BACTERIAL EMPIRE
2022, VOL. 5, NO. 1, e340

DEVELOPMENT AND EVALUATION OF SHELF LIFE AND SENSORY ACCEPTABILITY OF LYCHEE LOLLY ICE CREAM

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https://doi.org/10.36547/be.344

ABSTRACT

Background: Lolly ice cream is a frozen sweetened product made of heat treated mix, with or without other ingredients and permitted additives. The objectives of this study were to develop lychee flavored lolly ice cream, to determine the overall acceptance of lychee flavored ice cream (sensory evaluation) and to use accelerated shelf-life testing to study the changes in acidity, total soluble solid (TSS), total solid, microbiology, and sensory characteristics of lolly ice cream.
Methods: The physical and chemical characteristics and the acceptance of lychee lolly ice cream flavored with lychee were evaluated and compared with lemon and orange lolly ice cream. A testing panel consisting 16 panelists studied the acceptability of the sample based on a 9-point hedonic scale. The consumer's preferences were measured by statistical analysis of the scores obtained from the response of the panel.
Result: Lychee flavored lolly ice cream showed overall acceptance than orange and lemon lolly ice cream. Our results suggest that the shelf life of lolly ice cream sample was 1 year at -20°C and set expiration date on ice cream might also contribute to effective management of ice cream characteristics in the retail chilled chain.

Keywords: Frozen, flavored lolly ice cream, overall acceptance, Lychee, hedonic scale

INTRODUCTION

Lolly ice cream is a frozen product made by suitable blending and processing of sugar and flavor, with or without stabilizer or color, and with the incorporation of air during the freezing process **(Sukumar, 1980)**.
The richness in nutritive constituents of lolly ice cream has been realized by all; however some hazards may lies between production and handling. So great difficulties with regard to chemical product prepared by pasteurization, homogenization, aeration and freezing that has been maintained at uniform consistency is called ice cream. It is cheap, healthy, nutritious and palatable product.
Ice cream is a three phase network consisting on air, solid and liquid in final product. Liquid phase contains ice crystals in embedded form and air cells in dispersed form. Milk proteins, soluble and insoluble salts, fat particles, stabilizers and sugars are also present in liquid phase.
Stabilizers and emulsifiers are the important ingredients of lolly ice cream. Stabilizers are added in lolly ice cream to increase the viscosity of the mix, to improve air incorporation, air cell distribution, body and texture, storage stability and melting properties. It also minimize the development of large crystals and ultimately to get finished structure in ice cream. Therefore, most lolly ice cream manufacturers use blends of stabilizers to achieve the desired characteristics **(Bhandari, 2001).**
Guar gum is being used as stabilizer in lolly ice cream manufacturing. It is a complex carbohydrate obtained from a legume crop, guar, widely grown in India and Pakistan and is very much cheap. Guar and Xanthan gums are used on a widespread basis throughout the food industry to thicken the products, to impart creamy consistency to ice creams, also contribute good mouth feel, as well as help to protect the product during the distribution chains' inevitable heat/thaw cycles. Emulsifiers are used to improve whipping quality of the mix, produce a drier ice cream, provide smoothness body and texture in finished product and produce a product with good stand up properties and melt resistance **(Goff, 1988).** Presently lolly ice cream industries are using stabilizers/ emulsifier blends, which are imported and very costly. So, present research was undertaken to find out the best combination of locally available stabilizers/emulsifier which can be used as an alternative.
During storage periods, the lolly ice cream may subject to the microbiological, chemical and sensory changes with different levels. However these products are vulnerable to spoil by certain microorganism, some of which are beneficial and others are harmful to human beings **(Esmail, 1997)**. Any of these may account for the various specific species of bacteria **(Yaman *et al*., 2006)** such as *Salmonella spp*., *Listeria spp*., *Yersinia spp*., *Staphylococcus aureus*, *Escherichia coli*, *coliforms*, *Bacillus spp*.

