European Journal of Food Science and Technology
Vol.8, No.2, pp.32-45, May 2020
Published by ECRTD UK
Print ISSN: ISSN 2056-5798(Print)
Online ISSN: ISSN 2056-5801(online)

CHARACTERIZATION AND EVALUATION OF PHYSICOCHEMICAL AND SENSORY ACCEPTABILITY OF ICE CREAMS INCORPORATED WITH PROCESSED GINGER

Mylvaganam Pagthinathan
Department of Animal Science, Faculty of Agriculture, Eastern University, Sri Lanka. Vantharumoolai , Sri Lanka

ABSTRACT: *The study was undertaken to develop different forms of the ginger ice cream using 5% ginger juice, 5% ginger paste and 5% ginger syrup. These ice cream samples were analyzed for physicochemical, microbial and sensory properties during 28 days of frozen storage at -20 ^{0}C. Incorporation of the juice, syrup and paste in ice cream reduced total solids, fat, acidity and total soluble solid, and increased antioxidant activity. Ash content increased with the ginger paste, whereas it decreased with the ginger juice and syrup. First dripping time amplified and melting rate declined with all the ginger preparations. And also textural properties increased and microbial activity decreased with ginger added ice creams. During storage, the total solid, ash, fat, total soluble solid content, dripping time and textural properties were significantly (p<0.05) increased. pH content, antioxidant activity and melting rate were significantly (p<0.05) decreased with the storage period. Organoleptic properties were evaluated though the panel of 30 members. As a results of organoleptic characteristics revealed that, 5% of ginger syrup incorporated ice cream had the highest mean score of overall quality of all sensorial properties namely, colour, taste and overall acceptability.*

KEYWORDS: ginger, ice cream, physicochemical properties, sensory evaluation, storage

INTRODUCTION

Ice cream is a delicious frozen dairy product and made up from two phases: a continuous phase comprising sugars, proteins, salts, polysaccharides and water, and a disperse phase which consists of ice crystals, air bubbles and partially coalesced fat globules (Singoa and Beswa 2019). The ice-cream is made up from heterogeneous ingredients and which will reflect on the sensory characteristics (Goff 1995, Bajad et al. 2016). Moreover the ice cream is complex products which are made up in different pattern in various localities of various countries and accordingly there is impact of preparation method on physico-chemical properties of ice cream mix and reflect on final quality of the product. Ice cream stability, acidity, pH, density, viscosity, surface tension, interfacial tension and adsorption will have impact on the final quality of the Ice-cream (Bajad et al. 2016). The growing consumer demand for ice cream, its high product acceptability and inflexible competition have forced manufacturers to try for development through innovations in the types of products (Gabbi et al. 2018). Previously, it has been reported that, ice cream possess nutritional properties from its major ingredient (milk) even though it does not offer any health benefits. Hence, new varieties of ice cream are developing by addition of functional ingredients such as antioxidants and phenolic to food products are created the attention of health benefit among consumers (Aboulfazli et al. 2016, Gabbi et al. 2018).

Ginger (*Zingiber officinale*) is one of the most commonly consumed dietary condiments throughout the world (Surh et al. 1998, Gabbi et al. 2018). Ginger is a medicinal plant belonging to Zingiberaceae family and it is indigenous to South Asia and South-Eastern Asia (Purseglove et al. 1981). It has important biologically active elements, including the main pungent components: gingerols and shogaols (Singh et al. 2008). These compounds are enhancing the body's internal production of antioxidants and inhibit the production of free radicals (Rehman et al. 2011). Ginger is one of the natural antioxidant and phenolic compounds rich condiments. However, the effect of ginger incorporation in different processed forms such as extract, paste and syrup in ice cream could provide product diversification and health benefits to the consumers (Waterhouse et al. 2013, Gabbi et al. 2018). Melting properties are important in ice cream with respect to their relation to sensory quality. Melting rate of ice cream affects by various factors such as additives used, amount of air incorporated (overrun), nature of ice crystals, composition and network of fat globules formed during freezing. Addition of processed ginger products considerably increased the first dripping time (Herald *et al*., 2008) and reduced the overrun by impeding air incorporation (Bajwa et al. 2003, Pinto et al. 2004, Gafour et al. 2007). However, information on the effect of different type's processed ginger incorporation in ice cream and characterization are lacking. Therefore, this study compared the physicochemical and sensory properties of ice cream incorporating differently processed ginger.

MATERIALS AND METHODS

Processing of Ginger

Ice creams were prepared using different forms of processed ginger namely ginger juice, ginger paste and ginger syrup. The ginger was clean and peeled prior to processed products. Peeled ginger was cut into pieces and then grated using a blender for ginger juice preparation. Then after, it was filtered using a muslin cloth and extraction used as a ginger juice. Ginger paste was prepared according the method described by Gabbi et al. (2018) that the peeled ginger was cut into 1 cm diameter pieces and were steam blanched for 11 minutes and crushed into a fine paste using an electric blender. For ginger syrup, peeled ginger were cut into thin round slices then after sliced ginger, water and sugar (ginger, water and sugar ratio (1:1:1) were heat up to boiling temperature (100 ^{0}C). Then the heat was reduced to a steady simmer and cooked for 30 minutes. Syrup was strain through fine mesh and ginger pieces were discarded and remaining uses as a syrup. Ginger juice, paste and syrup were put into a glass bottle and stored in deep- freezer at -4 ^{0}C until used for experiment (Gabbi et al. 2018).

