that of the probiotic with sugar soy based dietary ice cream & probiotic sugar free ice cream.

## Key words

Ice cream, soy milk, probiotic, sugar free sensory acceptance

## **1. INTRODUCTION :**

Sensory Analysis involves describing and scientifically measuring the characteristics of a product that are perceived by the senses: sight, sound, smell, taste, and touch. By analyzing sensory information, one can provide guidelines for developing food products on which attributes to focus on when making decisions. This decision-making process considers factors such as ingredients and economic aspects. It goes beyond simply tasting food; it also includes describing the color, texture, flavor, aftertaste, aroma, tactile feel, and even sound of the food. Sometimes, sensory analysis is used interchangeably with sensory evaluation. Sensory analysis assesses the characteristics (texture, flavor, appearance, smell, etc.) of a product or food through the senses (sight, smell, taste, touch, and hearing) of the panelists. This analysis method has been utilized for generations to determine whether to accept or reject food products. Initially, it was seen as a method that complements technological and microbiological safety inspections in assessing food quality. However, its significant evolution and impact in recent years have elevated it to being one of the most crucial approaches for innovation and implementation to guarantee consumer acceptance of the final product. In the past, soy was primarily known for its high protein content, earning it the nickname "vegetal meat." However, modern research has delved into its various functional properties, leading to its integration into healthy eating routines. The nutritional value of soy is apparent due to its significant mineral content, including potassium, phosphorus, and vitamins. Additionally, soy contains beneficial components like isoflavones, which possess antioxidant properties that can lower the risk of cancer, heart diseases, postmenopausal bone loss, and osteoporosis (Esteves and Monteiro, 2001; Goes-Favoni et al., 2004). Ice cream, on the other hand, can be seen as a nutritious treat due to its macronutrient composition, providing carbohydrates, proteins, and lipids that supply energy for a balanced diet (Marshall and Arbuckle, 1996). It is enjoyed by individuals across various age groups (Munhoz et al., 2010). Soy ice cream is a great option for those who are lactose intolerant struggle to digest the sugar in milk. Lactase is an enzyme in the that breaks down lactose into simpler sugars like glucose and galactose. Symptoms of lactose intolerance include nausea, flatulence, abdominal pain, and diarrhea. Enjoying ice cream can also help increase soy intake and its benefits.

A prebiotic is a non-digestible food ingredient that boosts the growth and/or activity of specific bacteria in the colon, benefiting the host. To be classified as a prebiotic, it must pass through the upper gastrointestinal tract without being broken down or absorbed, act as a preferred food source for beneficial colon bacteria, and promote a healthier microflora in the colon. Claims about prebiotics improving health conditions need further scientific verification, including relief from constipation, suppression of diarrhea, and reducing the risks of various diseases like osteoporosis, cardiovascular issues, obesity, and possibly type 2 diabetes. Some prebiotic ingredients, such as non-digestible oligosaccharides, have shown to enhance calcium absorption, but the effects depend on the specific type and amount consumed. By including ripened banana flour as a prebiotic ingredient in ice cream production, it's possible substitute six percent of sugar in probiotic ice cream that originally contains sugar, including in the control sample. Comparisons were made between the control sample (consisting of soy milk, cow milk, and banana powder) and probiotic sugar-added ice cream (sharing the same ingredients as the control, but with added cultures), as well as the control sample and probiotic sugar-free ice cream (comprising only cow milk, cultures, and dextrose, fructo-oligosaccharide, and oligofructose for sugar replacement). The data comparisons and interpretations for all these variations are presented in the subsequent paragraphs. This study aimed to develop and assess the sensory appeal of an ice cream made with soy milk and banana powder with a mixed fruit flavor (control), along with probiotic sugar-added ice cream (mixed fruit flavor) and probiotic sugar-free ice cream (strawberry flavor).

## **OBJECTIVES :**

- Benchmark to Standards – Ensuring the product meets expectations.
- Competitive/Comparative Analysis – How good is it relative to others.
- Product Development – Discovering new standards.
- Cost/Value Optimization – Can we make it as good for less?
- Determine sensory acceptability of the developed product in terms taste, color and aroma along the three group of respondents.
- Determine the most preferred formula for each product.

## 2. MATERIALS AND METHODS

**Materials preparation:** . The materials used in this study are the Ice cream samples, water, hand sanitizer, tissue paper, sample container, wooden ice cream sticks, hedonic sensory sheet and ballpen.

The three ice cream samples were coded accordingly. Single sample container is used for the whole sensory panels. Every sensory panel member was provided with three wooden ice cream sticks & we had given them awareness that not to reuse the wooden ice cream sticks for different ice cream samples. The sample container used is clean and identical for all samples at all sessions. Serving temperature was at room temperature to remove possible errors and bias on the samples. As to the flow of this study, Figure 4 shows a flow diagram of the procedures of this study. The ice cream samples were prepared, collected and coded accordingly. It is followed by subjecting each sample to sensory evaluation using the 5-point Hedonic Scale score sheet. After which, the panel of evaluators were given another set of questionnaires for preference test, and asked them to rank in descending order to determine their most preferred product.