The interest of the food industry in the development of new products is constantly increasing and becoming more challenging, due to consumers' awareness about healthier foods.

Objectives:

1. To develop lychee flavored lolly ice cream
2. To determine the overall acceptance of Lychee flavored lolly ice cream (sensory evaluation)
3. To find out the proximate composition and shelf life of Lychee lolly ice cream.

MATERIALS & METHODS

The research wok was conducted at the laboratory of Dhaka Ice cream Industries Limited. This study was undertaken in the period from January 2019 to December 2019.

Sample Collection

The chemicals and reagents were used from laboratory stock. Three samples Lemon lolly (T_1), Lychee lolly (T_2) and Orange lolly (T_3) were evaluated made with three flavors which were added to the lemon, lychee and orange flavor. The samples were preserved in a freezer at -20°C.

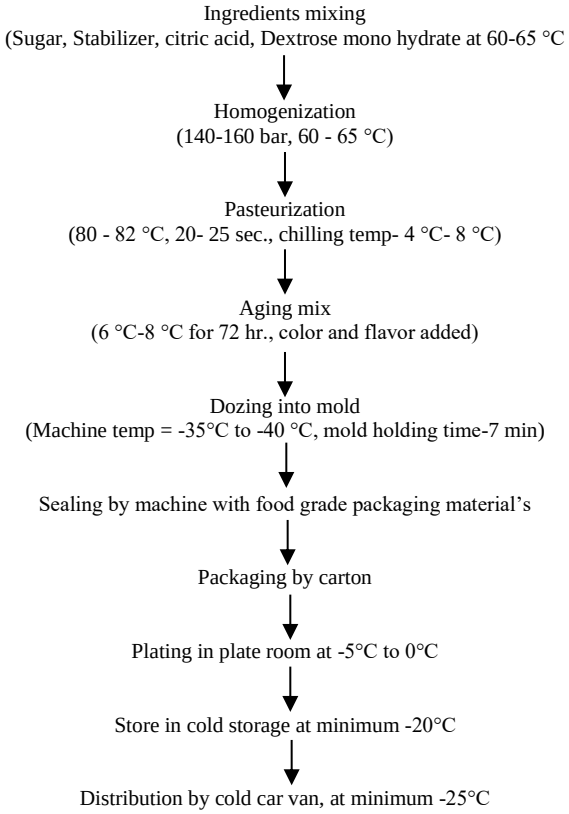
Methods

Ingredients used in lolly ice cream

Ingredients	Amount (%)
Sugar	20%
Stabilizer	0.20%
citric acid	0.2%
Dextrose mono hydrate	0.35%
Flavor	0.16%
Color	0.015%
Water	79.075%

Preparation of lolly ice cream

This study was carried out according to the following experimental design (Schematic)



Proximate Analysis of Lolly ice cream

Total Solids Content

Total solids content of lolly ice cream sample were determined according to the modified method of **AOAC (1990)**.

Acidity

Acidity was determined following the methods of **Jacob (1959) and Rangana (1977)**.

Total soluble solids (TSS)

Refractometer (Model no. HI 96801, ROMANIA) was used to measure total soluble solid.

Moisture content

Moisture content was determined according to the AOAC method.

Microbiological test

Yeast Extract Agar

Yeast extract agar was used 23 gm of yeast extract agar in 1000 ml and pH 7.2±0.2.

Total Bacteria count

The method described by **Houghby *et al*. (1992).** From each dilution, 1 ml sample was aseptically transferred into sterile Petri dishes in duplicate, followed by adding 10 ml of standard plate count agar at 45-46°C. The Petri dishes were covered and mixed by gentle rotation then allowed to solidify. The plates were inverted and incubated at 37ºC for 48 hours. The colonies were counted.

Coliform count: Number of colony × factor of dilution = cfu/ ml.