Procedure for Ice Cream Preparation

The ice cream was produced according to Yangılar (2015) and Gabbi et al. (2018) with some modifications. Initially, the fat ratio of cows' milk was adjusted to 6% by adding cream. Cow milk was homogenized. Then, the milk was divided into four equal parts of 4 kg. For each mix, skim milk powder (250 g), sugar (750 g), gelatin (stabilizer) (10

Vol.8, No.2, pp.32-45, May 2020
Published by ECRTD UK
Print ISSN: ISSN 2056-5798(Print)
Online ISSN: ISSN 2056-5801(online)

g) and corn flour (10 g) were added to each mix. The mixtures were pasteurized at 85 ^{0}C for 30 minutes and allowed for cooling. It was beaten well and kept in refrigerator for 1 hour, and then it was taken out and beat again. This beaten procedure was repeated for several times. Processed ginger juice, ginger paste and ginger syrup were added at the concentration of 5 % (w w^{-1}) to the cooled ice cream mixture separately prior to freezing. Without ginger ice cream was used as control for this study. The frozen ice cream was drawn at - 4 ±1 °C from the freezer and filled in plastic cups, hardened in a chest freezer at -20 °C for 24 h and stored at same temperature for further studies. The samples were analyzed at day 0, day 7, day 14, day 21 and day 28 of the storage. Ice cream samples were produced in triplicate.

Physicochemical Analyses

The processed ginger incorporated ice cream samples were analysed in three replicates for each parameter. Total solids were determined by oven drying at 105 °C to get constant weight according to AOAC (2000). Ash content was determined by using muffle furnace at 550 °C for 4 h as described by AOAC (2000). The milk fat content of the ice cream was determined by the Gerber method as described by AOAC (2000). The titrable acidity was determined by titrating with 0.1 N NaOH according to AOAC (2000). The pH of ice cream sample was measured directly using a digital pH meter (model: Delta 320 pH meter) after calibration with fresh pH 4.0 and 7.0 stranded buffer. About 20 mL of the ice cream sample was poured in a 50 mL beaker and the electrode was inserted while the sample was gently agitated. The final steady pH reading was recorded (Singo and Beswa 2019). Total soluble solid of the ice cream sample was measured by using hand refractometer. Ice (10 g) cream was taken and allowed for melting. Then one drop of that solution was put into the hand refractometer and value was taken using scale of the refractometer.

Determination of Antioxidant Activity

The total antioxidant capacity was estimated by ferric reducing antioxidant power (FRAP), assay (Benzie and Strain 1996). FRAP reagent was prepared by mixing 1 mL of (10 ml L^{-1}) TPTZ solution in 40 mmol L^{-1} HCl, 1 ml of $FeCl_3$ (20 mmol L^{-1}) and 10 ml of acetate buffer, (0.3 mol L^{-1}, pH=3.6). Twenty microliters of the extract was mixed with 1 mL FRAP reagent, incubated at room temperature for minutes and the absorbance measured at 593 nm exactly after 4 min. FRAP reagent was used as a control. The absorbance of 1000 micro-liters $FeSO_4$ standard was measured following the same procedure as for the samples. The ferric reducing antioxidant power was expressed in mM g^{-1} fresh weight (FW).

Dripping Time

First drip time and melting rate was estimated at 20 ± 1 ºC using the method of Akesowan (2008) and Singh et al. 2014 with little modifications. First dripping time and melting rate of ice cream were estimated at 32 ^{0}C. The hardened ice cream (25 g), held at frozen temperature (-20 ºC) was placed on a sieve which had 5 mm wide and square openings. Then the time for first drop on melting of ice cream was documented as the first dripping time and melting time was also determined by the volume of the melted ice cream during the first ten minutes was recorded and further measured at every 5 min interval until the time of 40 min was reached.

Determination of Texture

Texture was determined according the method described by Awad et al. (2005) with little modification, using food rheology tester (IMADA mode FRT series). Ice cream samples was taken out from the freezer (at -20 ^{0}C) and stored at - 5 ^{0}C for 30 min. Ice cream sample was tested at 50 % compression, with crosshead speed at 10 mm min^{-1}. Hardness, cohesiveness, gumminess, chewiness and adhesiveness were determined in the triplicate from the force – distance curve obtained from two- bite deformation curve of the texture profile.

Microbiological Analysis

The ice cream samples were analyzed for total bacterial count and Total Staphylococcal count using nutrient agar as per standard APHA (1992) and Singh et al. (2014) procedures.

Sensory Analysis

In sensory evaluation, the ice cream samples were subjected to seven -point hedonic scale test, and the acceptability of samples was judged by 30 untrained members to determine consumer preference as described by Gabbi et al. (2018). Before serving, the hardened ice cream samples were placed in a sealed thermal box to reach and maintain a temperature of approximately 10 °C. Then sensory characteristics, such as colour, flavour, taste, texture and overall acceptability of the ice cream samples were judged by the panelists at day 0, week day 7day 14, day 21 and day 28 of storage period.

Statistical Analysis

Samples were randomly collected, and parametric data were analyzed by using Multivariate Analysis of Variance (MANOVA) and used to determine the significance level of the treatments, while the Duncan's Multiple Range Test (DMRT) was used for mean separation. The sensory analysis was carried out using Friedman's test for non-parametric data analysis.

