

Evaluation of Physicochemical and Sensory Properties of Ice Cream Incorporating Processed Amla

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ABSTRACT

Amla incorporated ice cream can be considered as an herbal ice cream and a healthy food and the present study was designed develop various types of Amla ice cream using Amla juice, Amla powder, and dried Amla (candy), and to evaluate its physicochemical and sensory properties during four weeks of storage at 10°C frozen temperature. The results of this study revealed that, the total solid (37.78±0.02%), fat (8.87±0.31%) and total soluble solid (28.93±0.14%) content were significantly ($p<0.05$) higher in without Amla incorporated ice cream. The titratable acidity (0.55±0.01%) content was significantly ($p<0.05$) higher in Amla juice incorporated ice cream. pH was significantly higher without Amla incorporated ice cream (6.58±0.01%). Amla juice incorporated ice cream showed the highest antioxidant activity (131.0mg/ml) and least value (72.14 mg/ml) showed in without Amla incorporated ice cream. The first dripping time was significantly ($p<0.05$) higher in candy incorporated ice cream (14.29±0.25 min) and lowest value showed in without Amla incorporated ice cream (6.04±0.61 min). During storage, the total solid, ash, fat, total soluble solid content, acidity, and dripping time were significantly ($p<0.05$) increased. Moisture content, pH content, antioxidant activity and melting rate were significantly ($p<0.05$) decreased with the storage period. Sensory properties were evaluated through the panel of 10 members. As a result of organoleptic characteristics revealed that, 5% of dried Amla (candy) incorporated ice cream had the highest mean score (throughout the storage period) of overall quality of all sensorial properties namely, color, taste, texture, aroma, and overall acceptability. Finally, it could be concluded that the processed Amla is enriching the ice cream manufacture and it is important to improvement of human nutrition.

Keywords: Amla, ice-cream, physicochemical properties, storage dripping time.

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I. INTRODUCTION

The agricultural income in Sri Lanka is significantly influenced by milk and milk products. Milk is used as human food worldwide and is considered one of the most important food products for many people due to its high nutritional value [1]. Ice cream is a frozen milk dessert. It is made by freezing and aerating pasteurized milk and a mixture of other ingredients. The composition of ice cream varies from product to product, the average composition of ice cream is 12% milk fat, 11% skim milk components, 15% sugar and 0.3% stabilizer, 0.3% emulsifier [2]. Growing consumer demand for ice cream, high product acceptance and fierce competition have forced manufacturers to continue developing through innovations in product types. Therefore, new types of ice cream are being developed to improve the taste buds and improve the health of consumers. The addition of functional ingredients such as antioxidants and phenol to foods helps to draw the attention of health-conscious consumers [3]. Herbs and spices produce a variety of phytochemicals (secondary metabolite). They are not only used as food preservatives and flavorings, but they have also been used as traditional medicines for thousands of years. Abundant medicinal plants are presented in the

Indian traditional systems of medicine (like Ayurveda, Unani, siddha), mostly used one amongst them is Indian gooseberry or amla, also known as *Phyllanthus emblica* Linn. (Syn. *Emblica officinalis* Gaertn.) Belongs to the family *Euphorbiaceae* [4], which is an important medicinal herb in Ayurveda and Unani systems of medicine. Amla is highly nutritious and is one of the richest sources of Vitamin-C, amino acids, and minerals [5]. It contains several chemical constituents like tannins, alkaloids, and phenols [6]. This study was designed to make an ice cream by adding differently processed Amla such as Amla juice, Amla powder and Amla candy, in order to study the quality of Amla added ice cream.

II. METHODOLOGY

A. Preliminary Study and Treatment

Based on the preliminary study, different concentrations of Amla juice (1%, 3%, 5%, 7% and 9%) were added to the ice cream as a trial. According to the data collected from the sensory evaluation, the suitable concentration of Amla juice for use for ice cream production was identified at 5% (w/w). T1 ice cream with 5% Amla juice added, T2 ice cream with 5% Amla powder added, T3 ice cream with 5% dried Amla

(candy) added, and T4 ice cream without Amla added was used as a control. For each treatment, three replicates were carried out.