Coli form Bacteria count

The method described by **Christen *et al*. (1992).** Mac Conkey agar was used. From each dilution, 1 ml sample was aseptically transferred into sterile Petri dishes followed by addition of 10 ml Mac Conkey Agar medium at 44-46°C. The contents were allowed to solidify, then additional 3-4 ml agar were added to each Petri dishes as on overlay to completely cover the surface of the solidified medium to inhibit surface colony formation. The plates were then inverted and incubated at 37°C for 48 hours.

Yeast count

The method described by **Frank *et al*. (1992)**. One milliliter from each dilution was carefully transferred into Petri dishes using sterile pipettes, and then adding 10-12 ml of yeast extract agar into plates. It was mixed by gentle rotation and incubated at 25°C for 5 days.

Total Viable Count (TVC)

TVC is achieved by plating dilutions of the culture until 30-300 colonies exist on a single plate.

Storage Stability of Lolly Ice Cream

Processed lolly ice creams were stored and the acidity, TSS, color, flavor, texture and microbial growth were observed up to 1 year.

Sensory Evaluation of Lolly Ice Cream

The sensory evaluation of three types of lolly ice cream was evaluated for color, flavor, taste and overall acceptability parameters by 16 panelists. The 9 point hedonic scale ratings was: 9 (Like extremely), 8 (Like very much), 7 (Like moderately), 6 (Like slightly), 5 (Neither like or unlike), 4 (Dislike slightly), 3 (Dislike moderately), 2 (Dislike very much), 1 (Dislike extremely).

Statistical Analysis

Data were analyzed using statistical software SPSS a single factor analysis of variance was carried out. Significant difference was estimated using Duncan Multiple Range Tests (DMRT). Differences were considered to be significant at ≤ 0.05.

RESULT AND DISCUSSION

Changes of Acidity during Storage

The titrable acidity of lemon lolly (T_1), lychee lolly (T_2) and orange lolly (T_3) ranged from 0.22- 0.18%, 0.22 -0.18% and 0.22-0.17% respectively. In the preparation day, the titrable acidity of samples T_1, T_2 and T_3 were 0.22 %, 0.22 % and 0.22 % respectively. After 1 year of storage the total solids of samples T_1, T_2 and T_3 were slightly increased 0.18%, 0.18% and 0.17 % respectively shown in Figure 2. Accelerated shelf-life testing is used a variety of products with long expiration period to rapidly estimate changes in characteristics **(Breda *et al*., 2012; Chandler and McMeekin, 1989)**.

Changes of TSS during Storage

The total soluble solids of chemically preserved lemon (T_1), lychee (T_2) and orange lolly (T_3) ranged from 21.4-20.4 ºbrix, 21.6-21 ºbrix and 21.6-20.6 ºbrix respectively. The total soluble solids of samples T_1, T_2 and T_3 were 21.4, 21.6 and 21.6 °brix in the preparation day. After 1 year of storage the total soluble solids of samples T_1, T_2 and T_3 increased to 20.4, 21 and 20.6 ° brix respectively shown in Figure 3.

Changes of Moisture during Storage

The Moisture content of chemically preserved ranged from 77.693- 77.309%. Lolly prepared with lemon, lychee and orange flavor contained 77.488%, 77.309% and 77.399% moisture content respectively on the day of preparation and 77.488%, 77.905% and 77.354% respectively after 1 year of storage. After 1 year storage,

moisture content remained more or less same for T_1 and T_3 sample and an increase for T_2 sample.