RESULTS AND DISCUSSION

Effect of Storage on Total Solid, Ash, Fat and TSS Contents in Ginger Added Ice Cream

Total solids (TS), ash, fat and total soluble solid (TSS) of ginger added ice cream are given in Table 1. At day 0 the higher amount of total solid content was observed in without ginger added ice cream and lower value observed in ginger juice added ice cream. Addition of different types of processed ginger to the ice cream were ($p<0.05$) differed from without ginger added ice cream. The TS contents of ice cream were decreased with addition of all ginger preparation, due to their low dry matter content and higher moisture content than the ice cream mix. These results are in close agreement with Pinto et al. 2004 who reported that without ginger added ice cream contained 38.23% total solids, further, he was reported that the addition of ginger juice decreases the total solids content of ice cream simultaneously. Similar finding were previously reported adding of ginger juice (Balestra et al. 2011), ginger juice, paste and powder (Gabbi et al. 2018, (Goraya and Bajwa 2015) and ginger shreds (Pinto et al. 2006. During at 7 day of storage, highest value of total solid content was observed in without ginger added ice cream and lowest value showed in ginger juice incorporated ice cream. So, adding of different types of processed ginger TS of ice cream were decreased due to their higher moisture content than the ice cream mix. At 28 day of storage, highest mean value showed in without ginger added ice cream and lowest value was showed in ginger juice incorporated ice cream. Furthermore, TS content increased during 28 days of storage. This increment may be due to water evaporation along the refrigerated storage period (El-Nagar and Shenana 1998). Moisture migration is the principle physical change occurring in frozen foods. Moisture can evaporate from the ice cream in the freezer and recrystallized on the top of the ice cream (Buyong and Fennema 1988). At day 0 higher amount of ash content was observed in ginger paste added ice cream and lower value observed in ginger juice added ice cream (Table 1).

Table 1. Effect of storage on total solid, ash, fat and TSS content in ginger added ice cream

Treatment	Day 0	Day 7	Day 14	Day 21	Day 28
	TS % (Mean ± SD)				
T1	35.18 ± 0.34^{j}	36.84 ± 0.28^{i}	38.87 ± 1.00^{fg}	39.61 ± 0.48^{ef}	41.64 ± 0.03^{d}
T2	35.71 ± 0.49^{j}	38.02 ± 0.68^{gh}	39.83 ± 0.83^{ef}	40.54 ± 1.16^{e}	42.07 ± 0.13^{cd}
T3	36.75 ± 1.01^{i}	38.15 ± 0.03^{g}	39.56 ± 0.56^{ef}	41.66 ± 0.68^{d}	43.90 ± 0.58^{ab}
T4	37.62 ± 0.95^{hi}	39.54 ± 0.84^{ef}	41.84 ± 0.04^{d}	42.97 ± 0.33^{bc}	44.34 ± 0.66^{a}
	Ash % (Mean ± SD)				
T1	0.68 ± 0.06^{de}	0.72 ± 0.04^{cd}	0.73 ± 0.02^{cd}	0.74 ± 0.02^{bcd}	0.76 ± 0.05^{bcd}
T2	0.61 ± 0.03^{e}	0.69 ± 0.06^{de}	0.72 ± 0.06^{cd}	0.73 ± 0.09^{cd}	0.74 ± 0.02^{bcd}
T3	0.75 ± 0.98^{bcd}	0.76 ± 0.02^{bcd}	0.79 ± 0.04^{abc}	0.84 ± 0.01^{ab}	0.86 ± 0.03^{a}
T4	0.62 ± 0.03^{e}	0.68 ± 0.07^{de}	0.73 ± 0.06^{cd}	0.73 ± 0.10^{cd}	0.72 ± 0.04^{cd}
	Fat% (Mean ± SD)				
T1	7.27 ± 0.06^{f}	7.33 ± 0.15^{f}	7.47 ± 0.15^{ef}	7.50 ± 0.10^{ef}	7.57 ± 0.40^{e}
T2	7.53 ± 0.06^{ef}	7.60 ± 0.10^{ef}	7.65 ± 0.44^{e}	8.67 ± 0.38^{d}	8.70 ± 0.35^{cd}
T3	7.30 ± 0.17^{f}	7.50 ± 0.26^{ef}	7.56 ± 0.15^{ef}	7.60 ± 0.46^{e}	8.65 ± 0.85^{d}
T4	8.87 ± 0.31^{d}	8.97 ± 0.35^{cd}	9.13 ± 0.45^{bc}	9.20 ± 0.06^{ab}	9.25 ± 0.20^{a}
	TSS% (Mean ± SD)				
T1	28.07 ± 2.05^{g}	31.60 ± 0.08^{f}	35.00 ± 0.53^{de}	38.47 ± 0.31^{c}	40.53 ± 0.81^{b}
T2	28.73 ± 0.70^{g}	31.93 ± 0.76^{f}	35.73 ± 0.12^{d}	38.93 ± 0.42^{c}	40.57 ± 0.06^{a}
T3	28.20 ± 1.78^{g}	31.93 ± 0.42^{f}	34.87 ± 0.64^{de}	38.80 ± 0.60^{c}	40.93 ± 0.61^{b}
T4	29.07 ± 0.95^{g}	33.80 ± 0.72^{e}	38.67 ± 0.90^{c}	40.73 ± 0.90^{b}	42.40 ± 1.40^{a}

T1= Ginger juice added, T2= Ginger syrup added, T3= Ginger paste added, T4 = without Ginger added. The Values are means of triplicates ± standard deviation. Mean with the same letters are not significantly different at ($p< 0.05$).

