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Original Research Article

Comparative Studies of Ice Cream Prepared From Herbal Menthol and Crystal Menthol

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A B S T R A C T

Ice-cream was prepared by incorporating herbal menthol and crystal menthol at different proportions. The product obtained was subjected for sensory and chemical analysis. The herbal menthol extract was added 0.5, 1.0 and 1.5 per cent in TH2, TH3, TH_4 and crystal menthol was added as 0.2, 0.4 and 0.6 per cent in TC_2, TC_3 and TC_4. For comparison purpose control ice-cream was prepared as T_1. All treatments were found acceptable on 9-point hedonic scale with overall acceptability scores for treatments 8.17, 7.80, 7.59, 7.24, 6.87, 6.68 and 8.14, respectively. In physic-chemical properties acidity was observed as increasing order whereas fat and overrun showed decreased trends as compared to control ice-cream in both type of ice-cream treatments. Protein in herbal menthol added ice-cream increased and decreased in crystal menthol added ice-cream. Mixed viscosity increased in crystal menthol ice-cream samples whereas decreased in herbal menthol ice-creams. In both type of menthol added ice-cream chilling effects was found more as compared to control ice-cream. The herbal type menthol was found more suitable as compared to crystal one to prepared menthol added ice-cream which imparts cooling sensation without affecting the sensory and physical properties of ice-cream.

Keywords

Ice-cream, Herbal and Crystal menthol, Sensory and physico-chemical properties

Introduction

The diversification in food items on the basis of test, nutritional and functionality are the major concern of consumers due to the awareness, scientific attitude and changing life style with increasing purchasing power. So may new food items are coming in the market with their specification. Thus the ice-cream prepared from addition of some herbals may improve the nutritive quality. An ice-cream is a highly popular, palatable, nutritious and commercially important dairy product. It is a valuable accompaniment to the normal diet for all age groups especially for children. The production of ice-cream and its popularity is increasing rapidly. The dairy industry also more interested in ice-cream business due to its popularity, more profit margin and long shelf life as compare to other milk products as well as good stability in storage and transportation. It is manufactured with homogenized and pasteurized mix followed by ageing the mix

at low temperature and finally freezing the aged mix with the incorporation of air at proper conditions (Guner *et al.,* 2007). The food and nutritive value of ice-cream is two to three times higher for fat and protein than normal milk. Ice-cream is also rich source of calcium, phosphorous and other minerals of vital importance in building good bones and teeth. Being rich in lactose, ice-cream favours greater assimilation of the calcium content in the diet. Along with that, ice-cream is an excellent source of vitamin A, a good source of vitamin B_1(Thiamine) and B_2 (Riboflavin), and fairly good source of niacin, vitamin E, and in fruit ice-cream, vitamin C and the digestibility and palatability of ice-cream is also very high (De 2004).

Many innovations are developed in ice-cream and till research on it is being throughout the world. Bajwa *et al.,* (2003) investigated the effect of different concentrations (10 to 25 per cent) of strawberry pulp on the physic-chemical properties of ice-cream viz., overrun, standup time, meltdown, moisture, ash, total solids, MSNF, sucrose, ascorbic acid, pH and acidity were affected significantly by ice-cream treatments as well as storage. Murtaza *et al.,* (2004b) prepared ice-cream by using fig for investigation the effect of fat replacement by fig addition on ice-cream quality and found that figs decreased the overrun, meltdown, moisture, pH, MSNF, lactose and sucrose while increased significantly the standup time, total solids, protein, acidity and ash contents. Choo *et al.,* (2009) prepared three formulations by using virgin coconut oil (VCO) viz., VCO4, VCO8 and VCO12 was substituted with 4%, 8% and 12% of VCO, respectively. Temiz and Yesilsu (2010) examine the effects of grapes and mulberry pekmez concentrate on the physical, chemical and sensory properties of ice-cream samples. The addition of pekmez to ice-cream formulation positively affected total solids, total sugar, invert sugar saccharose, titratable acidity, ash and melting while protein, pH, overrun and viscosity were negatively influenced. Kumar *et al.,* (2012) observed the effect of *tulsi* as an herb on the functional, rheological and textural characteristics of ice-cream and reported that there was a proportionate decrease in the fat, protein, reducing sugars, non-reducing sugars and total solids (TS) in the experimental samples with increasing the levels of *tulsi* extract compared to control. Agrawal *et al.,* (2015) observed that the effect of variation of ginger juice on some physical and sensory properties of cream by using ginger juice as a flavouring agent in ice-cream at different levels of 0, 1, 2, 3, 4 and 5% w/w of ice-cream mix respectively.

Menthol (*Mentha arvensis*) which belongs to the family *Libeaceae* is a common edible and aromatic perennial herb which is cultivated throughout the India. Its common name is *pudina*.