Changes of Total Solid during Storage

The total solids of samples T_1, T_2 and T_3 were 22.512%, 22.691%, and 22.601% in the preparation day. After 1 year of storage the total solids of samples T_1, T_2 and T_3 decreased to 21.512%, 22.095%, 21.646% respectively shown in Figure 3. The highest total solids content was found in lychee lolly ice cream may due added stabilizers and sugar in the mix. Ice cream mix with low total solids (high water content) has proportionately more water to freeze than a higher total solids mix (low water content) hardened to the same storage temperature. The percent total solid of the ice cream mix is directly related to ice crystal size distribution **(Flores and Goff, 1999a)** and lower total solids ice cream contains lager ice crystals **(Donhowe *et al*., 1991)**.
However a total solid was highest in machines ice cream with mango flavor (32.64±3.06) and chocolate flavor (36.71±3.74). The shrinkage during storage due to loss of air in ice cream is also reported by **Rothwell (1991)**. Because melting of ice cream is influenced by its composition and by fat globule size **(Koxholt *et al*., 2001)**.

Microbial Load of Lolly Ice cream

Microbiological activity, its multiplication and load were calculated (Table 1, 2 and 3) during 1 year storage period for the three samples at -20º C. This study was performed by Colony count method and the dextrose tryptone Agar (DTA) media was used.

Table 1 Coli form Count of Lolly Ice cream during Storage Period

	Specifications	After 24 hr. incubation (37°C)		
		Lemon lolly	Lychee lolly	Orange lolly
Initial	<10 cfu/g	Nil	Nil	Nil
3 months	<10 cfu/g	Nil	Nil	Nil
6 months	<10 cfu/g	Nil	Nil	Nil
9 months	<10 cfu/g	Nil	Nil	Nil
1 year	<10 cfu/g	Nil	Nil	Nil

There is no growth of coliform during the 1 year storage period for the three flavored lolly ice cream. However, after 72 hours incubation period, yeast count were obtained <10 CFU/g from ice cream of three flavored lolly ice cream.
The SPC were found in lemon, lychee and orange lolly ice cream <1000, <1100, <800 CFU/g respectively after 48 hr incubation period in the preparation day. After 3 month the SPC were found for the three sample T_1, T_2 and T_3 were <1400, <1900 and <1100 CFU/g respectively. SPC growth was lower than in orange lolly then the lychee and lemon lolly. After 1 year storage growth of SPC were <5000, <5500 and <6000 for the T_1, T_2, and T_3 sample respectively. SPC growth was lower than in lemon lolly then the lychee and orange lolly ice cream. The results were in agreement with the finding of **Keller *et al*.,(1987)** who reported that the fresh ice cream contain no more than 100,000 cfu/g of total bacterial counts, but above that result obtained by **Zeinab, (2005)** of total bacterial counts of chocolate and mango flavored lolly ice cream and homemade ice cream.

Table 2 SPC Count Lolly Ice cream during Storage Period

	Specifications	After 48 hr. incubation Temperature:- +37(°C)		
		Lemon lolly	Lychee lolly	Orange lolly
Initial	<100000 cfu/g	<1000	<1100	<800
3 months	<100000 cfu/g	<1400	<1900	<1100
6 months	<100000 cfu/g	<2100	<2400	<1600
9 months	<100000 cfu/g	<3500	<3300	<3800
1 year	<100000 cfu/g	<5000	<5500	<6000

Table 3 Yeast/ mold Count Lolly Ice cream during Storage Period

	Specifications	After 72 hr. incubation Temperature:- +25(°C)		
		Lemon lolly	Lychee lolly	Orange lolly
Initial	<10 cfu/g	<10	<10	<10
3 month	<10 cfu/g	<10	<10	<10
6 month	<10 cfu/g	<10	<10	<10
9 month	<10 cfu/g	<10	<10	<10
1 year	<10 cfu/g	<10	<10	<10

Table 4 Organoleptic evaluation of prepared lolly ice cream stored during 0 to 1 year