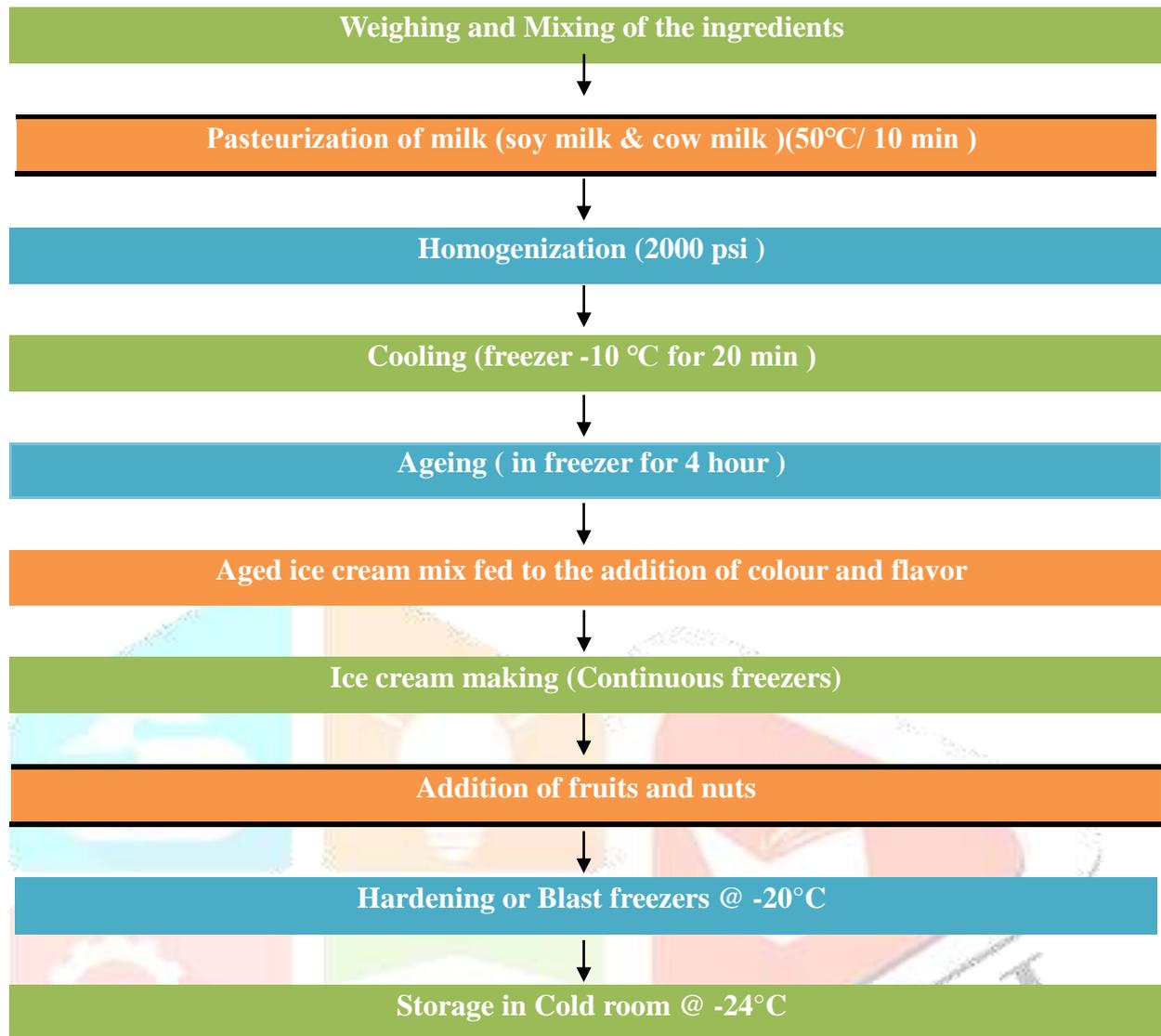
### 2.1 preparation of ice cream

All the three ice creams were produced by the soy-based ice cream (control) , soy based probiotic added sugar & probiotic sugar free ice cream . The composition of the ice creams for (3.3 kg) are mentioned in the **Table .1** . The ice creams were prepared on a pilot scale, according to the flowchart in **Figure 1** for control ice cream preparation , **Figure 2** for probiotic with sugar ice cream & **Figure 3** for sugar free ice cream preparation flow chart.

