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Studies of Sensory Evaluation and Shelf-Life of Foxtail Millet Based Softy Ice-Cream

Devica R. Sangma*, B.K. Mishra

Department of Rural Development and Agricultural Production, North Eastern Hill University, Tura, Meghalaya

ABSTRACT

The present study was conducted to study the sensory acceptability and microbial changes occurred in foxtail millet based softy ice-cream during storage. Three compositions of Foxtail millet based softy ice-cream was prepared by blending different levels of Foxtail millet (Setaria italica) along with probiotic bacteria i.e., Lactobacillus helveticus. Then the foxtail millet based softy ice-cream was stored at deep refrigeration (-18 - 20o C) to detect the keeping quality of the product. Sensory evaluation and shelf-life was carried out in 0, 2, 4, 6, 8 and 10 days of storage at deep refrigeration. On the basis of sensory evaluation, the second composition (3% foxtail millet and 2% Lactobacillus helveticus) was found superior by the panellists. Further during the shelf life study, it was found that the third composition (3% Lactobacillus helveticus) has got the maximum viable count for Lactobacillus helveticus as compared to first (1%) and second composition (2%). Few colonies were detected for third and second composition on 10th days of storage (2.6 and 2.8 cfu/ml) which was within the acceptable limit. No colony was detected in 0 to 9 days of storage. When all the three compositions of foxtail millet based softy ice-creams were subjected to coliform count, it was found that all the compositions did not have any coliform count in the product. The findings of the present study showed that Foxtail millet based softy ice-cream can be of great benefit as it has significant amount of viable count of good bacteria and if proper care and cleanliness is maintain during the time of manufacture, the product can be stored for ten days or more.

Keywords : Foxtail Millet, Lactobacillus Helveticus, Sensory Analysis, Shelf-Life, Viable Count.

I. INTRODUCTION

Softy ice-cream is delicious, wholesome nutritious, frozen dairy food. It has occupied a unique place in diet of the people all over India. The term soft-serve has been applied largely because products are marketed in soft form and ready for consumption shortly drawn from freezer. It is sold under the trade name softy ice-cream in our country. It has occupied a unique place in diet of the people in all over India (Sonwane & Hembade, 2014). Dairy products such as yogurts, cheeses and ice-creams contain nutrients such as proteins, vitamins and minerals. Consumption of dairy products been associated with decreased risk of osteoporosis, hypertension, colon cancer, obesity and insulin resistance syndrome. The main dietary source of calcium and vitamin D are dairy products (Weaver, 2003).

Millets are one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. They are highly nutritious, non-glutinous and not acid forming foods. Hence they are soothing and easy to digest. They are considered to be the least allergenic and most digestible grains available. Compared to rice, especially polished rice, millets release lesser percentage of glucose and over a longer period of time (millets.wordpress.com).Millets are known to contain the highest percentage of healthy dietary fibres among cereals and a higher mineral content than rice or wheat. Millets are a good source of other bioactive compounds like phytates, phenols and tannins, which can contribute to antioxidant activity important to health, aging and in preventing metabolic diseases (Pinto & Jana, 2013).

The special features of the millets, their beneficial uses and health consciousness of the consumer have made food scientists and engineers to develop various food products and mechanize the processes. Along with nutrition, millets offer health benefits in daily diet and help in the management of disorders like diabetes mellitus, obesity, hyperlipidaemia, etc. (Veena, 2003). Incorporation of highly nutritious ingredient like milet in softy ice-cream will help in improving the nutritional as well as functional properties of ice cream.

Many studies have measured sensory properties of ice-cream to examine the relationship among various ingredients and sensory characteristics such as flavour and texture. Hyvonen *et al.* (2003) found that the nature of strawberry flavouring affects flavour perception and that modifying fat distribution influences flavour release in ice cream. (Specter and Sester 1994) found that replacement of milk fat with tapioca dextrin or potato maltodextrin also significantly affects textural properties; increasing coarseness and wateriness and decreasing creaminess of ice-cream. Stampanoni-Koeferli *et al.* (1996) showed that the addition of fat increased the buttery and creamy notes in ice-cream as well as its mouth coating, while increases in sugar levels increased sweetness, caramel and vanillin attributes, and decreased milkiness. Guinard et al. (1996) demonstrated that sugar and, to a lesser extent, fat were key determinants of ice-cream acceptability and that too little or too much sugar or fat was detrimental to ice-cream quality. Several studies also determined that higher fat content positively influenced the overall sensory quality of ice-cream (Zheng *et al.* 1997; Roland *et al.* 1999; Ohmes *et al.* 1998).