Storage period	Treatment	Color	Flavor	Texture
00	Lemon lolly Ice cream, T_1	Natural	Natural flavor of Lychee lolly	Uniform
	Lychee lolly Ice cream, T_2	Natural		
	Orange lolly Ice cream, T_3	Natural		
3 month	Lemon lolly Ice cream, T_1	No change	No off flavor	Uniform
	Lychee lolly Ice cream, T_2	No change	No off flavor	Uniform
	Orange lolly Ice cream, T_3	No change	No off flavor	Uniform
6 months	Lemon lolly Ice cream, T_1	No change	No off flavor	Uniform
	Lychee lolly Ice cream, T_2	No change	No off flavor	Uniform
	Orange lolly Ice cream, T_3	No change	No off flavor	Uniform
9 months	Lemon lolly Ice cream, T_1	No change	No off flavor	Uniform
	Lychee lolly Ice cream, T_2	No change	No off flavor	Uniform
	Orange lolly Ice cream, T_3	No change	No off flavor	Uniform
1 year	Lemon lolly Ice cream, T_1	No change	No off flavor	Ice form on surface
	Lychee lolly Ice cream, T_2	No change	No off flavor	Ice form on surface
	Orange lolly Ice cream, T_3	No change	No off flavor	Ice form on surface

Sensory evaluation

A panel of 16 judges tested the color, flavor, taste and overall acceptability of lolly ice cream prepared with three different flavor lemon, lychee and orange. The mean scores for color, flavor, taste and overall acceptability of different flavor of lolly

such as T_1, T_2 and T_3 are presented in Table 5. Sensory characteristics decreased significantly during the experimental period ($p < 0.05$), and decreased more rapidly at higher storage temperatures **(Derossi *et al.*, 2016)**.

Table 5 Mean score for color, flavor and taste and overall acceptability of lemon, lychee and orange lolly ice cream

Treatment	Sensory Attribute			
Sample	**Color**	**Flavor**	**Taste**	**Overall Acceptability**
T_1 Lemon Lolly Ice cream	5.1875^c	5.1250^c	5.1250^c	5.1875^c
T_2 Lychee Lolly Ice cream	7.5625^a	7.2500^a	6.8125^a	7.1875^a
T_3 Orange Lolly Ice cream	6.3750^b	6.1875^b	5.9375^b	6.2500^b

a, b, c superscript indicates respectively the higher, medium and lower value . The test values along the different column carrying different superscripts are significantly different ($p < 0.05$).

Color

A one way analysis of variance ANOVA (Appendix 2) and DMRT (Appendix 3) was carried out for color preference and results revealed that there was significant ($P<0.05$) difference in color acceptability among the lolly ice cream (Table 5). In case of T_2 sample was more acceptable than sample $T_1$and T_3. Sample T_2, T_1 and T_3 secured the score 7.5625, 5.1875 and 5.9375, respectively and ranked as "Like very much", “Neither like nor dislike” and "Like slightly".

Flavor

ANOVA (Appendix 4) and DMRT (Appendix 5) was carried out also for flavor preference and there was significant ($P<0.05$) difference in flavor acceptability among the lolly ice cream (Table 5). Sample T_2 was more acceptable than sample T_1 and T_3. Sample T_2 secured the highest score 7.2500 and ranked as "Like moderately". Sample T_1 and T_3 ranked as “Neither like nor dislike” and "like slightly"

Taste

ANOVA (Appendix 6) and DMRT (Appendix 7) was carried out for taste preference and there was significant ($P<0.05$) difference in taste acceptability among the lolly ice cream (Table 5). The sample T_2 was more acceptable than T_1 and T_3. Sample T_2 secured the highest score 6.8125 and ranked as "Like moderately". Sample T_1 and T_3 ranked as “Neither like nor dislike” and "like slightly" securing score 5.1250 and 5.9375, respectively.

Overall Acceptability

From the results of the ANOVA (Appendix 8, 9), that there was significant ($p<0.05$) difference in overall acceptability of the sample tested as the calculated F (40.332) greater than the tabulated F value (2.960). This indicates that so far as overall acceptability is concern the sample was not equally acceptable. Significant difference exist when F (Calculated)> F (Tabulated). From Table 5, the sample T_2 is the most acceptable product receiving 7.1875 out of 9.0 compared to the other treatment and ranked as "Like moderately". T_3 securing 6.2500 ranked as "like slightly" and T_1 securing 5.1875 ranked as “Neither like nor dislike ".