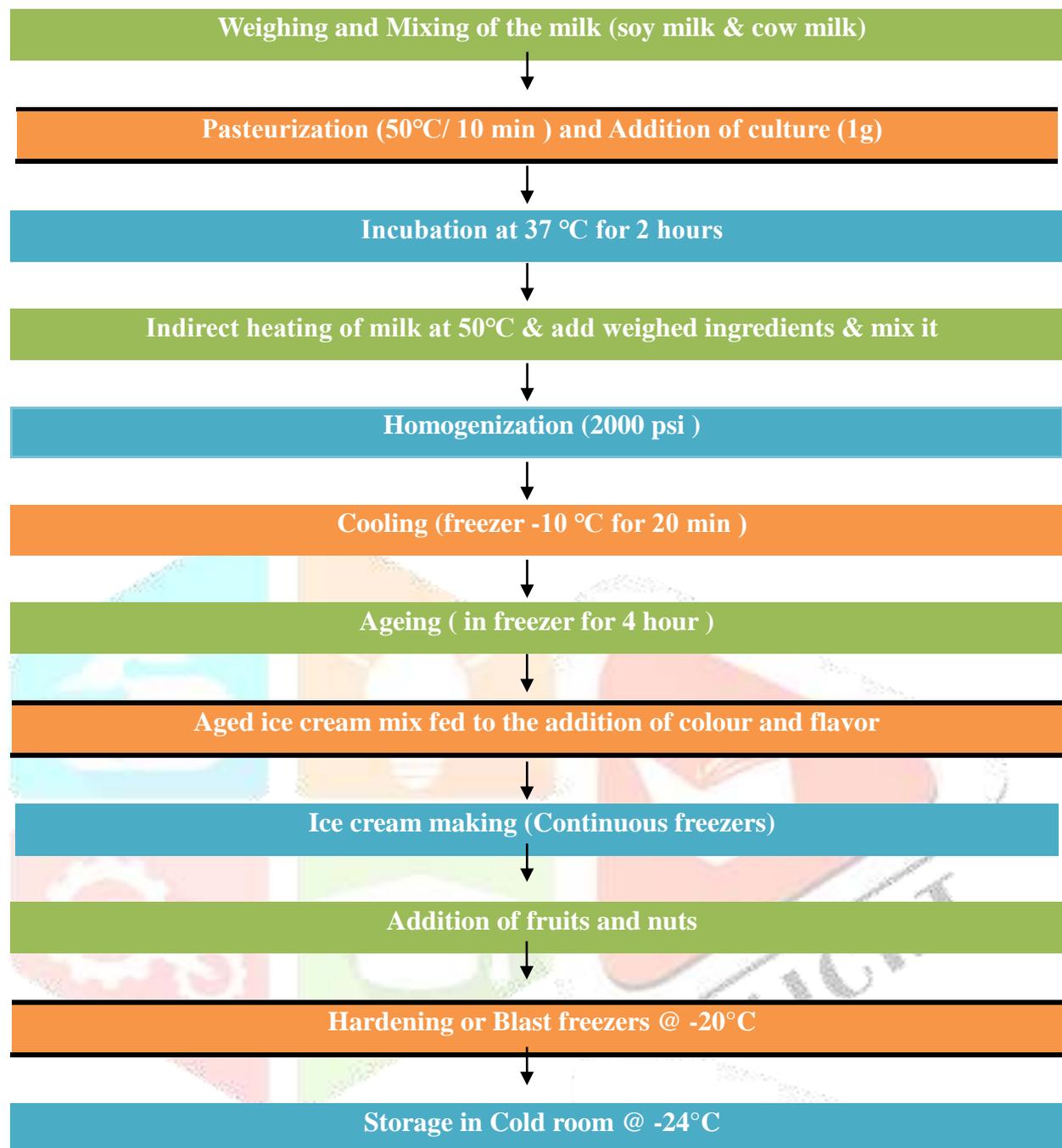
#### THE COMPOSITION OF THE ICE CREAMS

Components	Soy milk based ice cream (control sample)	Probiotic added sugar ice cream	Probiotic sugar free ice cream
Milk	50 % in that	50 % in that	50 % in that
a) Soya milk	a) 70%	a) 70%	a) -
b) cow milk	b) 30%	b) 30%	b) 50 %
Water	10.54%	10.54%	12.5%
Banana powder	10%	10%	20%
SNF	9%	9%	11%
Sugar	8%	8%	-
Fat	6%	6%	6%
Premix	0.0375%	0.0375%	0.0375%
Lactobacillus lactis	-	0.5 gm	0.5 gm
Fructo oligosaccharide	-	-	6.06%
Dextrose	-	-	9.09%
Oligofructose	-	-	0.30%
Flavours	2ml mixed fruit essence	2ml mixed fruit essence	2ml strawberry essence

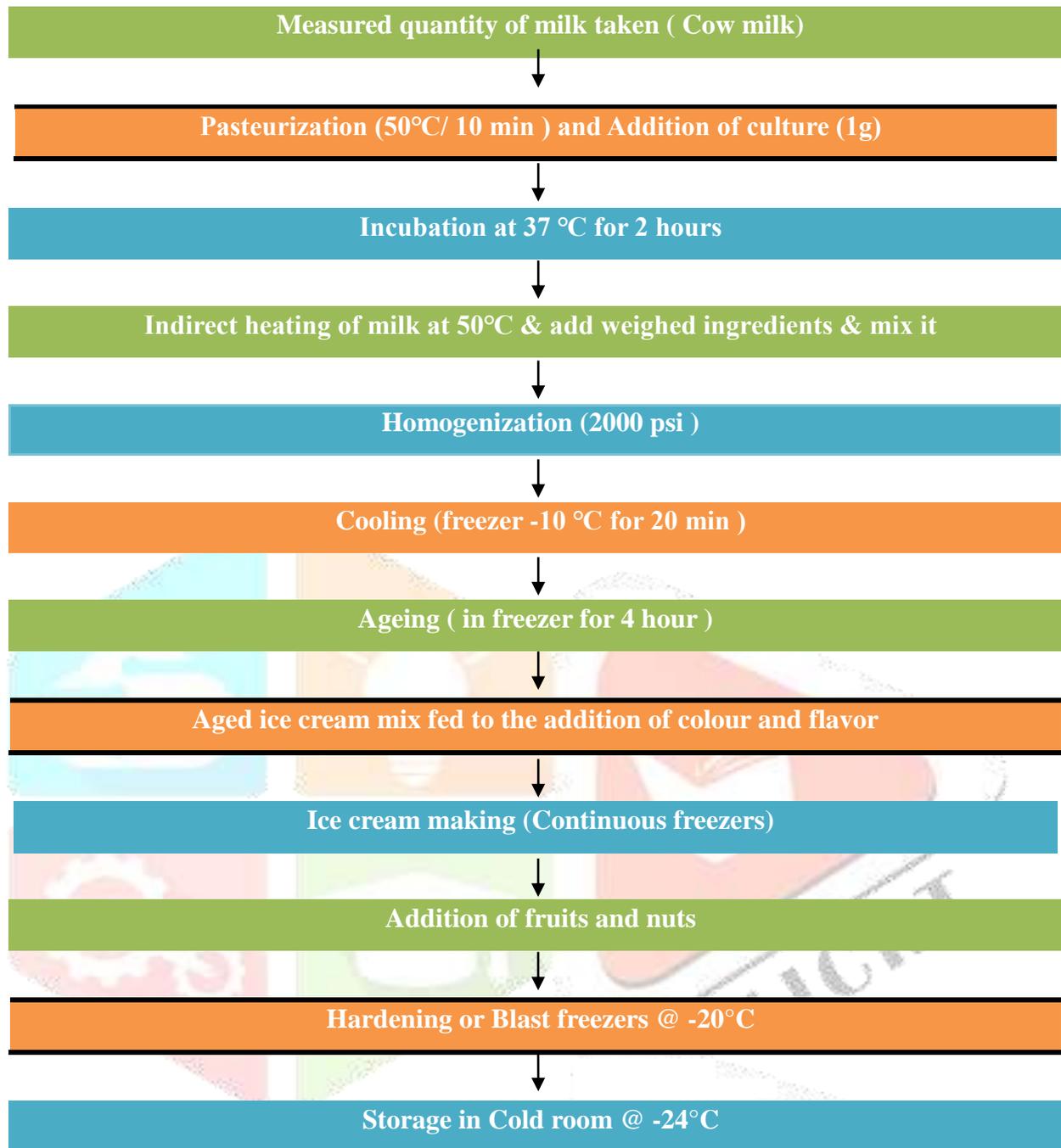
**Table 1:** The formulations of the soy milk ice cream and of the soy-based probiotic added sugar ice cream , probiotic sugar free ice cream.