B. Processing of Amla

In this research white Amla (*Emblica officinalis*) was used. Fruit of the Amla plant was used for the preparation of different forms of Amla for this research. Fresh Amla fruit was selected from the market. Amla fruits were sorted and spoiled, contaminated, and damaged fruits were rejected. The Amla fruits were washed thoroughly using clean water to remove dirt. Damaged and discolored parts of the fruits were removed and processed into various products such as juice, powder, and candy. Amla was cut into pieces and grinded. After it was filtered by using a muslin cloth and extracted as a juice. Amla juice was poured into bottle and kept in deep freezer at -4°C until used for experiment. For the preparation of Amla powder Amla fruits were cut and dried in sunlight for couple of days until juice is evaporated and the pieces were dried up, then ground and sieved until achieve smooth powder. For the preparation of Amla candy Amla fruits were boiled with water in pressure cooker. Then seeds were removed, and the pieces of Amla were put in a storage box and sugar was added on the top, left for two days till Amla pieces float on sugar syrup. After two days the pieces were removed from the sugar syrup and dried in sun. Then stored in dry container until used for experiment.

C. Ice Cream Preparation

The required amount of cow milk and processed ginger were measured. Cow milk was homogenized and then pasteurized at 85°C for 30 minutes [7]. Sugar was added and mixed well while boiling. A little amount of boiled milk was separated and then milk powder and gelatin were stirred in the milk separately. And also, a little amount of boiled milk was separated and allowed for cooling and corn flour was stirred in that milk. Then all of them are added to the boiling milk and mixed well.

After adding all ingredients ice cream mixture was heated for 15 minutes and after allowed for cooling. It was poured into cups and beaten well. It was kept in refrigerator for 1 hour, then it was taken out and beat again. This beaten procedure was repeated 3 times. Processed Amla preparations were added to the cooled ice cream mixture separately prior to freezing. It was poured into cups and labelled. Then it was stored in the freezer at temperature about -10°C for one month. The samples were analyzed at day 1, week 1, week 2, week 3 and week 4 of the storage.

D. Nutritional Analysis

Total solid content was measured according to [8] method. Ash was analyzed by combusting the sample in a muffle furnace at 550°C for 4 h. Fat content of ice cream was determined using the Gerber method as described in [9]. Titratable acidity and pH values of ice-cream were determined according to [10]. Antioxidants were measured using the DPPH method according to [11].

E. Physical Analysis

Dripping time and melting rate were determined according to methods described by [12].

F. Sensory Analysis

Sensory evaluation was conducted untrained 30 panelists were used for organoleptic evaluations like texture, flavor, color, taste, and overall acceptability. Seven-point hedonic scale, ranging from (score=7) to (score=1) where, 7 indicates like very much and 1 indicates dislike very much, was used for evaluation as described by [3]. A questionnaire was used for the sensory assessment. Each panelist was asked to evaluate the samples from different treatments which were arranged to assess the organoleptic qualities.

G. Statistical Analysis

Samples were randomly collected, 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 nonparametric data analysis.

III. RESULTS AND DISCUSSION

A. Proximate Composition of Processed Amla

The nutritional attributes of processed Amla product are indicated in Table I. Amla powder had higher levels of total solid content ($93.44\pm 0.09\%$), ash content ($9.31\pm 0.39\%$), fat content ($0.52\pm 0.02\%$) and acidity ($4.48\pm 0.07\%$) than juice and candy. The processed Amla preparations were found to hold high antioxidant activity, which was highest ($83.16\pm 3.19\%$) in the juice.

TABLE I: PROXIMATE COMPOSITION OF PROCESSED AMLA

Constituents	Amla juice	Amla powder	Candy
Total solid (%)	9.93 ± 0.15	93.44 ± 0.09	82.24 ± 1.02
Ash (%)	0.99 ± 0.01	9.31 ± 0.39	1.75 ± 0.06
Fat (%)	0.10 ± 0.03	0.52 ± 0.02	0.12 ± 0.01
Acidity (% lactic acid)	4.11 ± 0.02	4.48 ± 0.07	0.54 ± 0.08
Antioxidant activity (%)	83.16 ± 3.19	55.88 ± 0.98	79.7 ± 1.23

The Values are means of two replicates \pm standard deviation.

B. Nutritional Composition, Ph and Dripping Time of Ice Cream at Day One

Different types of processed Amla-added ice cream significantly ($p < 0.05$) differed from without Amla-added ice cream because total solids of ice cream were decreased with the addition of Amla juice, candy, and powder due to their low dry matter content and higher moisture content than the ice cream mix. Similar results were stated previously with Amla juice, powder candy and Amla shreds [13]. According to result shown in Table II higher amount of ash content ($0.69\pm 0.01\%$) was observed in Amla powder added ice cream and lower value ($0.61\pm 0.01\%$) observed in Amla juice added ice cream. These results agreed with [13]. Fat content was significantly higher ($8.87\pm 0.31\%$) in without-Amla added ice cream and lower ($7.27\pm 0.06\%$) in Amla-juice added ice cream. It was observed that the addition of processed Amla decreased the fat content of ice cream. This was due to the low fat in Amla. Fruits and other plant

material contain less fat, so their incorporation leads to decrease in fat content [13]. While the higher TSS (29.07 ± 0.95 brix) was observed in without Amla-added ice cream and lower value (28.07 ± 2.05 brix) observed in Amla juice added ice cream. The TSS content declined with the addition of Amla juice and powder, but Candy added ice cream shows that similar result to the without Amla-added ice cream. According to [14] the brix decreased as the water content increased.