Menthol is a naturally occurring in mint plants, but great quantities are also produced synthetically. It is used as cooling and flavoring agent in many products particularly found in lip balms, cough medicines, mouth wash, tooth paste, chewing gum, and candy, as well as in beauty products and perfumes. The cooling sensation it imparts when in contact with the skin or oral membranes. The active constituent of peppermint, found in the leaves and flowering tops, is menthol and is the alcoholic component responsible for the plant's characteristic quality to produce a cooling sensation, as well as its medicinal properties. The presences of various esters, particularly menthyl acetate, impart the familiar minty aroma and flavor so familiar to use. Mentha leaves oil include a variety of

the compounds known as monoterpenes and the class of chemicals called sesquiterpenes (Wikipedia, 2008).

In 1958, Congress enacted the Food Additives Amendment (FAA) to the Federal Food, Drug, and Cosmetics Act amid growing concern over the safety of substances added to foods. The FAA set forth standards and guidelines by which the safety of food additives must be established before they can be added to foods (FAA, 1958).

As per this law, the Flavor and Extract Manufacturers Association of the United States (FEMA) created the FEMA GRAS program in which the safety of flavor ingredients were evaluated for potential GRAS status by an independent panel of experts in the fields of chemistry, toxicology, pharmacology, medicine, pathology, and flavor safety assessment. The Average usual ppm/Average maximum ppm use levels of menthol for Baked goods, Beverage (non-alcoholic), Beverage (alcoholic) and Milk products is 60/250, 30/120, 100/400 and 200/800, respectively and possible average daily intake (PADI) is 13,400 µg/day (Smith *et al.,* 2001).

The maximum application of *Mentha arvensis* (*pudina*) were found in medicinal field to treat stomach disorders and chest pains for example dabar market *Pudinhara* for stomach disorder such as indigestion, gas, acidity etc (Tandan *et al.,* 1991); as an ingredient of cough drops and ointments like vicks vaporub etc (Anonymous 2013); widely used in medication for the relief of common cold symptoms such as nasal congestion and cough (Eccles 1994); *Mentha spp.* oil effect on digestive system and it helps to promote the production of digestive juices, so we can use on a regular basis to help our body.

As menthol have GRASS states for its application in dairy foods (200/800 Average usual ppm/Average maximum ppm) and possible average daily intake (PADI) is 13,400 µg/day, its application in food items are very rear, but *puddina* leaves usually use at domestic level in kitchen. Very few evidence and rare systematic studies are observed for use of menthol in large scale at industrial level in food and milk products. Out of that, prepared vegetable impregnated *paneer* using mint leaves. He added steam blanched and chopped mint leaves before coagulation of milk and observed an increased in iron and calcium content in *paneer* with increased amount of vegetable leaves (5 per cent to 30 per cent), found that 10 per cent level was most acceptable in *paneer* and had a shelf life of 10 days under refrigeration (Phul 2000). Majumdar *et al.,* 2009, developed functional juice by using Ash gourd *(Benincasa hispida)* and Mint leaves *(Mentha spicata)* in the ratio of 3:1 had acceptable for 6 months and microbiologically safe. Bandyopadhyay *et al.,* (2007) prepared fortified *Sandesh* by incorporating mint, beet and ginger. Kanatt *et al.,* (2008) investigated that Chitosan and mint mixture use as a preservative for meat and meat products. Srivastava *et al.,* (2010) prepared sweet and salty low fat cultured milk beverage containing mint. And other features of menthol in food matrix were study by Sani and Shojaei (2015) studied effect of herbal extract on fungal growth in UF-Feta cheese, no mold growth, change in texture and color on surface of cheese samples containing *Mentha longifolia* and *Carum carvi* essential oils during 120 days of storage at 4˚C and 30 days in 25˚C. Moreover, cheese samples containing *Mentha longifolia* and *Carum carvi* essential oils received maximum general approval for sensory attributes by sensory panels. The result of Sani and Shojaei (2015) studies found helpful in increasing the shelf life of

foods, controlling their putrefying and preventing food poisoning. It can also be a step towards reducing the use of synthetic preservatives, and increase using natural preservatives. Tehrani and Sadeghi (2015) observed that effect of mint essential oil on growth of *Listeria monocytogenes* during the ripening and storage of *iranian* white brined cheese. Based on the findings, mint essential oil in different densities of 0.03, 0.015 and 0.0075 per cent contain santi-listeria monocytogenes nature that reduces the number of listeria monocytogenes bacteria significantly in samples with essential oil in comparison with samples without essential oil. The most nature of anti-listeria relates to 0.03 percent- density mint essential oil. All these work are gave the idea for the development of ice-cream by using menthol. Menthol present in crystal form in market and also getting in fresh herbal form was felt to compare both form for the development of ice-cream.

Materials and Methods

The present investigation was carried out at the Department of Animal Husbandry and Dairy Science, College of Agriculture, Latur, (MS). For this investigation, the material used and methods employed were as below.