However, at the time of storage, Ash content of processed ginger incorporated ice cream, it noticed that, the ash content were significant ($p<0.05$) differences among the all types of ice creams. The ash content of the ice cream ranged from 0.61% to 0.86%. At 7day, the higher value of ash content presented in ginger paste added ice cream and lowest mean value of ash content observed in without ginger added ice cream. At 28 day, the highest value showed in ginger paste added ice cream and lowest value showed in without ginger added ice cream. All treatments showed slightly increased ash content along the storage period. These differences may be due to the changes in dry matter along the refrigerated storage period (Yangilar and Yildiz 2018).

Fat content was($p<0.05$) highest (8.87±0.31%) in without ginger added ice cream and lower value (7.27±0.06%) in ginger juice added ice cream at day 0. It was observed that the addition of processed ginger decreased the fat content of ice cream. This might be low fat content in ginger and these finding are in concordance with Pinto et al. (2004), Gabbi et al. (2018), who reported that fat content in ice cream decreased on addition of ginger shreds and ginger juice, paste candy and powder, respectively. The fat content declined progressively as the amount of processed ginger increased (Gabbi et al. 2018). At 7 day of storage, highest fat contents (8.97±0.35 %) was ($p<0.05$) recorded without ginger added ice cream and lowest value (7.33±0.15%) observed in ginger juice added ice cream, respectively. The results showed that, there were slightly change of fat content during storage time. In frozen storage, the ice cream mix undergoes partial coalescence, where clumps and clusters of the fat globules form and build an internal fat structure fat structure or network by trapping air within the coalesced fat (Akalin et al. 2008, Chang and Hartel 2002).

Similarly, TSS was highest n without ginger added ice cream and lower value in ginger juice added ice cream at day 0. The TSS content declined with the addition of ginger juice and paste, it might be increasing of water it leads to decreasing of brix (Choi and Shin 2014). TSS content of processed ginger added ice cream noticed that, the TSS content were significant ($p<0.05$) differences among the all types of ice cream during storage (Table 1). At 7 day of storage, the higher mean value of TSS content (33.80±0.72%) presented in without ginger added ice cream and lowest mean value of TSS content (31.65±0.05%) observed in ginger juice added ice cream. By considering results at 28 day, the highest and lower value of TSS were showed in without ginger and ginger juice incorporated ice cream. The increased of TSS may be due to the reduction of moisture along the refrigerated storage period (Silva and Silva 2011).

Effect of Storage on pH and Titratable Acidity Contents in Ginger Added Ice Cream

The pH of all ice cream samples decreased significantly ($p<0.01$) during the storage period (Table 2). The pH of without added ice cream was appreciably higher than that with ginger items at 0 day. It decreased from 6.59±0.01 to 6.42±0.03 without added ginger ice cream during storage. These results were in agreement with that obtained by Gabbi et al. (2018), who reported that the ginger juice and powder inclusion caused a significant increase in acidity and decrease in the pH of the ice cream samples. While titratable acidity value increased progressively with pH. At Day 7, the higher value of titratable acidity observed in ginger juice incorporated ice cream and lower value recorded without ginger added ice cream. At 28 days, the higher titratable acidity observed in ginger juice incorporated ice cream and lower value recorded without ginger added ice cream. The titratable acidity was increased gradually during the storage period. The increase in the acidity was possibly due to the formation of lactic

Published by ECRTD UK
Print ISSN: ISSN 2056-5798(Print)
Online ISSN: ISSN 2056-5801(online)

acid by lactic acid bacteria (LAB) and psychrophillic bacteria during storage (Singh et al. 2014). This result is in agreement with the study of who reported as slight increase in titratable acidity during four week of storage and with the study of Kosikowski and Mistry (1997).

Effect of Storage on First Dripping Time and Melting in Ginger Added Ice Cream

The first dripping time was higher in ginger paste added ice cream and lower value observed in without ginger added ice cream. Addition of processed ginger products to the ice cream significantly ($P<0.05$) increased the first dripping time than without ginger added ice cream. First dripping time ranged vary from 6.36 min to 15.93 min and presented in Table 3. At 0 day, the higher mean value of dripping time observed in ginger paste incorporated ice cream and lower value recorded without ginger added ice cream. According to results at 28 days, the higher value showed in ginger paste added ice cream compared to other treatments and least value showed in without ginger added ice cream. First dripping time of all ice cream samples increased with storage period. These results are accordance with finding of Singh et al. (2014). Meltdown is an important property of an ice cream affecting sensory quality of ice cream from viewpoints of eye appeal and mouth feel (Jadhav et al. 2017). As indicated in Figure 1 a and b, melting rate were higher in without ginger added ice cream and lowest in ginger paste added ice cream throughout the storage period and malting rate was decreasing with storage period Gabbi et al. (2018).reported that melting rate was decreasing when amount of processed ginger was increasing in the ice cream, this might be the extra solids, including some starch from the ginger. In addition, incorporation of ginger reduced the overrun by blocking air incorporation (Bajwa et al. 2003, Pinto et al. 2004, Gafour et al. 2007).