**CONTROL ICE CREAM PREPARATION FLOW CHART**

**Figure 1 :** Flowchart of the mixed fruit flavored , soy milk based dietary ice cream

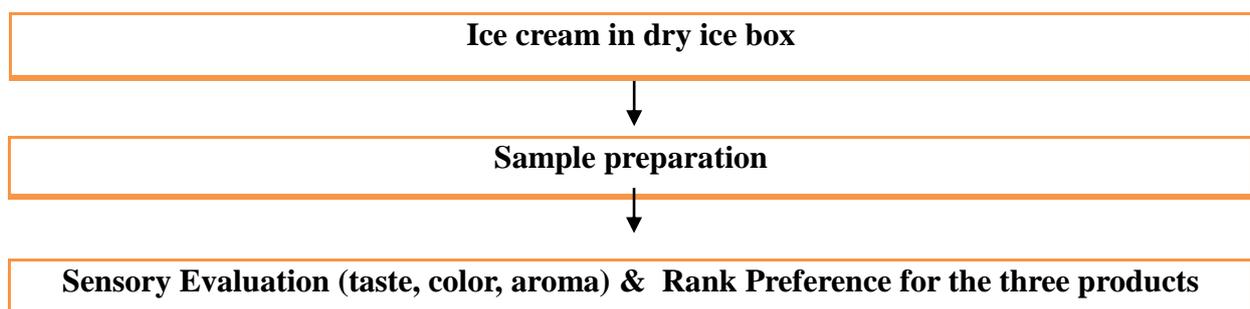
**PROBIOTIC WITH SUGAR ICE CREAM PREPARATION FLOW CHART**

**Figure 2:** Flowchart of the probiotic (mixed fruit flavored) , soy milk based dietary ice cream

**SUGAR FREE ICE CREAM PREPARATION FLOW CHART**

**Figure 3 :** Flowchart of the probiotic sugar free (straw berry flavored) dietary ice cream

## **2.2 SENSORY EVALUATION OF DEVELOPED PRODUCTS**



**Figure 4 :** Flow of Sensory Evaluation of Developed Products

### 2.3 sensory evaluation

In order to verify the acceptance and the purchase intention, the test was performed at the Hangyo ice creams pvt ltd. Udupi and in Department of Food technology ,Kuvempu University Jnana Sahyadri Shankaraghatta Shivamogga district, Karnataka , with the intention to sensorially evaluate all the three formulations. Participants were asked to read and sign an informed consent form, prior to the sensory evaluation. **The test was made by 45 assessors not trained**, and 10 assessors were trained (Hangyo ice creams pvt ltd Udupi) within a range of age 20 to 25 and 30 to 40 respectively and from both sexes. The assessors must score these five attributes: colour & appearance, flavor & taste , mouth feel, sweetness & Fruits /Nuts % (Satisfactory or Unsatisfication). For this purpose, we used a structured 5 points hedonic scale, using ranges varying from “poor” to “excellent”. Participants could write additional comments on the bottom of the sensory sheet.

### 3. RESULTS & DISCUSSION :

Most of the assessors were not yet tasted the soy based ice creams and also they didn't tasted probiotic ice cream & sugar free ice cream . In sensory evaluation control ice cream had a good acceptance compared to the probiotic soy milk based dietary ice cream & probiotic sugar free dietary ice cream. Following “mean data” that are mentioned were got by calculating the mean and standard deviation for total 51 sensory panelists (table 2).