Treatment combinations

For comparison between two type of ice-cream prepared by using herbal menthol and crystal menthol with buffalo milk, the following treatment combinations were finalized on weight basis as follows:

Preparation of *Mentha arvensis* extract

Fresh leaves of *Mentha arvensis* were collected, sorted without bruising and washed under tap water. These leaves were ground in a mixer grinder by adding of distilled water at proportion (1: 0.5) volume basis. The obtained mentha extract was filtered by muslin cloth and collected in a glass bottle.

The menthe extract (Fig. 1) was prepared as reported by Satpute, 2016 with slight modification.

Preparation of ice-cream

For preparation of ice-cream, all ingredients were weighted separately in the appropriate proportion and prepared ice-cream as per the method suggested by De, 2004 (Fig. 2).

Sensory and physico-chemical evaluation of herbal and crystal menthol ice-cream

The ice-cream was subjected to sensory evaluation by the semi expert panel of judges. It was evaluated for colour and appearance, flavour, test and mouth feel and overall acceptability. 9 point hedonic scale, developed by Quarter Master Food and Container Institute, U.S.A. was used. The score of various treatments in respect of colour and appearance, flavour, taste and mouth feel and overall acceptability was worked out.

Herbal and crystal menthol ice-cream samples of different treatments were subjected for physico-chemical analysis *viz*. The pH of ice-cream was measured by using digital pH meter at a temperature of 25^0C. The acid content of ice-cream was determined the procedure described in IS: 1479 (1967) Part- I. The Fat content of ice-cream was determined by Gerber‘s method as in IS: 1224 (part II) 1977.

The Moisture and total solid content of ice-cream was determined by standard procedure as described IS: SP (Part XI)

1981. The protein content of ice-cream was determined by method described in A.O.A.C. (1965). The overrun refers to the increased in volume of ice-cream over the volume of ice-cream mix was calculated as per the procedure of Marshall *et al.,* (2003). Measurements of the mix viscosity was taken after overnight aging at 4 ^{0}c on spindle No 4 at 30 rpm by using Brooke Field Visco-meter (LVDV-E visco-meter).

Statistical analysis

In all four replications were carried out. The data obtained were analyzed statistically by using completely randomized design (CRBD) as per Panse and Sukhatme (1985) and software developed by Sheoran *et al.*, 1998 as Statistical Software Package for Agricultural Research Workers.

Results and Discussion

Sensory evaluation of ice-cream

The mean score for colour and appearance of herbal menthol ice-cream in treatments TH2, TH3 and TH4 were 8.19, 7.72 and 7.57, respectively whereas the mean score of ice-cream prepared by using crystal menthol for treatments TC2, TC3 and TC4 were 7.94, 7.90 and 7.81, respectively. The treatment T1 was control considered for both herbal and crystal menthol ice-cream. The ice-cream of treatment TH2 was prepared by using herbal menthol found significantly superior over other all treatments and at par with control. From this data it is clearly indicate that as the herbal menthol increased the colour and appearance non-significantly decreased, but not much more changes were found in crystal menthol ice-cream. The decreased value of ice-cream due to menthol application can be recovered by using clarified and micro filtered menthol extract which are also supported by other workers likes, Choo *et al.,* (2009) and Singh *et al.,* (2014) for colour and appearance in ice-cream prepared by incorporating plain cookie, chocolate cookie, vanilla cake and chocolate cake ice-cream samples scores decreased.

The mean scores for flavor of control, herbal menthol and crystal menthol ice-cream for treatments T1, TH2, TH3, TH4, TC2, TC3, and TC4 were 8.21, 8.46, 7.96, 7.60, 6.38, 5.75 and 5.56, respectively. It is notice from table 1 that all treatments are significantly differed from each other excluding TC3, and TC4. Treatment TC3, and TC4 was found at par each other and rejected by the sensory panel on 9 point hedonic scale. All treatments of herbal menthol and only one treatment of crystal menthol were found acceptable; indicate that use of crystal menthol was not appropriate for the development of ice-cream. The treatment TH2 secured highest score as compare to other treatments as well as control also.

Comparable findings were found by Bhandari and Balachandran (1984) prepared spray dried ice-cream mix by using pre-gelatinized potato starch as stabilizer and Tween-go as emulsifier. They were reported the flavor score of ice-cream 38.7, 37.2, 35.1, 35.3, 37.4, 34.4, 33.1, and 27.6 respectively; Marzieh *and* Mazaheri (2008) studied the effect of using some stabilizers of ice-cream and Choo *et al.,* (2009) recorded the flavor score of formulation of COMM (7.04) lower than the score obtained by the formulation VCO12 (7.81) and VCO8 (7.66), respectively.