Lychee lolly ice cream T_2 secured the highest score for color, flavor, taste and overall acceptability among all the samples and was closely followed by sample T_3 having orange flavor after 1 year storage. So, sample T_2 may be regarded as the best lolly ice cream among the other samples.

CONCLUSION

To assess the quality evaluation, chemical properties and the shelf life of prepared lolly ice cream, three samples namely lemon (T_1), lychee (T_2) and orange lolly (T_3) ice cream respectively was stored at -20 ^oC for 1 year. The changes of TSS, acidity, total solid and moisture were found at an interval 0, 3, 6, 9 months, 1 year. Negligible Changes in physical and chemical constituents was observed in the prepared lolly ice cream throughout 1 year of storage.

The statistical analysis of the score response by the taste-testing 16 panelists on the sensory attributes of lolly ice cream revealed that color, flavor, taste and overall acceptability of the differently lolly ice cream were significantly ($p<0.05$) different. It was found that color, flavor, taste and overall acceptability of lolly ice cream of sample T_2 (lychee lolly ice cream) was more acceptable than other samples.

Immediately after preparation of lolly ice cream, total number of viable count was zero and after 3 months intervals revealed that total colony increased slightly with the increase of storage period which was consumable level for human. Coli form count was not found during 1 year of storage. After 1 year storage, number of total bacteria was less in lychee lolly ice cream compare to other sample.

Our results suggest that the shelf life of lolly ice cream sample was 1 year at -20°C and set expiration date on ice cream might also contribute to effective management of ice cream characteristics in the retail chilled chain. Lychee lolly ice cream was more acceptable than the other flavored ice cream.

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Appendix 1

Rating score for color, flavor, taste and overall acceptability of Lolly ice cream

No. of Panelists	Sample T_1 (Lemon lolly ice cream)				Sample T_2 (Lychee lolly ice cream)				Sample T_3 (Orange lolly ice cream)			
	color	flavor	taste	Overall acceptability	Color	flavor	taste	Overall acceptability	color	flavor	taste	Overall acceptability
1	7	6	6	6	8	8	7	8	7	6	7	7
2	7	6	6	6	7	8	8	8	8	7	7	7
3	6	5	5	5	7	8	6	7	6	7	7	7
4	5	6	6	6	7	8	7	7	6	7	8	7
5	5	5	6	5	8	7	6	7	7	7	6	7
6	4	7	7	6	8	7	7	7	7	7	7	7
7	5	3	4	4	8	8	7	8	7	6	5	6
8	4	4	4	4	8	8	7	8	7	5	5	6
9	5	6	4	5	7	8	7	7	6	7	5	6
10	5	5	5	5	8	7	7	7	6	4	6	5
11	5	5	4	5	8	7	7	7	6	6	5	6
12	6	5	6	6	8	7	7	7	6	6	6	6
13	6	5	4	5	8	7	6	7	7	6	5	6
14	4	5	5	5	7	6	6	6	5	6	5	5
15	5	4	5	5	7	6	7	7	5	6	6	6
16	4	5	5	5	7	6	7	7	6	6	5	6
Total	83	82	82	83	121	116	109	115	102	99	95	100
Mean	5.1875	5.125	5.125	5.1875	7.5625	7.25	6.8125	7.1875	6.375	6.1875	5.9375	6.25

Appendix 2

ANOVA (Analysis of variance) for color of Lolly ice cream

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	45.125	2	22.563	36.100	.000
Within Groups	28.125	45	.625		
Total	73.250	47			

Appendix 3

Duncan's Multiple Range Test (DMRT) for color, P<0.05

Treatment code	Original order of means	Treatment Code	Ranked order of means
T_1	5.1875^c	T_2	7.5625^a
T_2	7.5625^a	T_3	6.3750^b
T_3	6.3750^b	T_1	5.1875^c