With regard to **colour & appearance** control ice cream obtained rating of 3.8 remaining between the terms “Good” & “Very good” , while the probiotic with sugar ice cream got 3.71 remaining between the terms “Good” & “Very good” and where as the probiotic sugar free ice cream obtained 4.0 remaining between the terms “Good” & “Very good”.

For the attribute **flavour & taste** control ice cream obtained rating of 4.1 remaining between the terms “Excellent” & “Very good” ,while the probiotic with sugar ice cream also got the result of 4.01 whose term is as same the control sample and where as the probiotic sugar free ice cream obtained 3.2 remaining between the terms “Good” & “Very good”.

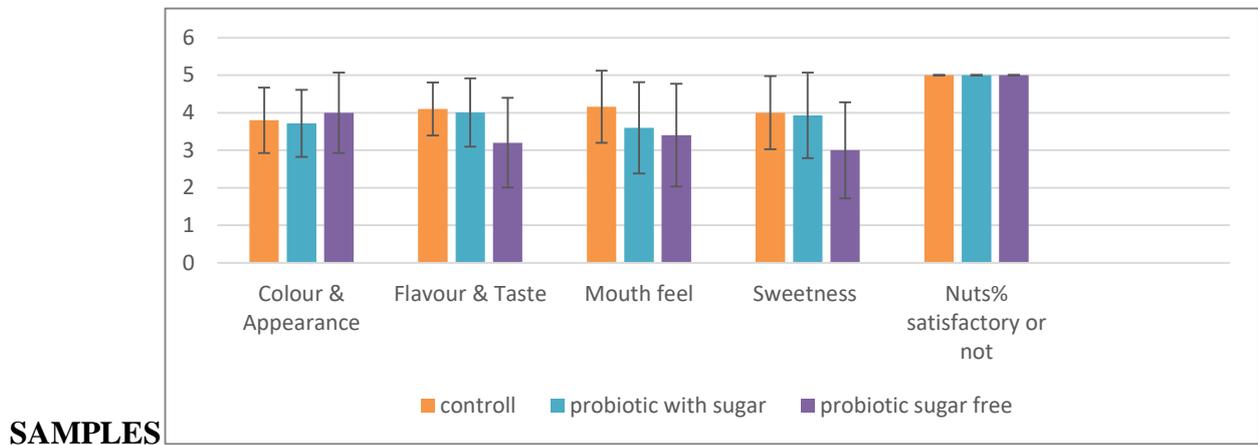
For the attribute **mouthfeel** , control ice cream obtained rating of 4.16 which corresponds between the terms “Excellent” & “Very good” , while the probiotic with sugar ice cream got 3.6 remaining between the terms “Good” & “Very good” and where as the probiotic sugar free ice cream obtained 3.4 remaining between the terms “Good” & “Very good”.

For the attribute **sweetness** control ice cream obtained rating of 4.0 which corresponds to the terms between “Very good” & “Excellent” , while the probiotic with sugar ice cream got 3.93 remaining between the terms “Good” & “Very good” , where as the probiotic sugar free ice cream obtained 3.0 which corresponds to the “good”.

For the attribute **nuts percentage** all the assessors felt that satisfactory amount of nuts are included & we asked them what type of nuts we have added in all the ice creams & the answers were like almond , pista,cashews. Most of the assessors opinion was pista and almond & we told them those are actually “roasted pumpkin seeds” but they looks like pieces of pista & nuts played an important role in mouthfeel.

The assessors overall like percentage and purchasing intention for the given ice cream samples were, 79% said that certainly they would buy the control sample and 76% definitely or probably would buy the probiotic with sugar soy-based dietary ice cream, including those who choosed to buy the control ice cream. The probiotic sugar free ice cream was liked by 65.6% & the diabetic persons who were aged between 45-50 . The sensory parameters evaluated showed that the control ice cream i.e soy-based dietary ice cream had a good acceptance compared to that of the probiotic with sugar soy based dietary ice cream & probiotic sugar free ice cream.

**GRAPHICAL REPRESENTATION OF OVERALL SENSORY ACCEPTANCE OF ICE CREAM**



**SAMPLES**

**Fig 5 :** Graphical representation of overall sensory acceptance of ice cream samples



**Fig 6:** Control ice cream sample



**Fig 7:** Probiotic with sugar ice cream sample



**Fig 8 :** Probiotic sugarfree sample



**STATISTICAL ANALYSIS**

This Statistical analysis was carried out with the help of Microsoft Excel spread sheet and the data obtained are given below.

**Table 2:** Statistical analysis was conducted to determine the means and standard deviation of the physical data and sensory data. An ANOVA was conducted to determine differences between means (Result of the total 51 memebrrs)