The mean score of mouth feel for control and herbal menthol ice-cream for the treatments T1, TH2, TH3 and TH4 as, 8.06, 8.25, 7.81 and 7.54 and for crystal menthol ice-cream for treatments TC2, TC3 and TC4

were 6.88, 6.19 and 5.69, respectively. From the above observations it is clearly indicated that the mouth feel score of herbal menthol for treatments TH2, highest than all treatments might be due to the use of menthol extract and secured high score by TH2 (8.25). The ice-cream samples prepared by using crystal menthol were found lower as compared to ice-cream prepared by adding herbal menthol. The treatment TC2 and TC3 of crystal menthol was secured acceptable score on 9 point hedonic scale and other treatment TC4 was rejected by sensory panel.

Similar reducing trends for mouth feel were observed by Marzieh and Mazaheri (2008), Singh *et al.*, (2014) and Pandiyan *et al.*, (2010) in their respective work on ice-cream prepared by using different type stabilizers for ice-cream, bakery flavoured ice cream and use of skim milk powder in ice-cream, respectively. Kamte (2015) and Satpute (2016) was also observed same pattern in case of menthol application for the development of whey beverage by using beetroot.

The mean sensory score for body and texture for control, herbal menthol and crystal menthol ice-cream of treatments T1, TH2, TH3, TH4 TC2, TC3 and TC4 were 8.08, 7.81, 7.72, 7.68, 7.78, 7.67 and 7.67, respectively. It was observed from table 1 that, treatment TH2 of herbal (7.81) and TC2 of crystal (7.78) was found higher within the respective group. From the data of body and texture it is revealed that all treatments of herbal menthol as well as crystal menthol were at par with each other and found suitable for ice-cream preparation. But other parameters of sensory properties were not agreed for this statement particularly flavors and texture in which crystal ice-cream was found at lower grade. It is also notice that as herbal menthol extract and crystal menthol level was increased with decreased the score for body and texture between themselves and as compare to control also.

Similar result was found by Marzieh and Mazaheri (2008) for body and texture score obtained for P (4.28) type stabilizer is lower than M (4.31) type stabilizer respectively and by Choo *et al.,* (2009) recorded the body and texture score of formulation of COMM (6.72) lower than the score obtained by the formulation VCO12 (7.75) and VCO8 (7.40) respectively. Singh *et al.,* (2014) observed the match able body and texture scores in all types of bakery flavoured ice-cream.

The mean overall score for overall acceptability of control, crystal menthol and herbal menthol ice-cream for treatments T1, TH2, TH3, TH4, TC2, TC3 and TC4 were 8.14, 8.17, 7.80, 7.59, 7.24, 6.87 and 6.68, respectively. It is revealed from table 1 that the highest score secured by TH2 (8.17) followed by T1 (control), TH3, TH4, TC2 and TC3 indicating the decreasing order due to the addition of menthol in both crystal as well as herbal except treatment TH2. Treatment TH2 was better than control; means application of herbal menthol was suitable at 0.5 per cent level for the development of ice-cream. It is bind to conclude from the above mention result and discussion regarding sensory parameters that treatments TH2 of herbal ice-cream prepared using 0.5 per cent menthol extract was superior over others treatments which had the highest mean score on sensory parameters. Similar result reported by Choo *et al.,* (2009) the overall acceptability score of formulation of VCO8 (7.54), VCO12 (7.99) and COMM (7.37). Formulation VCO12 (7.99) is superior to score obtained by other formulation. Same trend found by Pawar *et al.,* (2011) the sensory scores for overall acceptability were 7.57, 8.18, 8.67 and 7.50 respectively.

Treatment Combinations

Treatment	Per cent menthol extract	Ice cream mix
T_1 (Control)	0	100
TH_2	0.5	99.5
TH_3	1.0	99.0
TH_4	1.5	98.5
TC_2	0.2	99.8
TC_3	0.4	99.6
TC_4	0.6	99.4

Table.1 Organoleptic evaluation of ice-cream prepared by using herbal and crystal menthol score recorded mention blow table

Sr. No.	Parameters	Treatments								
		T_1 Control	**TH_2**	**TH_3**	**TH_4**	**TC_2**	**TC_3**	**TC_4**	**S.E. ±**	**C.D. at 5%**
1)	Colour and Appearance	8.21^{a}	8.19^{a}	7.72^{b}	7.57^{b}	7.94^{b}	7.90^{b}	7.81^{b}	0.14	0.41
2)	Flavour	8.21^{a}	8.46^{a}	7.96^{ac}	7.60^{b}	6.38^{e}	5.75^{f}	5.56^{f}	0.114	0.33
3)	Mouth feel	8.06^{ab}	8.25^{a}	7.81^{ab}	7.54^{a}	6.88^{c}	6.19^{d}	5.69^{d}	0.117	0.52
4)	Body and Texture	8.08^{a}	7.81^{b}	7.72^{b}	7.68^{b}	7.78^{b}	7.67^{b}	7.67^{b}	0.12	0.25
5)	Overall Acceptability	8.14^{a}	8.17^{a}	7.80^{ab}	7.59^{abc}	7.24^{bc}	6.87^{bc}	6.68^{c}	0.48	1.01