Antioxidant Activity of Ice Cream During Storage

Antioxidant activity was higher in ginger added ice cream than without ginger added ice cream while ginger juice added ice cream showed the highest antioxidant activity (30.47 ± 0.78 mM g^{-1}) at 7 day of storage and lowest value was recorded in without ginger added ice cream (9.13 ± 0.31 mM g^{-1}) (Table 4). Inclusion of processed ginger preparations caused a significant increase in antioxidant activity because different types of processed ginger added products had variable ranges of antioxidant activity (Gabbi et al. 2018) whereas the antioxidant activity of ice cream was decreased during storage period. The decreasing of antioxidant activity might be attributed to the decrease in bioactive component such as Maillard reaction products and total phenols (Singh et al. 2014).

Textural Properties of Ice Cream During Storage Period

Textural properties of ice cream include hardness, cohesiveness, springiness, chewiness and gumminess of ice cream were significant ($p<0.05$) differences among the all types of ice cream, as indicated in Table 5. At day 7, highest mean value of hardness was ($p<0.5$) observed in ginger paste added ice cream and lowest mean value observed in without ginger added ice cream. Addition of processed ginger hardness increased due to low air content in the ice cream matrix (Wilbey et al. 1998, Muse and Hartel 2004, Goff and Hartel 2013). Hardness of ice cream was increasing with storage its due to the increasing of TS, TSS and reducing moisture content of the ice cream. Addition of processed ginger in ice cream was increasing of springiness and ginger paste had higher springiness compare to other all types of ice cream , it due to reduction of air content in the ice cream matrix (Wilbey et al. 1998, Muse and Hartel 2004). Similarly, cohesiveness, cohesiveness and chewiness were higher in ginger added ice cream than without ginger added ice cream. Finally, ginger paste added ice cream showed the higher values for all textural properties of ice creams. Previously, these finding are reported by El-Nagar et al. (2002) for cohesiveness, gumminess and Soukoulis et al. (2009) for chewiness.

Table 2: pH and titratable acidity content variation during storage period

Treatment	Day 0	Day 7	Day 14	Day 21	Day 28
	pH (Mean ± SD)				
T1	6.57 ± 0.01^{ab}	6.51 ± 0.02^{c}	6.46 ± 0.02^{de}	6.42 ± 0.03^{f}	6.37 ± 0.01^{h}
T2	6.58 ± 0.01^{a}	6.52 ± 0.02^{bc}	6.48 ± 0.01^{d}	6.44 ± 0.02^{ef}	6.39 ± 0.01^{g}
T3	6.57 ± 0.01^{ab}	6.51 ± 0.02^{bc}	6.46 ± 0.02^{de}	6.43 ± 0.01^{ef}	6.38 ± 0.01^{gh}
T4	6.59 ± 0.01^{a}	6.54 ± 0.03^{b}	6.48 ± 0.02^{d}	6.45 ± 0.02^{def}	6.42 ± 0.03^{f}
	Acidity % (Mean ± SD)				
T1	0.27 ± 0.01^{defg}	0.30 ± 0.03^{bcdef}	0.34 ± 0.02^{abc}	0.36 ± 0.02^{ab}	0.39 ± 0.01^{a}
T2	0.23 ± 0.05^{gh}	0.24 ± 0.02^{fgh}	0.26 ± 0.01^{defgh}	0.30 ± 0.05^{bcdef}	0.34 ± 0.04^{abc}
T3	0.25 ± 0.01^{efgh}	0.28 ± 0.01^{cdefg}	0.31 ± 0.04^{bcde}	0.32 ± 0.03^{bcd}	0.36 ± 0.03^{ab}
T4	0.21 ± 0.06^{h}	0.21 ± 0.01^{h}	0.23 ± 0.01^{gh}	0.26 ± 0.05^{efgh}	0.31 ± 0.06^{bcde}

T1= Ginger juice added, T2= Ginger syrup added, T3= Ginger paste added, T4 = without Ginger added. The Values are means of triplicates ± standard deviation. Mean with the same letters are not significantly different at ($p< 0.05$).

Table 3: First dripping time of ice cream (min)

Treatment	Day 0	Day 7	Day 14	Day 21	Day 28
		Mean ± SD			
T1	10.31 ± 0.97^{f}	11.01 ± 1.52^{f}	10.74 ± 1.52^{f}	12.05 ± 0.09^{ef}	12.53 ± 1.05^{ef}
T2	13.08 ± 0.44^{de}	13.29 ± 1.16^{cde}	13.31 ± 1.07^{cde}	12.94 ± 0.57^{de}	13.35 ± 0.98^{cde}
T3	14.02 ± 0.34^{bcd}	14.97 ± 0.12^{abc}	15.32 ± 0.48^{ab}	15.70 ± 0.58^{ab}	15.93 ± 1.21^{a}
T4	6.36 ± 1.01^{h}	6.83 ± 1.55^{h}	7.07 ± 1.09^{gh}	7.36 ± 0.80^{g}	8.09 ± 0.39^{g}

T1= Ginger juice added, T2= Ginger syrup added, T3= Ginger paste added, T4 = without Ginger added. The Values are means of triplicates ± standard deviation. Mean with the same letters are not significantly different at ($p< 0.05$).