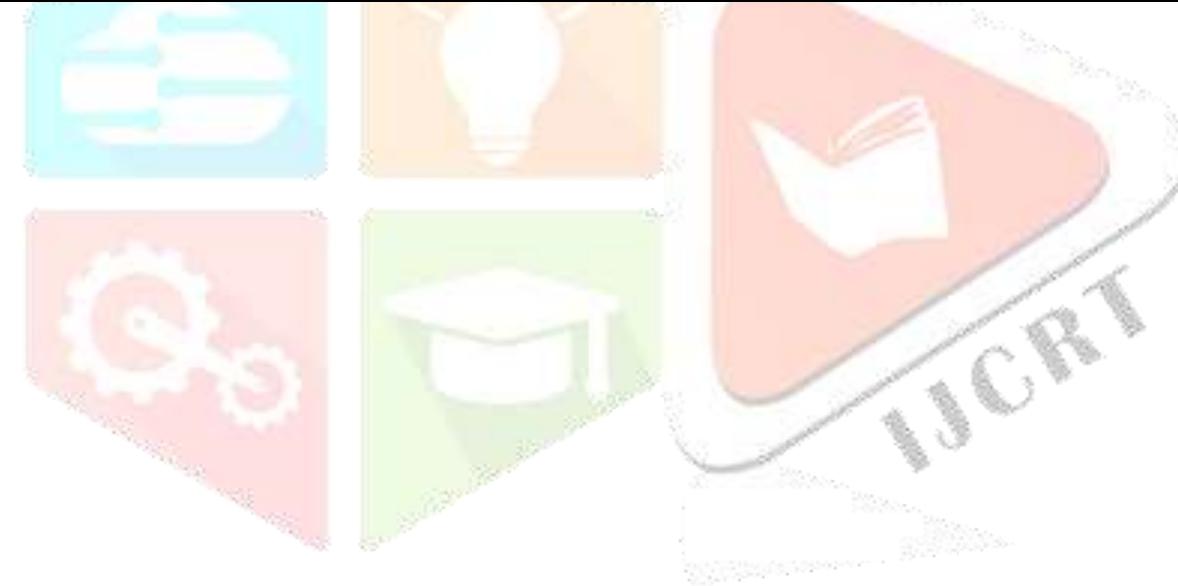
SI No	Colour & Appearance	Flavour & taste	Mouthfeel	Sweetness	Fruits/nuts% (satisfactory or Unsatisfactory)
Samples	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Satisfactory or not
Control	3.8 $\pm$ 0.87	4.1 $\pm$ 0.70	4.16 $\pm$ 0.96	4.0 $\pm$ 0.97	satisfactory
Probiotic with sugar	3.71 $\pm$ 0.89	4.01 $\pm$ 0.91	3.6 $\pm$ 1.2	3.95 $\pm$ 1.14	satisfactory
Probiotic sugar free	4.0 $\pm$ 1.07	3.22 $\pm$ 1.19	3.4 $\pm$ 1.37	3.0 $\pm$ 1.28	satisfactory

**Table 3:** Statistical analysis was conducted to determine the means and standard deviation of the physical data and sensory data. An ANOVA was conducted to determine differences between means (Result of the 43 memebrrs age between 20-30)

SI No	Colour & Appearance	Flavour & taste	Mouthfeel	Sweetness	Fruits/nuts% (satisfactory or Unsatisfactory)
Samples	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Satisfactory or not
Control	3.48 $\pm$ 0.91	3.976 $\pm$ 0.706	4.2 $\pm$ 0.94	3.9 $\pm$ 0.83	satisfactory
Probiotic with sugar	3.93 $\pm$ 0.87	3.90 $\pm$ 0.83	3.83 $\pm$ 1.03	4.11 $\pm$ 0.90	satisfactory
Probiotic sugar free	4.09 $\pm$ 0.8	3.30 $\pm$ 0.88	3.23 $\pm$ 0.81	3.13 $\pm$ 1.05	satisfactory

**Table 4:** Statistical analysis was conducted to determine the means and standard deviation of the physical data and sensory data. An ANOVA was conducted to determine differences between means (Result of the 8 members age between 30-40).

SI No	Colour & Appearance	Flavour & taste	Mouthfeel	Sweetness	Fruits/nuts% (satisfactory or Unsatisfactory)
Samples	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Satisfactory or not
Control	4.12 $\pm$ 0.83	4.25 $\pm$ 0.70	4.12 $\pm$ 0.99	4.12 $\pm$ 1.12	satisfactory
Probiotic with sugar	3.5 $\pm$ 0.92	4.12 $\pm$ 0.99	3.37 $\pm$ 1.40	3.75 $\pm$ 1.38	satisfactory
Probiotic sugar free	3.87 $\pm$ 1.35	3.0 $\pm$ 1.51	3.5 $\pm$ 1.93	3.0 $\pm$ 1.51	satisfactory



**COMPARISION OF CONTROL SAMPLE WITH THE PROBIOTICS WITH SUGAR DIETARY ICE CREAM & PROBIOTICS****SUGAR FREE DIETARY ICE CREAM****Table 5: Analysis of F value & P value was conducted to determine the F and P value of the physical data and sensory data.****(Result of the 43 memebtrs age between 20-30)**

SI No	Colour & Appearance			Flavour & taste			Mouthfeel			Sweetness			Fruits/nuts% (satisfactory or Unsatisfactory)
	F	P (F<=f) one-tail	F Critical one-tail	F	P (F<=f) one- tail	F Critica l one- tail	F	P (F<=f) one-tail	F Critica l one- tail	F	P (F<=f) one- tail	F Critica l one- tail	Satisfactory or not
Probiotic with sugar	0.9512	0.4352 ****	0.6021	0.7080	0.1335 **	0.5984	0.6784	0.1064 **	0.598	0.8364	0.2827 ***	0.5984	satisfactory
Probiotic sugar free	1.1458	0.3286 ***	1.6607	0.6424	0.0778 **	0.5984	1.1243	0.3529 ***	1.6709	0.6104	0.0568 **	0.5984	satisfactory