The observations are the average of four replications

Table.2 Physico-chemical analysis of ice-cream prepared by using herbal and crystal menthol score recorded mention blow table

Sr. No.	Parameters	Treatments								
		T_1 Control	**TH_2**	**TH_3**	**TH_4**	**TC_2**	**TC_3**	**TC_4**	**S.E. ±**	**C.D. at 5%**
1)	Acidity	0.27^{a}	0.30^{b}	0.32^{c}	0.34^{d}	0.33^{cd}	0.34^{d}	0.35^{ed}	0.005	0.016
2)	pH	6.19^{a}	6.20^{ac}	6.23^{b}	6.24^{b}	6.21^{c}	6.24^{b}	6.27^{d}	0.006	0.018
3)	Fat	10.22^{a}	9.77^{b}	9.53^{c}	9.31^{d}	9.81^{b}	9.71^{e}	9.67^{f}	0.017	0.05
4)	Protein	5.15^{a}	5.21^{b}	5.28^{c}	5.31^{d}	5.12^{e}	5.10^{ef}	5.08^{f}	0.007	0.02
5)	Total solids	36.61a	36.62a	36.67a	36.72b	36.51c	36.35d	36.12e	0.034	0.072
6)	Moisture	63.27^{a}	63.32^{ab}	63.37^{b}	63.38^{bc}	63.48^{d}	63.65^{e}	63.87^{f}	0.034	0.071
7)	Overrun	31.65^{a}	30.63^{b}	29.78^{c}	28.08^{d}	30.23^{bc}	29.45^{bc}	27.45^{d}	0.267	0.791
8)	Mix viscosity	25.82^{a}	25.48^{b}	25.28^{c}	25.09^{d}	26.21^{e}	26.28^{f}	26.32^{g}	0.037	0.013

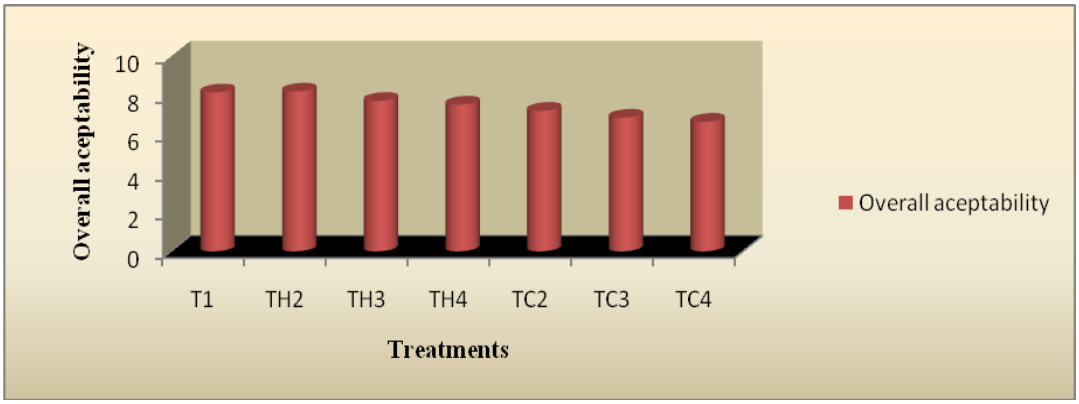
The observations are the average of four replications

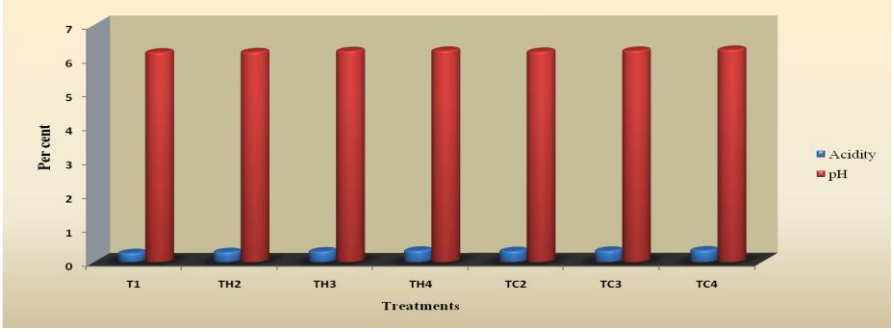
Fig.1 Flow diagram for preparation of menthe (*pudina*) extract