Hence considering the need to maintain the quality of the product capable of providing to consumers while storing the product the present study was carried out to check the sensorial quality and shelf – life of the Foxtail millet based softy ice-cream.

II. MATERIALS AND METHOD

'Standardization of Technology for the Preparation of Foxtail millet based softy ice- cream' was carried out in the Animal Science laboratory of Rural Development and Agricultural Production Department (RDAP), North Eastern Hill University, Tura Campus, West Garo Hills, Meghalaya. The materials and methods adopted during the entire study are presented as follows:

Collection of Milk and other materials:

Milk: To carry out this study, cow milk was collected from the demonstration farm of Rural Development and Agricultural Production, North Eastern Hill University located at Chasingre of Tura, West Garo Hills, Meghalaya.

Skimmed milk powder and sugar: Skim milk powder (Amul Brand) and sugar were purchased from the Super market of Tura, Meghalaya.

Food grade colour and Flavour: Strawberry food grade colour and Vanilla essence was also procured from market.

Amul fresh cream: purchased from for standardization of milk fat level.

Foxtail millet: Foxtail millet (*Setaria italica*) was purchased from Najing Bazar of Tura, Meghalaya.

Stabilizer: Sodium alginate was used as stabilizer for the preparation of Foxtail millet (*Setaria italica*) based softy Ice-cream.

Collection of Culture:

The present study was carried out by using the pure culture i.e., *Lactobacillus helveticus* which was received from the Anand Agricultural University, India. The culture was activated separately in sterilized skim milk, MRS broth and Agar at 37ºC for 12 hrs and thereafter stored at 5ºC. The cultures were revived once in a week in order to keep them active.

Processing of Foxtail millet (*Setaria italica)*

Foxtail millet (*Setaria italica)* was processed according to the procedure suggested by Desai *et al.* (2010). First, the Foxtail millet (*Setaria italica)* seeds were washed with water (3-4 times) and soaked in cool water for 5 hours. Excess water was drained out and seeds were tied in muslin cloth and kept for germination at room temperature for 24 hours. Then the seeds were spread uniformly on a stainless steel tray and dried in the hot air oven at 60-65^{o}C for 5-6 hours. Finally, the seeds were ground into flour with the help of Phillips mixture grinder. Finely ground flour was stored at 4^{o}C until used.

Preparation of cell pallet of Lactobacillus helveticus prior to add in the softy ice-cream mix

Lactobacillus helveticus was grown overnight at 37^{o}C in MRS broth media. After incubation, the bacterial cell pallet was collected by centrifugation at 7000 rpm for 5 min which was washed twice with Phosphate Buffer Saline (PBS) (Leite *et al.* 2014)

Softy ice-cream preparation

The softy ice-cream samples were prepared in the Animal Science laboratory, Department of Rural Development and Agricultural Production, NEHU Campus Tura. The skim milk powder and fresh cream (Amul Brand) was added to the fresh whole cow milk to adjust its fat content. Likewise all the necessary ingredients were mixed very well and three different batches containing of 2 kg each were prepared. The mixtures were then pasteurized at 72°C for 15 seconds, and let to cool down, after that stored at 4°C for overnight. The next day the softy ice-cream mix was whipped in the softy ice-cream making machine for 40-45 min. The ice cream was collected then filled in small cups and stored at 18-21 ^{o}C till analysed.

Standardization of parameters was done for three batches, containing of 2 kg each. The process parameters for three batches of foxtail millet based softy ice-cream were standardized as shown in the table below.

Sl. No.	Parameters	1st Batch (in %)	2nd Batch (in %)	3rd Batch (in %)
1	Pure culture	1	2	3
2	Foxtail millet	2	3	5
3	Colour	0.1	0.2	0.3
4	Flavour	0.1	0.2	0.3
5	SNF	10	20	35
6	Sugar	12	14	16
7	Stabilizer	0.6	0.6	0.6
8	Milk fat level	2	3	4

*Table 1: Standardization of process parameters

Three batches of foxtail millet based softy ice-cream (2 kg each), each of four replicates were prepared after standardizing all the necessary parameters.