Appendix 4

ANOVA (Analysis of variance) for flavor of Lolly ice cream

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	36.125	2	18.063	24.492	.000
Within Groups	33.188	45	.738		
Total	69.313	47			

Appendix 5

Duncan's Multiple Range Test (DMRT) for flavor, P<0.05

Treatment code	Original order of means	Treatment Code	Ranked order of means
T_1	5.1250^c	T_2	7.250^a
T_2	7.2500^a	T_3	6.1875^b
T_3	6.1875^b	T_1	5.1250^c

Appendix 6

ANOVA (Analysis of variance) for taste of Lolly ice cream

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	22.792	2	11.396	15.481	.000
Within Groups	33.125	45	.736		
Total	55.917	47			

Appendix 7

Duncan's Multiple Range Test (DMRT) for taste, P<0.05

Treatment code	Original order of means	Treatment Code	Ranked order of means
T_1	5.1250^c	T_2	6.8125^a
T_2	6.8125^a	T_3	5.9375^b
T_3	5.9375^b	T_1	5.1250^c

Appendix 8

ANOVA (Analysis of variance) for overall acceptability of Lolly ice cream

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	32.042	2	16.021	40.332	.000
Within Groups	17.875	45	.397		
Total	49.917	47			

Appendix 9

Duncan's Multiple Range Test (DMRT) for overall acceptability, P<0.05

Treatment code	Original order of means	Treatment Code	Ranked order of means
T_1	5.1875^c	T_2	7.1875^a
T_2	7.1875^a	T_3	6.2500^b
T_3	6.2500^b	T_1	5.1875^c