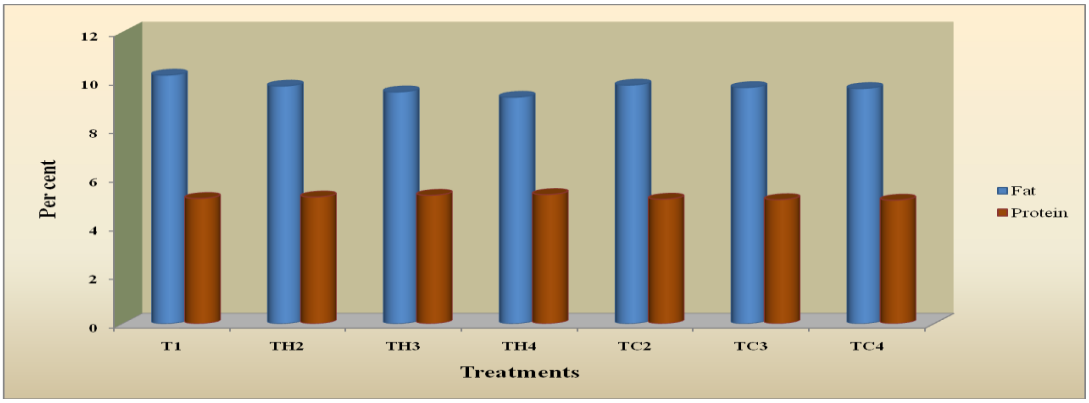
Collection of fresh *Mentha arvensis* leave
↓
Sorting (without bruising)
↓
Washing
↓
Grind in mixture (Add distilled water1:0.5 V/V basis)
↓
Filtration through muslin cloth
↓
Mentha extract

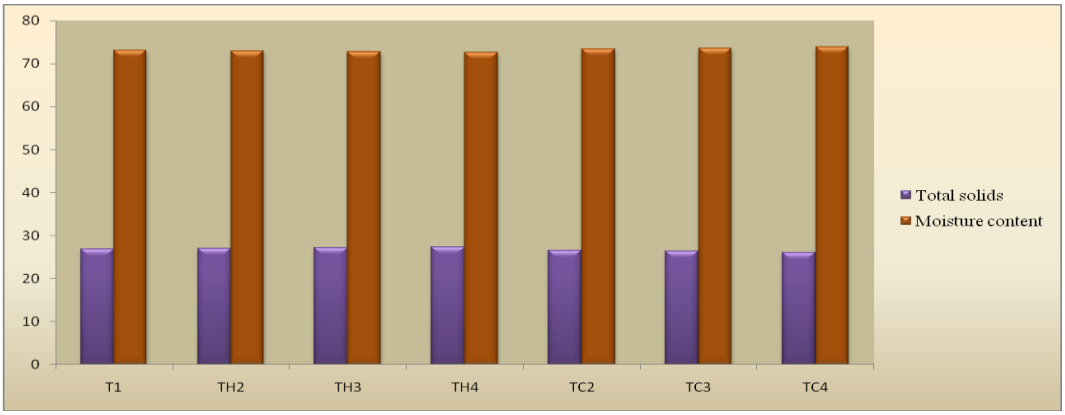
Fig.2 Flow chart for preparation of ice-cream (De, 2004)

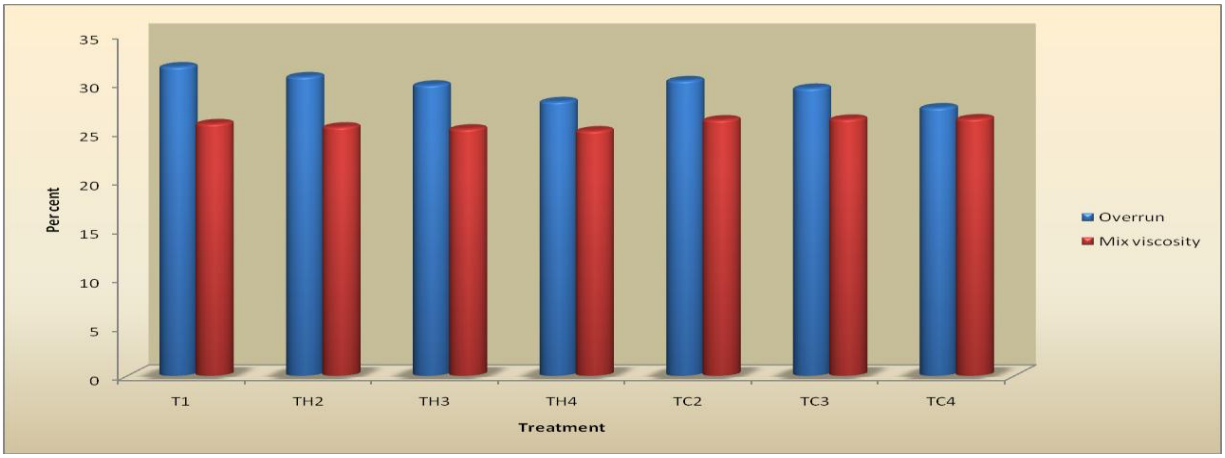
Receiving of Standardized Buffalo Milk (6% fat and 9 % SNF)
↓
Filtration
↓
Preheating (35-40^0 C)
↓
Formulation of ice-cream mix (Cream, Cane sugar, Stabilizer)
↓
Pasteurization (63^0 C for 30 min)
↓
Cooling (5^{0}C)
↓
Addition and mixing menthol as per treatments
↓
Ageing (4^0 C) 4-5 hrs
↓
Freezing (-4 to -50 C)
↓
Hardening and storage of ice-cream (-23 to -29^{0}C/24-48 hr)