**If (P ≤ 0.05)\* – Significant difference, P (0.05 – 0.15) \*\*, P (0.15 – 0.35) \*\*\*, P (0.35 – 0.45) \*\*\*\***

If  $P \leq 0.05$  then it indicates that there is a slight presence of significant difference between control ice cream and the other two ice creams, it is denoted by  $P \leq 0.05^*$ , where as if the P value of the attribute lies in between 0.05 – 0.15 then it is denoted by  $P (0.05 – 0.15)^{**}$  it means no such significant difference between control ice creams and other two ice creams. If the P value of the attribute lies in between 0.15 – 0.35 then it is denoted by  $P(0.15 – 0.35)^{***}$  it indicates that no such significant difference between control ice creams and other two ice creams in a greater manner and similarly if the P value of the attribute lies in between 0.35 – 0.45 then it is denoted by  $P (0.35 – 0.45)^{****}$  it indicates that no such significant difference between control ice creams and other two ice creams in a greater manner and attribute is acceptable in a excellent manner .

**COMPARISION OF CONTROL SAMPLE WITH THE PROBIOTICS WITH SUGAR DIETARY ICE CREAM & PROBIOTICS****SUGAR FREE DIETARY ICE CREAM****Table 6 : Analysis of F value & P value was conducted to determine the F and P value of the physical data and sensory data.****(Result of the 8 memebtrs age between 30-40)**

SI No	Colour & Appearance			Flavour & taste			Mouthfeel			Sweetness			Fruits/nuts% (satisfactory or Unsatisfactory)
	F	P (F<=f) one-tail	F Critical one-tail	F	P (F<=f) one-tail	F Critica l one- tail	F	P (F<=f) one-tail	F Critica l one- tail	F	P (F<=f) one- tail	F Critic al one- tail	Satisfactory or not
Probiotic with sugar	0.8125	0.3955 ****	0.2640	0.5090	0.1964 ***	0.2640	0.4954	0.1873 ***	0.2640	0.6736	0.3075 ***	0.2640	satisfactory
Probiotic sugar free	0.4666	0.1675 ***	0.2640	0.2187	0.0314 *	0.2640	0.6875	0.3166 ***	0.2640	0.4740	0.1729 ***	0.2640	satisfactory

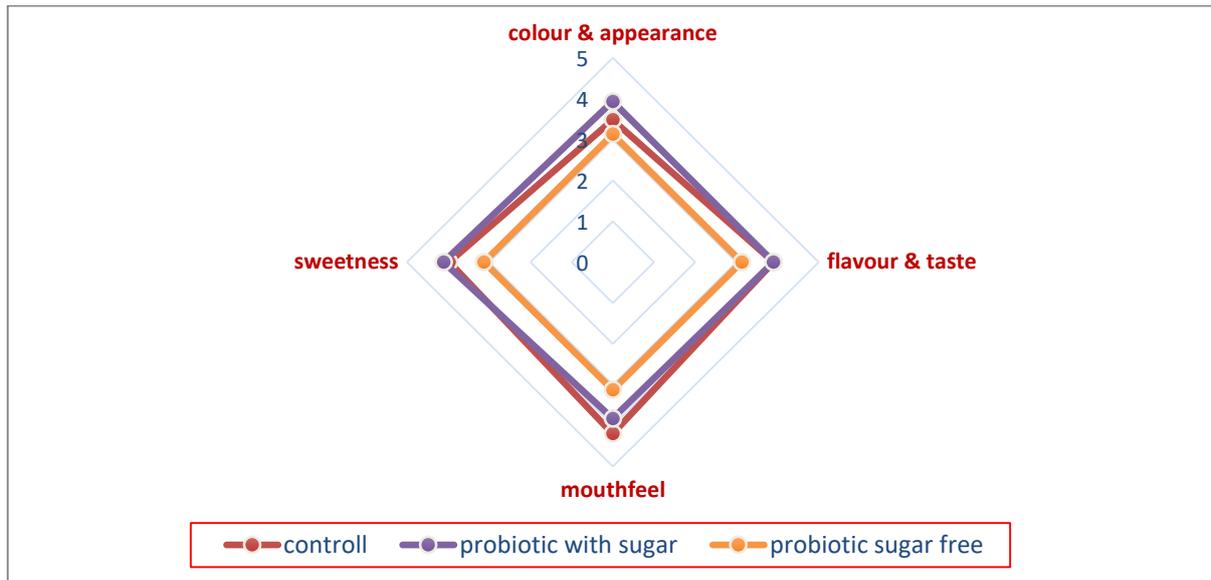
**If (P ≤ 0.05)\* – Significant difference, P (0.05 – 0.15) \*\*, P (0.15 – 0.35) \*\*\*, P (0.35 – 0.45) \*\*\*\***

If  $P \leq 0.05$  then it indicates that there is a slight presence of significant difference between control ice cream and the other two ice creams, it is denoted by  $P \leq 0.05^*$ , where as if the P value of the attribute lies in between 0.05 – 0.15 then it is denoted by  $P (0.05 – 0.15)^{**}$  it means no such significant difference between control ice creams and other two ice creams. If the P value of the attribute lies in between 0.15 – 0.35 then it is denoted by  $P(0.15 – 0.35)^{***}$  it indicates that no such significant difference between control ice creams and other two ice creams in a greater manner and similarly if the P value of the attribute lies in between 0.35 – 0.45 then it is denoted by  $P (0.35 – 0.45)^{****}$  it indicates that no such significant difference between control ice creams and other two ice creams in a greater manner and attribute is acceptable in a excellent manner. Here in the above table 5. Flavour and taste attribute of probiotic sugar free ice cream having the P value of 0.0314\* it indicates that attribute acceptable but there is a significant difference is found when compared to control ice cream.