FLOW CHART FOR PREPARATION OF SOFTY ICE-CREAM

Collection of Cow milk

⇓

Standardization

⇓

Pre-heating of milk (50^{o}C)

⇓

Blending of the ingredients (both liquid and dry ingredients)

⇓

Heat Treatment (80^{o}C/30 minutes)

⇓

Cooling (15^{o}C)

⇓

Keeping the ice-cream mix for overnight in Refrigerator for ageing (4-5^{o}C)

⇓

Addition of colour and flavour

⇓

Addition of probiotic bacteria (Lactobacillus helveticus)

⇓

Continuous freezing in softy ice-cream making machine (40-45 min)

⇓

Storage of the product/distribution (as desired depending on the product)

SENSORY EVALUATION

The foxtail millet based softy ice-cream were analysed by using nine point Hedonic Rating Scale in terms of colour, flavour, smell, taste and texture of the products (Amerine *et al.*, 1965). The sensory evaluation was carried out with the help of five randomly selected panellists.

SHELF LIFE

The shelf life study of foxtail millet based softy ice-creams were studied at 0, 2, 4, 6, 8 and 10 days where viability count of lactic acid bacteria, enumeration of yeast and mould and enumeration of Coliform were carried out.

Lactic acid bacteria count: Lactic acid bacteria count i.e., *Lactobacillus helveticus* was carried out by serial dilution. 10^{-4} dilution was taken and pour plating was carried out in MRS agar plates. For total bacterial count, the MRS agar plates were incubated at 37°C for 48 hours.
Enumeration of Yeast and mould: Yeast and mould count were performed in a selective media i.e., Rose Bengal agar plates by serial dilution and pour plating technique. The plates were incubated at 37°C for 3-5 days.
Statistical Analysis:
Significant differences between treatments were analyzed by using ANOVA (analysis of variance) with a level of significance at 5%. The statistical analysis of data was conducted by using Completely Randomized Block Design.

III. RESULTS AND DISCUSSION

Sensory Analysis

Table 2: Mean summary table for Colour, Flavour, Smell, Taste and texture

Periods/ Compositions	0	2	4	6	8	10	Mean
(A) Colour							
I	6.4	6.5	6.1	6.15	6.25	6.1	**6.25**
II	8.55	8.45	8.1	8.7	7.95	7.55	**8.21**
III	7.55	7.65	7.7	7.05	6.9	6.85	**7.28**
Mean	**7.5**	**7.53**	**7.3**	**7.3**	**7.03**	**6.83**	**7.25**
(B) Flavour							
I	6.15	6.2	6.1	6.1	6.2	6.15	6.15
II	8.6	8.45	8.4	8.3	7.7	7.4	8.14
III	7.55	7.55	7.55	7.4	6.85	6.65	7.25
Mean	7.43	7.4	7.35	7.26	6.91	6.73	7.18
(C) Smell							
I	6.05	6.1	6.1	6.2	6.1	6.2	6.12
II	8.7	8.65	8.55	8.6	7.7	7.4	8.26
III	7.4	7.65	7.4	7.15	6.65	6.45	7.12
Mean	7.38	7.46	7.35	7.32	6.82	6.55	7.14
(D) Taste							
I	6.8	6.35	6.1	6.15	6.1	6.15	6.27
II	8.95	8.65	8.8	8.65	8.55	7.65	8.54
III	7.8	7.7	7.7	7.35	7.25	6.65	7.41
Mean	7.85	7.56	7.53	7.38	7.3	6.82	7.41
(E) Texture							
I	7.2	6.6	6.55	6.5	6.1	6	6.49

II	8.65	8.5	8.45	8.5	8.05	7.85	8.33
III	7.6	7.5	7.5	7.05	6.9	7.1	7.27
Mean	7.81	7.53	7.5	7.35	7.02	6.98	7.36