Per cent
0
1
2
3
4
5
6
7
T1
TH2
TH3
TH4
TC2
TC3
TC4
Treatments
Acidity
pH


Per cent
0
2
4
6
8
10
12
T1
TH2
TH3
TH4
TC2
TC3
TC4
Treatments
Fat
Protein


0
10
20
30
40
50
60
70
80
T1
TH2
TH3
TH4
TC2
TC3
TC4
Total solids
Moisture content


Per cent
0
5
10
15
20
25
30
35
T1
TH2
TH3
TH4
TC2
TC3
TC4
Treatment
Overrun
Mix viscosity

Singh *et al.*, (2014) reported the overall acceptability scores of all ice-cream samples were reduced significantly ($p<0.01$). The overall acceptability scores of chocolate cookies and plain cookies ice-cream remained high but dropped sharply in both vanilla and chocolate cake ice-cream.

Physico-chemical analysis of herbal and crystal menthol ice-cream

The requisite samples of developed herbal and crystal menthol ice-cream were subjected for the proximate analysis *viz.* acidity, pH, fat, protein, total solids, moisture, over run and mix viscosity. The results obtained on account of this parameter are presented in table 2.

Acidity and pH

The acidity content of control, herbal menthol and crystal menthol ice-cream for treatments T_1, TH_2, TH_3, TH_4, TC_2, TC_3, and TC_4 were 0.27, 0.30, 0.32, 0.34, 0.33, 0.34 and 0.35, respectively. In both cases of ice-cream the acidity was found increasing order from 0.27 to 0.35, crystal form was more prone than herbal form.

Ice-cream with herbal menthol with 1.5 per cent (acidity 0.34) and crystal menthol with 0.6 per cent (0.35) had highest acidity. It was observed the acidity of control sample (T_1) was lower as compared to other samples it may be due to more ascorbic acid in mint leaves content (20.40 mg/100gm) as compared to pure ice-cream mix responsible for increased acidity supported by Tucker 2012 reported that as the herbal menthol extract increased ascorbic acid increased and acidity also increased.

The similar finding was reported by Hwang *et al.*, (2009), Temiz and Yesilsu (2010), Goraya (2013).

The pH of control, herbal menthol ice-cream for treatment T_1, TH_2, TH_3 and TH_4 were 6.19, 6.20, 6.23 and 6.25 and crystal menthol ice-cream treatment score for TC_2, TC_3 and TC_4 were 6.21, 6.23 and 6.27, respectively. Treatment TC_4 of crystal menthol ice-cream showed highest pH content while T_1 (control) sample ice-cream showed lowest pH. It was observed the increased the pH was found increased as the menthol proportion increased, the pH should be decreased due to the increased acidity but actually pH also found in increasing order which might be due to the presence of phenolic substance in mint leaves increased the pH and acidity of ice-cream with increased the level of herbal and crystal menthol.

This finding observed similarly reported by Sagdie *et al.*, (2011), Choo *et al.*, (2009) and Silva *et al.*, (2010) and Kumar *et al.*, (2012).

Fat and protein

The fat content of control and herbal menthol extracted ice-cream for treatment T_1, TH_2, TH_3 and TH_4 were 10.22, 9.77, 9.53 and 9.31. For crystal menthol ice-cream treatment score for TC_2, TC_3 and TC_4 were 9.81, 9.71 and 9.67, respectively. Near about all treatments significantly differ from each other except TH_2 and TC_2. It was also observed that maximum fat content was observed in T_1 while minimum fat content observed in TH_4 of herbal ice-cream, because of mint leaves contained less fat and more fibre hence their incorporation led to decrease in fat. Herbal menthol reduced the fat content more proportion than crystal one might be due to the pure crystalline nature of crystal menthol.

The similar results reported by Silva *et al.*, (2010), Bajwa *et al.*, (2003) and Murtaza *et al.*, (2004b).

The mean values for protein content of control, herbal menthol ice-cream were found as 5.15, 5.21, 5.28 and 5.31for treatment T_1, TH_2, TH_3 and TH_4, respectively whereas the corresponding values for crystal menthol ice-cream treatments were 5.12, 5.10 and 5.08 for TC_2, TC_3 and TC_4, respectively. All herbal treatment significantly differ with each other and control whereas crystal menthol treatments were found at par each other and low protein content as compare to herbal and control, it may be due to the contribution of protein from herbal in herbal ice-cream. Treatment TC_4 of crystal menthol ice-cream showed lowest protein content while treatment TH_4 of herbal ice-cream showed highest protein. The mint leaves content protein the increased the level of herbal menthol extract in ice-cream also increased the protein level. Comparable findings were found by Goraya (2013), Pandiyan *et al.*, (2010) and Silva *et al.*, (2010).