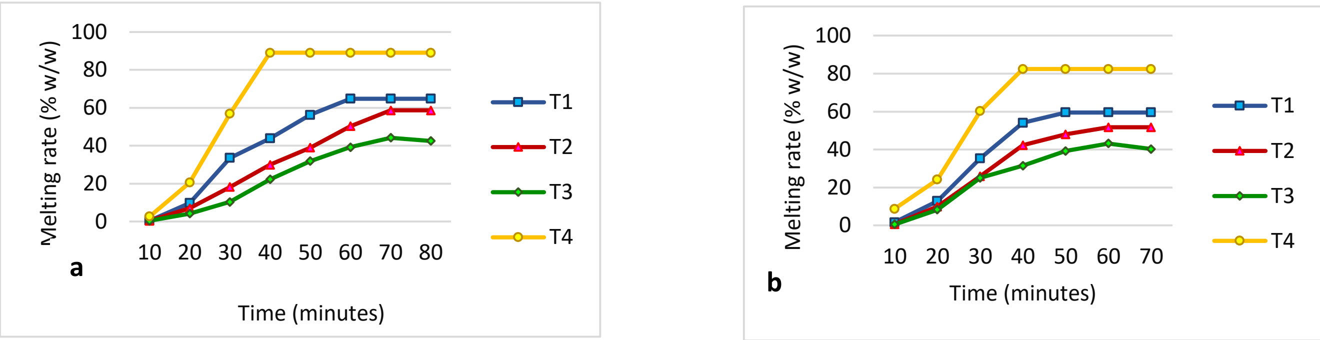

Figure 1. Melting rate variation in ice cream at 7 day (a) 28 day (b) of storage
T1= Ginger juice added, T2= Ginger syrup added, T3= Ginger paste added, T4 = without Ginger added

Table 4: Antioxidant activity of ice cream (mM g^{-1} (Antioxidant activity absorbance at 593 nm)

Treatment	**Day 7**	**Day 28**
	Mean ± SD	
T1	30.47±0.78^{a}	28.90±0.46^{a}
T2	24.47±0.57^{b}	21.83±0.32^{c}
T3	26.43±0.71^{ab}	24.73±0.02^{b}
T4	9.13±0.31^{d}	6.87±0.31^{e}

T1= Ginger juice added, T2= Ginger syrup added, T3= Ginger paste added, T4 = without Ginger added. The Values are means of triplicates ± standard deviation. Mean with the same letters are not significantly different at ($p < 0.05$).

Table 5: Hardness, springiness, cohesiveness, gumminess and chewiness variation during storage period

Treatment	**Hardness (N)**	**Springiness**	**Cohesiveness**	**Gumminess (N)**	**Chewiness (N)**
T1 (Mean ± SD)					
Day 7	8.70±0.10^{i}	0.68±0.02^{g}	0.41±0.03^{n}	3.60±0.28^{jk}	2.46±0.25^{k}
Day 28	9.97±0.15^{fg}	0.82±0.03^{cd}	0.50±0.01^{k}	4.98±0.08^{h}	4.07±0.07^{h}
T2 (Mean ± SD)					
Day 7	9.70±0.10^{fg}	0.71±0.01^{g}	0.46±0.01^{h}	4.43±0.07^{i}	3.14±0.04^{j}
Day 28	10.90±0.10^{e}	0.83±0.01^{cd}	0.56±0.02^{e}	6.14±0.22^{f}	5.12±0.21^{f}
T3 (Mean ± SD)					
Day 7	13.2±0.20^{d}	0.81±0.02^{cde}	0.63±0.02^{d}	8.30±0.27^{d}	6.7±0.26^{d}
Day 28	15.6±0.15^{a}	0.96±0.02^{a}	0.75±0.01^{a}	11.70±0.27^{a}	11.30±0.25^{a}
T4 (Mean ± SD)					
Day 7	2.87±0.40^{n}	0.50±0.01^{i}	0.23±0.01^{n}	1.44±0.22^{m}	0.73±0.12^{n}
Day 28	5.70±0.10^{k}	0.80±0.02^{def}	0.36±0.02^{k}	4.54±0.10^{i}	3.62±0.13^{i}

T1= Ginger juice added, T2= Ginger syrup added, T3= Ginger paste added, T4 = without Ginger dded.
The Values are means of triplicates ± standard deviation. Mean with the same letters are not significantly different at ($p < 0.05$).

Microbial Activity of Ice Cream Incorporated with Processed Ginger

As shown in Table 6, type of processed ginger incorporate was affected on the microbial activity in ice cream. The highest number of total bacteria counts and staphylococcus bacteria were observed in without ginger added ice cream and lowest mean value of total bacteria count and *Staphylococcus aurus* bacteria showed in ginger syrup incorporated ice cream. *E. coli* and *Salmonella* spp. were negligible in all the ice cream samples. All ginger preparations added ice cream showed lower microbial activity compared to the without ginger added ice cream due to antimicrobial activity of ginger, which specially has wide range antimicrobial activity against food borne pathogens such as *Escherichia* coli, *Pseudomonas aeruginosa*, *Staphylococcus* aureus, *Vibrio cholera*, *Bacillus* spp., and *Salmonella* spp.

Table 6: Microbial activity of ginger added ice cream

Parameter	T1	T2	T3	T4
TBC (CFU)	1.4×10^3	1.2×10^3	3.0×10^3	3.1×10^4
***Staphylococcus aurus* (CFU)**	8.0×10^2	7×10^2	8.5×10^3	9.0×10^3

T1= Ginger juice added, T2= Ginger syrup added, T3= Ginger paste added, T4 = without Ginger added

Evaluation of Sensory Qualities of Ice Cream Incorporated with Processed Ginger

At day 7 sensory evaluations performed through a panel of 30 untrained judges. A seven (7) point hedonic scale ranking method used for this analysis. Sensory evaluation of ice cream made by incorporating processed ginger of at 5% (w w^{-1}) concentration and the results were ($p<0.05$) varied among treatments for texture, taste colour flavor and overall acceptability shown in Figure 2. The samples with processed ginger and without ginger ice cream were liked most in terms of colour and Ginger syrup added ice cream obtained the highest scores for taste and overall acceptability. As the amount of juice and paste added ice cream was subsequently decreased and lower score obtained without ginger added ice cream. Similarly, Ginger juice added ice cream had lower acceptance due to their higher score for texture and aroma. Finally, most of the panel members were preferred Ginger syrup added ice cream in terms of taste, colour and overall acceptability.