Table 3: ANOVA Table for: A) Colour

Sources of variance	**d.f**	**S.S**	**Mean S.S**	**$F_{obs.}$**	**$F_{exp.\ 5\%}$**	**C.D (5%)**
Compositions	2	47.8	23.9	796.66**	3.23	0.08
Periods	5	5.01	1	33.33**	2.45	0.11
Comp. Vs Periods	10	2.85	0.28	9.33**	2.18	0.22
Error	54	1.76	0.03			

(**) – Highly significant

B) Flavour

Sources of variance	**d.f**	**S.S**	**Mean S.S**	**$F_{obs.}$**	**$F_{exp.}$ 5%**	**C.D (5%)**
Compositions	2	42.81	21.41	535.13**	3.23	0.11
Periods	5	4.21	0.84	21**	2.45	0.17
Comp. Vs Periods	10	2.3	0.23	5.75**	2.18	0.28
Error	54	1.96	0.04			

(**) – Highly significant

C) Smell

Sources of variance	**d.f.**	**S.S.**	**Mean S.S.**	**$F_{obs.}$**	**F_{exp}. (5%)**	**C.D (5%)**
Compositions	2	55.14	27.57	459.5**	3.23	0.11
Periods	5	6.14	1.23	20.5**	2.45	0.17
Comp. X Periods	10	3.86	0.38	6.33	2.18	0.34
Error	54	3.32	0.06			

(**) – Highly significant

D) Taste

Sources of variance	**d.f**	**S.S**	**Mean S.S**	**$F_{obs.}$**	**$F_{exp.\ (5\%)}$**	**C.D (5%)**
Compositions	2	41	20.5	683.33	3.23	0.14
Periods	5	6.21	1.24	41.33	2.45	0.19
Comp. X Periods	10	1.09	0.1	3.33	2.18	0.37
Error	54	2.01	0.03			

(**) – Highly significant

E) Texture

Sources of variance	**d.f**	**S.S**	**Mean S.S**	**F_{obs}**	**$F_{exp\ (5\%)}$**	**C.D (5%)**
Composition	2	62	31	442.85**	3.23	0.08
Period	5	7	1.4	20**	2.45	0.11
Comp. X Period	10	7	0.7	10	2.18	0.22
Error	54	4.12	0.07			

(**) – Highly significant

Colour: It is evident from table 2 (A), that the mean score for the three compositions of foxtail millet based softy ice-cream were 6.15, 8.14 and 7.25 respectively. The data showed that the second composition (8.14) got the maximum score when compared to the first (6.15) and the third composition (7.25). The first composition was found to be of low quality by the consumers in terms of colour. This can be attributed to lower amount of colour added in the mix (0.1% strawberry colour). All the differences between the three compositions were found to be highly significant (p<.05) (Table 3 A).

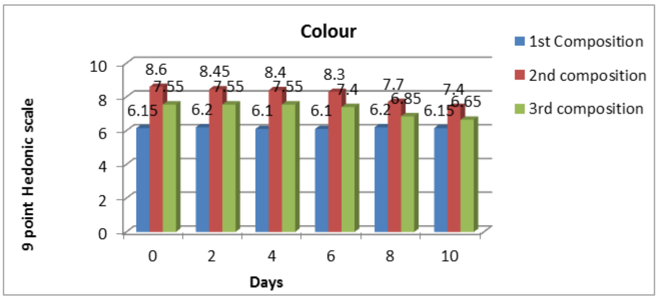

Figure 1: Colour of foxtail millet based softy ice-cream with respect to storage periods.

Flavour: Mean score for flavour of foxtail millet based softy ice-cream can be seen in table 2 (B) where ranged from 6.25, 8.21 and 7.28 for first, second and third composition respectively. First composition obtained the minimum score (6.25). This was obviously because of the lesser amount of flavour (0.1% vanilla flavour) added into to the softy ice-cream mix. The maximum score was found by the second composition whose amount of vanilla flavour was 0.2% followed by the third composition with 0.3% vanilla flavour. From the analysis table 3 (B), it was found that the differences between the three compositions were highly significant (p<.05). The minimum score for flavour was obtained by the first composition in 12 days (6.1). According to Figure 2, it can be observed that for all the compositions, flavour continuously decreases with periods.