TABLE II: NUTRITIONAL COMPOSITION, PH AND DRIPPING TIME OF ICE CREAM MANUFACTURED AT DAY ONE

Attributes	Treatments			
	T1	T2	T3	T4
Total solid (%)	36.22 ± 0.88^i	36.95 ± 0.04^j	36.77 ± 0.10^i	37.78 ± 0.02^{sh}
Ash (%)	0.61 ± 0.01^m	0.69 ± 0.01^i	0.66 ± 0.01^{edf}	0.62 ± 0.01^j
Fat (%)	7.27 ± 0.06^{bc}	7.53 ± 0.06^b	7.30 ± 0.17^{bc}	8.87 ± 0.31^a
pH	6.17 ± 0.02^d	6.20 ± 0.04^{cd}	6.18 ± 0.04^{cd}	6.58 ± 0.01^a
Acidity (%)	0.55 ± 0.01^{def}	0.36 ± 0.01^{ab}	0.23 ± 0.01^g	0.23 ± 0.02^{ef}
TSS (%)	28.62 ± 0.57^h	28.46 ± 0.67^h	28.70 ± 0.31^h	28.93 ± 0.14^h
Dripping time (min)	10.49 ± 0.24^h	13.39 ± 0.52^{edf}	14.29 ± 0.25^{cd}	6.04 ± 0.61^j

T1=Amla juice added, T2=Amla powder added, T3=Candy added, T4=without Amla added. Values are means of triplicates \pm standard deviation. Mean with the same letters are not significantly different at ($p < 0.05$).

Furthermore, higher titratable acidity content ($0.27 \pm 0.01\%$) was observed in Amla juice added ice cream and lowest value ($0.21 \pm 0.06\%$) shown in without Amla-added ice cream. And also, higher pH content ($6.59 \pm 0.01\%$) was shown in without Amla added ice cream, lower value ($6.56 \pm 0.01\%$) shown in Amla juice added ice cream. Amla juice and powder inclusion caused a significant increase in acidity and decrease in the pH of the ice cream samples. This result is due to the presence of ascorbic acid and phenolic substances in the Amla. The addition of phenolic rich substances, such as garlic acid and ellagic acid enhanced acidity of ice cream due to the acidic nature of these components. The results are similar to those reported by earlier researchers [15], [13]. The First dripping time was higher ($14.29 \pm 0.25\%$) in candy added ice cream and lower value ($6.04 \pm 0.61\%$) observed in without Amla added ice cream. Addition of processed Amla products to the ice cream significantly ($P < 0.05$) increased the first dripping time than without Amla-added ice cream. This result is similar to [16] reported previously.

C. Nutritional Composition, Ph, And Acidity During Storage

1) Total solids (TS), ash, fat and total soluble solid (TSS) contents in ice cream during storage period

Results revealed the highest mean value of TS content, observed at first week to fourth week in without Amla-added ice cream ($41.30 \pm 0.45\%$) and ($44.66 \pm 0.12\%$) respectively. The addition of different types of processed Amla to ice cream decreased the TS due to their higher moisture content than the ice cream mix. As a result, shown in Table III, TS content increased during four weeks of storage in all treatments. This increment may be due to water evaporation along the refrigerated storage period and

further lead to recrystallization on the top of the ice cream, where the ice crystals grow larger [17]. The higher mean value of Ash contents observed in Amla powder-added ice cream ($0.77 \pm 0.01\%$), ($0.91 \pm 0.01\%$) and lowest mean value in Amla juice added ice cream ($0.66 \pm 0.01\%$), ($0.74 \pm 0.01\%$) at first week and fourth week, respectively. According to results proved by this, there is a significant effect of processed Amla types on ash content of ice cream sample and all treatments showed slightly increased ash content along the storage period (Table III). These differences may be due to the changes in dry matter during the refrigerated storage period [18].

At first week of storage, the highest mean value of fat content showed by without Amla-added ice cream ($9.17 \pm 0.35\%$) and lowest value observed in Amla juice added ice cream ($7.43 \pm 0.15\%$), respectively. The results showed that there was a slight increase in fat content during storage time (Table III).