FIGURES

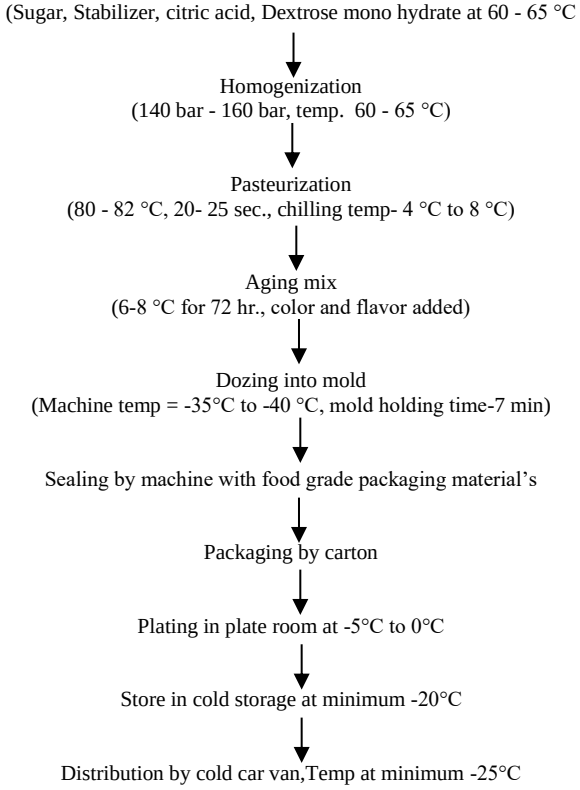

Figure 1 Flow chart for lolly ice cream

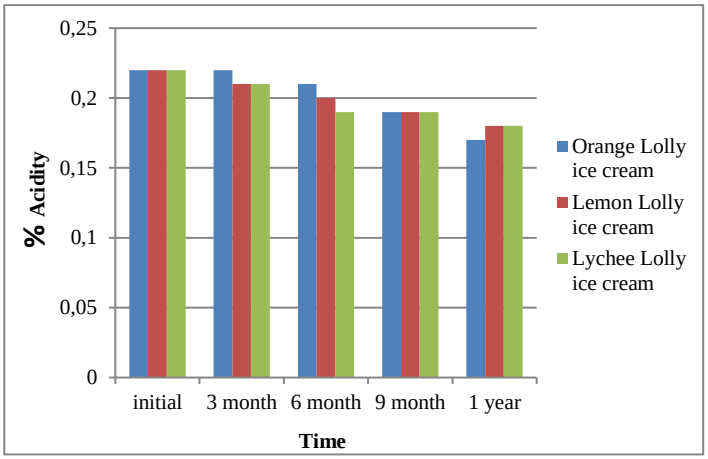

Figure 2 Changes of Acidity during Storage Period

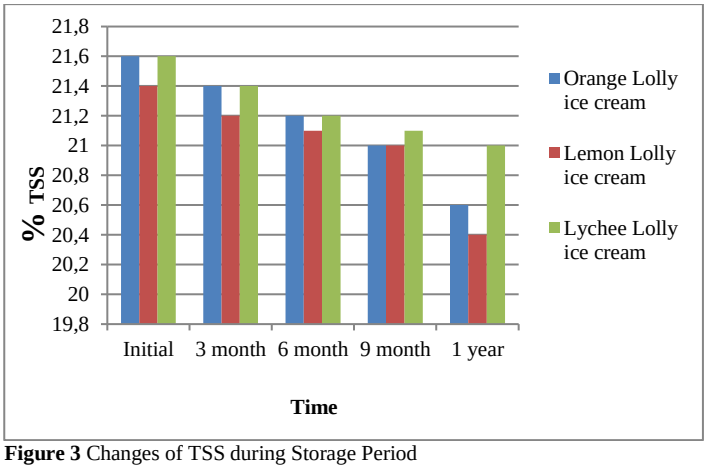

Figure 3 Changes of TSS during Storage Period

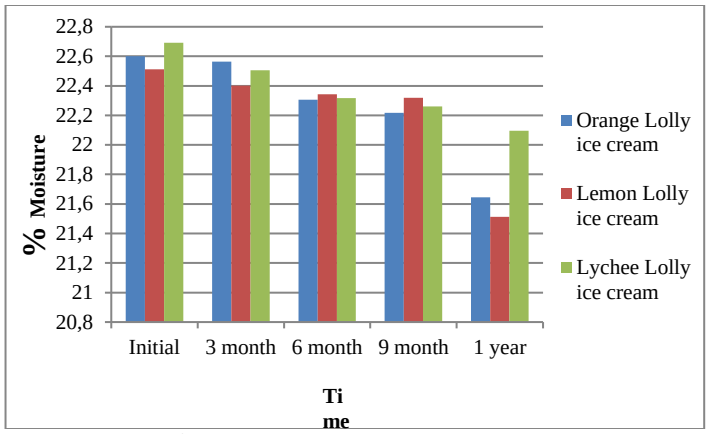

Figure 4 Changes of Moisture during Storage Period

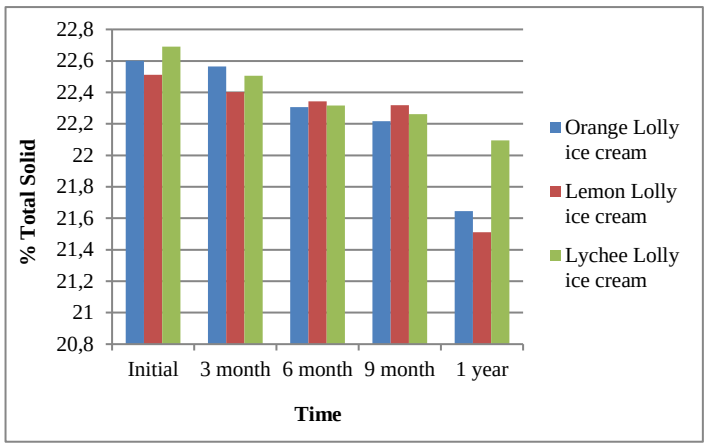

Figure 5 Changes of Total Solid during Storage Period