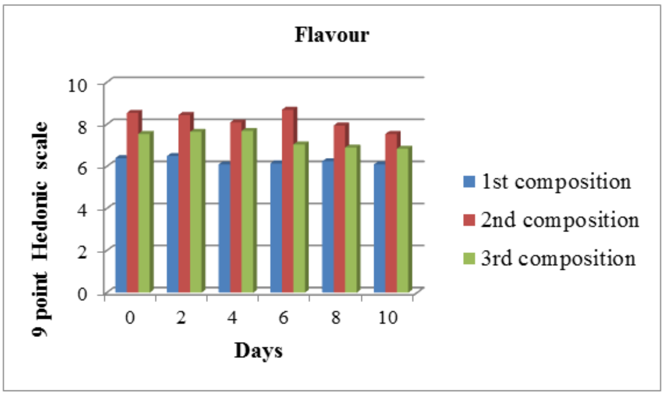

Figure 2: Flavour of foxtail millet based softy ice-cream with respect to storage periods.

Smell: The flavour of foxtail millet based softy ice-cream was influenced by the addition of vanilla flavour. As per the table 2 (C), the maximum value for smell was scored by the second composition with 0.2% vanilla flavour and 2 % foxtail millet (mentioned in materials and methods). When all the three compositions were compared with the help of identified panellists, they revealed that the first composition (0.1% vanilla flavour) was poor in exhibiting the smell of vanilla essence. On the other hand, second and third compositions were pleasing smell of vanilla flavour when sensory evaluation for smell was performed. Thus, from the present study, it was found that sensory parameters such as smell and flavour were related to each other. Higher the amount of flavour, the more will be the exhibition of smell by the product. From the analysis, it was found that the differences between the three compositions were highly significant (p<.05).

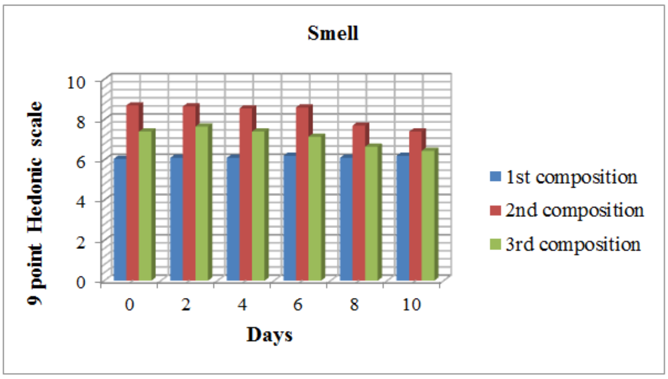

Figure 3: Smell of foxtail millet based softy ice-cream with respect to storage periods.

Taste: The average taste scores obtained by the second composition (8.54) was the maximum of all the three compositions (table 2 D). This was followed by the third composition which scored the was 7.41. All the differences between the 3 compositions were highly significant (p<.05) with respect to taste. The maximum score was observed by the second composition (8.95) in 0 day, whereas the lowest value was found to be 6.5 obtained by the first composition from 4 to 10 days continuously. Mean summary table also showed that the taste of foxtail ,millet based softy ice-cream decreased with the increased of storage duration as it ranged from 7.85 to 6.82 (from 0 to 10 days of storage). Composition 2 (2% lactobacillus helvesticus and 3% fat) and composition 3 (3% lactobacillus helvesticus and 4% fat) showed the highest creaminess than the composition 1 (1% lactobacillus helvesticus). Thus, we can say that the creaminess of the product was due to the fat and lactobacillus helvesticus culture in the softy ice cream mix.