**Fig 9 : GRAPHICAL REPRESENTATION OF SENSORY EVALUATION OF THE 43 MEMEBRS**

**AGE BETWEEN**

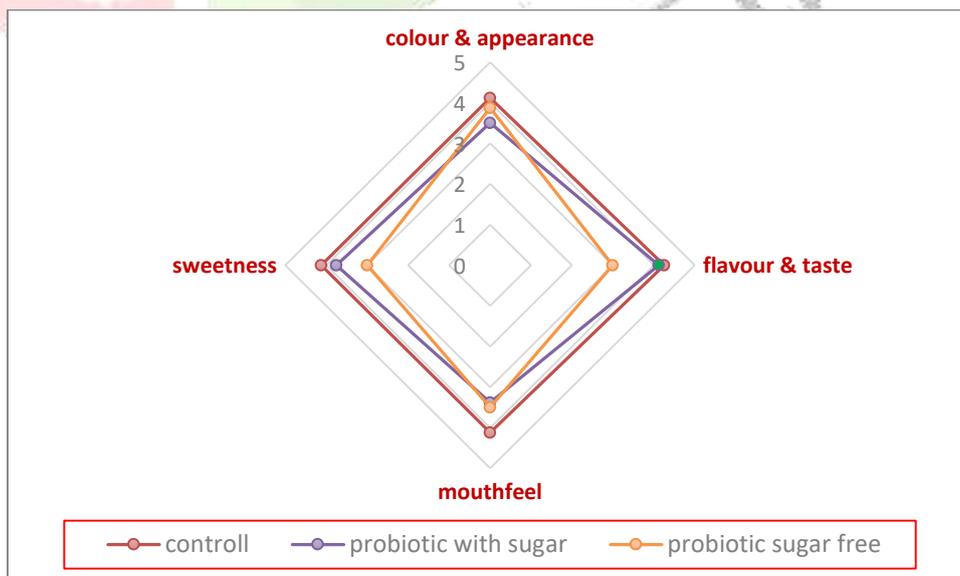
**20-30 YEARS**



**Fig 10 : GRAPHICAL REPRESENTATION OF SENSORY EVALUATION OF THE 43 MEMEBRS**

**AGE BETWEEN**

**30-40 YEARS**



#### 4. CONCLUSION

Our sensory results indicated that control ice cream i.e with no added culture /probiotics got excellent acceptance and the soy based probiotic with sugar icecream also got the good acceptance and assessors also would like to consume & to purchase it in future & probiotic sugar free ice cream was also liked for its colour & acceptance & taste wise also it felt good. Whereas control and probiotic with sugar ice cream were got the excellent acceptance rather than probiotics sugarfree ice cream.

Ice cream with probiotics i.e probiotics with sugar & probiotic sugar free have a shelf life of 15-20 days i.e **use by within 15 – 20 days** & also it means these products are at their best organoleptic properties within the given period of time, consuming after 20 days is not recommended & after 15-20 days product will be considered as expired. After the use by date ice cream is not suitable for the consumption, if we take an example of probiotic ice cream the chances of overgrowth of the culture may occur and may lead to the sourness of the ice creams and more sourness leads to the bitterness in ice cream, which is not acceptable in case of icecreams therefore it is **use by 15-20 days** after the ice cream manufactured. In case of control sample which doesn't contain any culture so we can store it for 3 months as it is not a fruit product so we can use this for up to 3 months & these ice creams have to be stored below the 5°C.

The probiotic with sugar having the benefit for the lactose intolerance people & whereas the probiotic sugar free ice cream having the benefit for the diabetic persons to consume ice creams. Ice cream having the medium fat, good in calories, adding banana powder acts as a little amount of sugar substitute & addition of the culture (*Lactobacillus lactis*) improves the gut health and incorporation of the pumpkin seeds acts as a good replacer for the other nuts which are used in many industries such as almond, cashews, pista, butterscotch chikki, etc. The pumpkin seeds having the health benefits as a powerful antioxidant, helps to maintain diabetes also helps to boost the immune system, bone health. In addition to these addition of the sugar substitutes such as dextrose, fructo oligosaccharide (FOS) and oligofructose having the functional properties similar to the sugar and a part of the sugar is replaced by banana powder as it having good in sweet taste & banana powder also acts as the pre-biotic ingredient & having the potential to increase the calcium absorption. Therefore, adding prebiotic ingredients has the potential to positively change the nutritional composition of ice cream.

By the sensory data analysis the comparison of control sample with the probiotics with sugar dietary ice cream & probiotics sugar free dietary ice cream (for 43 members aged between 20 to 30) showed that P values for all the attributes are greater than 0.05 ( $P > 0.05$ ) so there is no significant difference between attributes of control sample & probiotics with sugar ice cream and the probiotic sugarfree ice cream. The comparison of control sample with the probiotics with sugar dietary ice cream & probiotics sugar free dietary ice cream (for 8 members aged between 30 to 40) showed that all the P values are greater than 0.05 ( $P > 0.05$ ) except the flavour and taste attribute of the sugar free probiotic ice cream & no other attributes are compromised here i.e all the attributes of both the samples are acceptable. Continued research needs to be conducted to determine the ideal amount of probiotic culture to add to ice cream as it may interfere with the organoleptic properties of the ice creams.

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