Total solid and moisture

The total solids content of control, herbal menthol and crystal menthol ice-cream for treatment T_1, TH_2, TH_3, TH_4, TC_2, TC_3 and TC_4 were 36.72, 36.67, 36.62, 36.61, 36.51, 36.35 and 36.12, respectively. Treatment TC_4 (36.12) of crystal menthol ice-cream showed lowest total solids content while TH_4 (36.72) of herbal ice-cream showed highest total solids. This was due to total solids content (16.22 per cent) in fresh mint leaves.Similar results were reported by Ahanian *et al.,* (2014) Choo *et al.,* (2009) Bajwa *et al.*, (2003) Murtaza *et al.,* (2004b).

The average moisture content of control and herbal menthol ice-cream for treatments T_1, TH_2, TH_3 and TH_4 were 63.27, 63.32, 63.37 and 63.38 per cent, and for crystal menthol ice-cream treatments score for TC_2, TC_3 and TC_4 were 63.48, 63.65 and 63.87, respectively. Treatment T_1 was control for both herbal and crystal ice-cream showed intermediate moisture per cent as compared to trial treatments between herbal ice-cream and crystal ice-cream, which may be due to the micro capillary water retained in the interactive bond of crystal menthol components with milk components particularly proteins and low moisture in herbal treatments was due to the high moisture percent in herbal menthol as compare to ice-cream mix. The highest moisture content observed in TC_4, then subsequently observed reducing in TC_3 and TC_2 in crystal applied samples, whereas lowest moisture content observed in TH_4, then subsequently observed increasing order in TH_3 and TH_2 in herbal ice-cream which justified the above mention reason. In case of crystal applied ice-cream more stickiness was observed indicating some physico-chemical change might be occurred due to crystal menthol which looks to investigate and give scope for further study. Again one thing is observed from table 2 that the successive treatments at par with each other and alternative treatments differ significantly indicating the effect of menthol on moisture contain in ice-cream was influenced by incorporating menthol more than 0.5 and 0.2 per cent for herbal and crystal form, respectively. Similar results were recorded by Bajwa *et al.,* (2003) and Murtaza *et al.,* (2004b).

Overrun and mix viscosity

Ice-cream is sold by volume, and its overrun is thus an important property from the regulatory, as well as the product quality, point of view. Air is an important volumetric ingredient of ice cream. The air content is expressed as overrun, which is defined as the percentage increase in the volume of the ice cream mix achieved by whipping air into

the mix prior to freezing. This investigation under observed that the overrun content of control, herbal and crystal menthol ice-cream for treatment T_1, TH_2, TH_3, TH_4, TC_2, TC_3 and TC_4 were 31.65, 30.63, 29.78, 28.08, 30.23, 29.45 and 27.45, respectively. All developed treatments were significantly lower than the control treatment. Treatment TC_4 of crystal menthol ice-cream recorded lowest over run while T_1 (control) sample ice-cream was recorded highest over run. Incorporation of herbal and crystal menthol depressed the whipping ability of milk protein by hindering air incorporation and therefore caused a decrease over run of ice-cream, it is due modification in typical oil-in-water (o/w) emulsion or even converted into another physical state. Similar finding were recorded by Pinto *et al.,* (2006), Murtaza *et al.,* (2004b), Marzieh and Mazaheri (2008).

The viscosity of herbal and crystal menthol ice-cream with incorporating different levels of mentha extract and crystal menthol recorded. The mean viscosity of control, herbal and crystal menthol ice-cream for treatments T_1, TH2, TH3, TH_4, TC_2, TC_3 and TC_4 were found 25.82, 25.48, 25.28, 25.09, 26.21, 26.28 and 26.32 cPs., respectively. The viscosity was highest in control treatments i.e. T_1 (25.82 cPs) in control ice-cream as compared to mixed samples with menthol extract were TH_2 (25.48 cPs), TH_3 (25.28 cPs) and TH_4 (25.09 cPs) and for samples mixed with crystal menthol powder were TC_2 (226.21 cPs), TC_3 (26.28 cPs) and TC_4 (26.32 cPs) respectively. All treatments were significantly differed from each other and control ice-cream. Viscosity of milk decreases with increasing shear rate at a temperature below 40ºC (Randhahn, 1973), which Mulder and Walstra (1974) suggested may be due to disruption of clusters of milk fat globules, which were formed as a result of cold agglutination which might be occurred in the present study. Similar finding observed by Marzieh and Mazaheri (2008), Temiz and Yesilsu (2010) Kumar *et al.,* (2012) and Ahanian *et al.,* (2014).

The herbal type menthol is suitable @ 0.5 per cent of ice-cream mix as natural sensory means for the development of ice-cream which imparts cooling sensation without affecting the sensory and physical properties of ice-cream. The application of crystal type menthol produce unpleasant adulated mouth feel, suggest more modification like encapsulation of crystal menthol for its application.

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