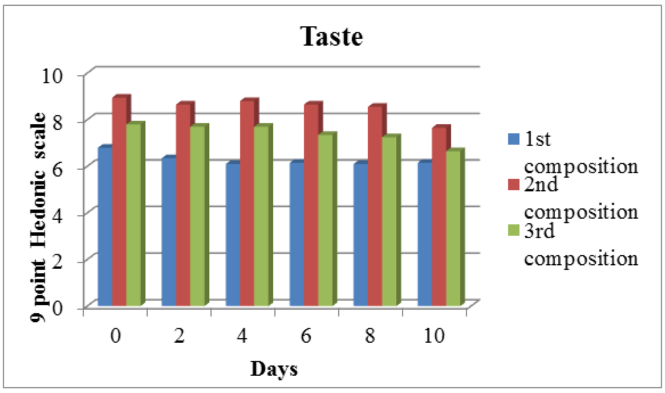

Figure 4: Taste of foxtail millet based softy ice-cream

Texture: The results of textural analysis were shown in table 2 (E). Based on the mean summary table, it was observed that the first composition obtained average score of 6.49 which was little lower in textural quality. The second and third compositions were good in textural quality when compared to the first composition as they obtained the scores 8.33 and 7.27 respectively. These two compositions were found to have softness and gumminess in texture. These textural properties of the product might be because of the fox millet contents in the softy ice-cream mixes. As mention in the chapter materials and methods, second composition contained 2% foxtail millet and 3 % fat and third composition contained 3% foxtail millet and 4% fat respectively. Whereas the first composition contained only 2% foxtail millet and 2% fat which was poor in creaminess, hardiness as well as gumminess in the texture. Hence, it can be interpreted that foxtail millet and fat per cent level can affect the textural behaviour of the product. The null hypothesis of differences in all the three composition was found to be highly significant (Table 3E) at 5% significant level. The results of mean scores were similar to the results obtained by Sonwane and Hembade (2014) in their study where they found that the mean score for texture quality of softy ice cream ranged from 6.68 to 8.27.

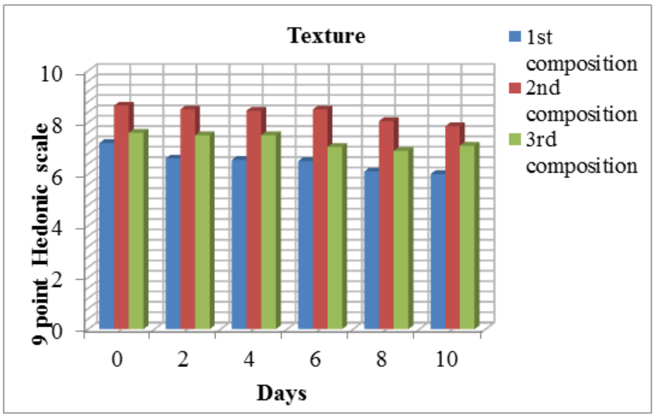

Figure 5: Texture of foxtail millet based softy ice-cream with respect to the storage periods

Shelf- life of foxtail millet based softy ice-cream

On the basis of viable Lactic Acid Bacteria, Coliform and Yeast & Mould counts, the shelf- life study were performed at 0, 2, 4, 6, 8 and 10 days.

Table 11: Mean summary table for *Lactobacillus helveticus* counts at different storage periods

Periods/	0	2	4	6	8	10	Mean
Compositions							
I	6.75	6.79	6.92	6.96	7.18	7.18	**6.96**
II	7.13	7.23	7.43	7.48	7.52	7.5	**7.38**
III	7.6	7.61	7.63	7.64	7.64	7.55	**7.61**
Mean	**7.16**	**7.21**	**7.33**	**7.36**	**7.45**	**7.41**	**7.32**

Table 12: ANOVA table for *Lactobacillus helveticus* counts at different storage periods

Sources of variance	d.f	SS	Mean SS	F obs	F exp at 5%	C.D (5%)
Compositions	2	5.19	2.595	14013**	5.18	0.005
Periods	5	0.75	0.15	810**	3.51	0.005
Comp. X Period	10	0.49	0.049	264.6**	2.99	0.01
Error	54	0.01	0.000185			