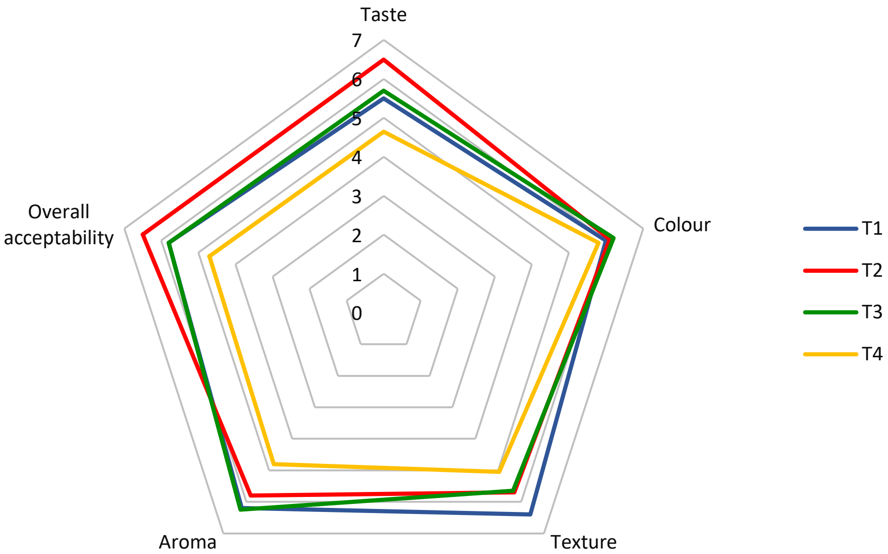

Figure 2: Sensory attributes various during First week of storage
T1= Ginger juice added, T2= Ginger syrup added, T3= Ginger paste added, T4 = without Ginger added

CONCLUSION

In the study ginger added ice cream were significantly influenced to composition, flavor and melting properties of the ice cream. Ginger juice added ice cream showed the highest antioxidant activity. Total solid, ash, fat, total soluble solid and titratable acidity of ice cream were significantly ($p<0.05$) increased during storage while pH and antioxidant activity of ginger added ice cream were decreasing with storage time. Ginger paste incorporated ice cream had the higher dripping time and lower melting rate during the storage period compared to other types of ice cream sample and melting resistance increased with all the ginger preparations added ice cream, compared to the without ginger added ice cream. Apart from that textual properties of ice cream were increasing with storage time. And also ginger syrup incorporated ice cream had lower microbial activity compared to other types of ice cream sample. Most of the panelists were preferred overall acceptability using ginger syrup added ice cream. However, further studies needed to conduct for commercialization of this product.

ACKNOWLEDGMENT
The author is grateful to Eastern University, Sri Lanka, Sri Lanka for financial assistant to the research work.

REFERENCES

Aboulfazli, F., Shori, A. B.& Baba, A. S. 2016. Effects of the Replacement of Cow Milk with Vegetable Milk on Probiotics and Nutritional Profile of Fermented Ice Cream. LWT Food Science Technology 70: 261–270.

Akalin, A., Karagozulu, C., Ender, G. & Unal, G. 2008. Effects of Aging Time and Storage Temperature on the Rheological andSensory Characteristics of Whole Ice Cream. *Journal of* Nutrition Research and Food Science 63(3): 293-295.

Akesowan A 2008. Effect of combined stabilizers containing Konjac flour and j-carrageenan on ice cream. Australian Journal of Technology 12: 81–85.

AOAC. 2000. Official Methods of Analysis, 17th edn. Washington, DC:Association of Official Analytical Chemists.

APHA 1992. Compendium of Methods for the Microbiological Examination of Foods. 3rd Edition, American Public Health Association, Washington, D.C

Awad, S. Hassan, A. N, & Muthukumarappan, K. 2005. Application of exopolysaccharide–producing cultures in reduced– fat cheddar cheese: Texture and melting properties. *Journal of Dairy Science,* 88 : 4204-4213.

Bajad, D., Kalyankar, S., Dehmukh, M., Bachanti, P. & Bajad, G. 2016. Impact of physico-chemical properties of mix on the final quality of ice-cream. Asian J. Dairy and Food Res 35(4): 293-297.

Bajwa, U., Huma, N., Ehsan, B., Jabbar, K. & Khurrama, A. 2003. Effect of different concentration of strawberry pulp on the properties of ice cream. International Journal of Agriculture Biology 5: 635-637.

Balestra, F., Cocci Pinnavaia, G. & Romani, S. 2011. Evaluation of antioxidant, rheological and sensorial properties of wheat flour dough and bread containing ginger powder. LWT-Food Science and Technology 44: 700-705.

Benzie, L.F. & Strain, J.J. 1996. The ferric reducing ability of plasma (FRAP) as a measure of ‘antioxidant power’ the FRAP assay, *Analytical biochemistry,* 239 (1): 70-76.