(**) – highly significant

Results for Lactic acid bacterial count (*Lactobacillus helveticus)*were given in mean summary table 11 with respect to different storage periods i.e. 0 to 10 days. The average viable count were 6.96, 7.38 and 7.61 for first (1% *L. helveticus*), second (2% *L. helveticus*) and third composition (3% *L. helveticus*) rspectively. Maximum viable count were shown by the third composition with the range of 7.64 cfu/ml in 8 days of storage. However, the first composition scored the minimum viable counts (6.75 in 0 day) as the lesser amount of pure culture was added during manufacture time. Mean summary table also indicated that the range for viable count of *Lactobacillus helveticus* increased from 7.6 to 7.45. The null hypothesis of no differences between composition as well as periods and composition versus periods were found to be highly significant ($p<.05$) (table 12). The result showed that foxtail millet based softy ice cream has higher number of viable counts for *Lactobacillus helveticus* throughout 10 days. Hence from the present study, it was evident that *Lactobacillus helveticus* are able to survive in the frozen foxtail millet based softy ice cream. Second and third commposition with 2% and 3% *L. helveticus* were found to be more acceptable and achieved good impression from the consumers. Moussa *et al.* 2005 found in their study for the 'Production of probiotic ice-cream' showed that the viable counts of lactic acid bacteria were above the recommended minimum limit of 10^6 cfu/g during 12 weeks of storage in which all the ice-cream samples received a high score in the organoleptic evaluation.

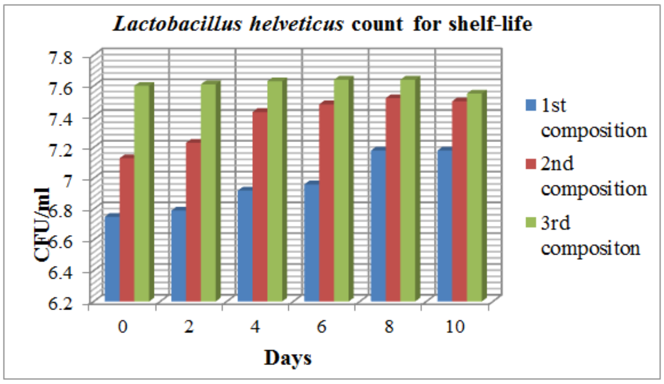

Figure 6: Lactobacillus helveticus counts at different storage periods

Yeast and mould count: Yeast and mould recognized as the important cause of spoilage of various dairy products. In the present study, Nutrient Agar (NA) medium was used for the enumearation of yeast and mold in the final product. Few colonies were detected for third and second composition on 10^{th} days of storage (2.6 and 2.8 cfu/ml) which was within the acceptable limit. No colony was detected in 0 to 9 days of storage. This may occur from the environmental condition, equipments and handlers while manufacturing the product.

Coliform count: Coliform are faecal bacteria but are also found commonly in the environment. Coliform count for ice-cream should not be more than 10/gm (FSSAI, 2015). All the three compositions of foxtail millet based softy ice-creams were subjected to enumeration of coliform. It was found that all the compositions did not have any coliform count in the product. The reason of no coliform in the product was due to hygenic condition maintained during each step of manufacture. The absence of coliform revealed that proper care was maintained while manufacturing as well as storing the product thereby giving the accetable quality of foxtail millet based softy ice cream.

IV. CONCLUSION

Softy ice-creams are considered as frozen food products which show great potential for use as vehicles for probiotic cultures which is consumed by all age groups. However, in order to maintain the quality of the product capable of providing to consumers, several process parameters in their processing stages need to be optimized. In order to achieve this goal, several factors should be strictly controlled, including: the appropriate selection of cultures to be used, the inoculum concentration, processing stage for the cultures to be added, the appropriate amount of colour, flavour, sweeteners, stabilizer, and the strict control of the procedures during manufacture as well as storage temperatures. It is important to confirm the viability of the probiotic cultures during storage of ice-creams with the advantage of giving benefit to the consumers after long storage periods. It is also very necessary to check whether the product is well enough to consume because longer the period of storage, the more might be the chances of getting contaminated by contaminants such as yeast mould and Coliform bacteria.

- In shelf life study, foxtail millet based softy ice cream showed higher number of viable counts for *Lactobacillus helveticus* throughout 10 days. Hence from the present study, it was evident that *Lactobacillus helveticus* are able to survive in the frozen foxtail millet based softy ice cream.
- There was no Coliform present in the product during the entire storage periods i.e., 0 to 10 days of storage. However, there were few colonies for yeast and mould detected at the end of the storage period which may be due to equipments and handlers while

Hence, it can be concluded that Foxtail millet based softy ice-cream can be of great benefit as it has significant amount of viable count of good bacteria and if proper care and cleanliness is maintain during the time of manufacture, the product can be stored for ten days or more. Moreover, this will help in the production of new variety of ice-cream which will of much benefit for the consumers preparing the product.

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