Buyong, N. and Fennema, O. (1988). Amount and size of ice crystals in frozen samples as influenced by hydrocolloids. Journal of Dairy Science 71: 2630-2639.

Chang, Y. & Hartel, R.W. 2002. Development of air cells in a batch ice cream freezer. Journal of Food Engineering, 55(1) :71-78.

Choi, M. & Shin, K. 2014. Studies on physical and sensory properties of premium vanilla ice cream distributed in Korean market. Korean Journal of Food Science 34(6): 757-762.

El-Nagar, G., Clowes, G., Tudorică, C.M., Kuri, V. & Brennan, C.S. 2002. Rheological quality and stability of yog-ice cream with added inulin. International Journal of Dairy Technology 55(2) :89-93.

El-Nagar, G.F. & Shenana, M.E., 1998, November. Production and acceptability of bioyoghurt. In Proc. 7th Egyptian Conference of Dairy Science and Technology, (Vol. 227).

Gabbi, D., Bajwa, U. & Goraya, R. 2018. Physicochemical, melting and sensory properties of ice cream incorporating processed ginger (Zingiber officinale). International Journal of Dairy Technology 7: 190-197.

Gafour W .A, Essawy E. A & Salem A. S. 2007. Incorporation of natural antioxidants into ice cream. The Egyptian Journal of Dairy Science 35: 117

Goff, H., Freslom, B., Sahagian, M., Hauber, T., Stone, A. & Stanley, D. 1995. Structural development in ice cream-dynamic rheological measurements. Journal of *Texture* Studies 26: 517-536.

Goraya, R. & Bajwa, U. 2015. Enhancing the functional properties and nutritional quality of ice cream with processed amla (Indian gooseberry). Journal of Food Science and Technology 52: 7861-7871.

Herald H J, Aramouni M & Ghoush M H A 2008 Comparison study of egg yolks and egg alternatives in French vanilla ice cream. Journal of Texture Studies 39. 284–295.

Jadhav, M., Nimbalkar, C. & Kad, V. 2017. Effect of different levels of Ginger Juice on Physico-chemical and sensory characteristics of Herbal ice cream. Research Journal of Chemical and Environmental Sciences 5(3): 45-50.

Kosikowski, F. & Mistry, V.V. 1977. Cheese and fermented milk foods (Vol. 586). Edwards Bros.

Muse, M. & Hartel, R. 2004. Ice cream structural elements that affects melting rate and hardness. Journal of Dairy Science 87(1): 166-167.

Pinto, S., Jana, A. & Solanky, M. 2004. Ginger juice based herbal ice cream and its physicochemical and sensory characteristics. International Journal of Dairy Science 57: 315-218.

Pinto, S., Rathour, A., Jana, A., Prajapati, J. & Solanky, M. 2006. Ginger shreds as flavouring in ice cream. Natural Product Radiance 5(1): 15-18.

Purseglove, J.W., Brown, E.G., Green, C.L. & S.R.J. Robins. 1981. Spices: Volumes 1 and 2. Longman Group Limited, London.

Rehman, R., Akram, M., Akhar, N., Jabeen, Q., Saeed, T., Alishah, S .M., Ahmed, K., Shaheen G. & Asif, H. M. 2011. Zingiber officinale Roscoe (pharmacological activity), Journal of Medicinal Plants Research 5: 344–348.

Silva, E. & Silva, L. 2011. Effect of different sweetener blend and fat types on ice cream properties. Science Technol. Aliment 31: 217-220.

Singh, A., Bajwa, U. & Goraya, R.K. 2014. Effect of storage period on the physicochemical, sensory and microbiological quality of bakery flavoured ice cream. International Journal of Engineering Research and Applications 4 :80-90.

Singh, G., Kapoor, I., Singh, P., De Heluani, S. & Lampasona, P. 2008. Chemistry, antioxidant and antimicrobial investigations on essential oil and oleoresins of Zingiber officinale. Food Chemistry and Toxicology 46: 3295-3302.

Singoa, T. M. & Beswa, D. 2019. Effect of roselle extracts on the selected quality characteristics of ice cream. International Journal of Food Properties 22 (1): 42–53.

Soukoulis, C., Lebesi, D. & Tzia, C., 2009. Enrichment of ice cream with dietary fibre: Effects on rheological properties, ice crystallisation and glass transition phenomena. Food Chemistry *115*(2) :665-671.

Surh, Y.J., Lee, E. & Lee, J.M. 1998. Chemoprotective properties of some pungent ingredients present in red pepper and ginger. Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis 402(1-2) :259-267.

Waterhouse D S, Edmonds L, Wadhwa S S & Wibisono R. 2013. Producing ice cream using a substantial amount of juice from kiwifruit with green gold or red flesh. Food Research International 50: 647–656.

Wilbey, R.A., Cooke, T. & Dimos, G. 1998. Effects of solute concentration, overrun and storage on the hardness of ice cream. In *Ice cream*. IDF Symposium, Athens (Greece), 18-19 Sep 1997. International Dairy Federation.

Yangılar, F. 2015. Effects of green banana flour on the physical, chemical and sensory properties of ice cream. Food technology and biotechnology 53(3) :.315-323.

Yangilar, F. &Yildiz, P. 2018. Effects of using combined essential oils on quality parameters of bioyogurt. Journal of Food Processing and Preservation, 42(1), p.e13332