The TSS value (Brix value) is an indication of the amount of sugar present in the sample. TSS content of processed Amla added ice cream noticed that, the TSS content were significantly ($p < 0.05$) differences among all types of ice cream from the first week to the fourth week, with the higher mean value of TSS content ($34.07 \pm 0.27\%$, $41.72 \pm 0.23\%$) presented in without Amla-added ice cream and the lowest mean value of TSS content ($31.90 \pm 0.43\%$, $40.55 \pm 0.33\%$) observed in Amla juice added ice cream respectively (Table III). The increase in TSS may be due to the reduction of moisture during the refrigerated storage period [14]. According to [21] a greater extent of TSS content leads to a slower meltdown of ice cream.

2) Titratable acidity and pH content in ice cream during storage period

At first week, the higher mean value of titratable acidity ($0.58 \pm 0.01\%$) observed in Amla juice incorporated ice cream and lower value ($0.23 \pm 0.02\%$) recorded without Amla added ice cream. At fourth week, the higher ($0.63 \pm 0.01\%$) titratable acidity observed in Amla juice incorporated ice cream and lower value ($0.34 \pm 0.10\%$) recorded without Amla added ice cream. The titratable acidity increased gradually during the fourth week of storage period (Table III). This result is matched with the study of [22]. The developed acidity of ice cream mixture is caused by the production of lactic acid by bacterial fermentation of the lactose in dairy products [23].

The pH content ranged from 5.60 ± 0.09 to 6.72 ± 0.06 . At first week, the highest mean value of pH was showed in without Amla-added ice cream (6.58 ± 0.01) and lowest value of pH was showed in Amla juice added ice cream and (6.51 ± 0.02). according to Table III, at fourth week, the highest mean value was recorded by without Amla added ice cream (6.72 ± 0.06) and lowest value of pH was showed in Amla juice added ice cream (5.60 ± 0.09). As the normal acidity of mixes varies with the percentage of milk solid non-fat (MNSF). The acidity and pH are related to the composition of the mix, an increase in MSNF raises acidity and lowers pH. The ascorbic acid content of ice cream incorporated with Amla juice, amla powder and shreds, Kiwi juice increased as the level of inclusion was raised [13].

3) Antioxidant activity of ice cream

In this study, Amla juice added ice cream showed the highest antioxidant activity (131.0 mg/ml) at first week and least value showed in without Amla added ice cream (72.14mg/ml). The higher antioxidant activity was found in Amla juice compared to the Amla powder and candy. Inclusion of processed Amla preparations caused a significant increase in antioxidant activity and total phenols because all processed Amla products had variable but high ranges of antioxidant activity.

The processed Amla (Indian gooseberry) incorporated ice cream samples were also found to have higher antioxidant activity and also this remarkable increase in antioxidant activity was due to more total phenols and tannins infusion into the ice cream [13]. According to results at fourth week, the higher value showed in Amla juice added ice cream (125.4 mg/ml) compared to other treatments and least value showed in without Amla added ice cream (68.56 mg/ml). Furthermore, antioxidant activity was decreased during storage period.

4) First dripping time and melting rate

First dripping time ranged vary from 6.36 min to 15.93 min. The higher mean value of dripping time observed in candy incorporated ice cream (14.29±0.64min, 17.60±1.11min) and lower value recorded without Amla added ice cream (6.80±0.23min, 8.33±0.21 min) at first day and fourth week, respectively. The first dripping time of all ice cream samples increased with storage period. In general, as the viscosity increases of the ice cream, resistance to melting and smoothness increases [12].

Moreover, all the processed Amla incorporated ice cream showed lower melting rate than without Amla added ice cream throughout the storage period. Incorporation of Amla

reduced the overrun by blocking air incorporation and also, Amla contains hydrocolloids (starch) which might be responsible for the increased viscosity thus increased meltdown time. First dripping time increased and melting rate decreased with an increase in fruit concentration and sugar content as well as the components in the ice cream having the ability to absorb water, which might increase the viscosity. Similar results were identified with respect to the melting resistance of ice cream as affected by addition of pumpkin, black mulberry, and red grape pulp [3].

D. Sensory Attributes at Day One

The sensory scores of the processed Amla incorporated ice cream at day one, the sensory scores for color ranged from 5.7 to 6.0. Most of the panelists preferred Candy added ice cream and least panel members preferred for without Amla added ice cream in terms of color and taste, The specific taste is attributed to astringency and sweet after sour taste, present in Amla. Taste is the primary factor, which determines the acceptability of any product, which has the highest impact on success of product [24]. The texture ranged from 5.4 to 5.8. So, higher consumer preference showed in Candy added ice cream and least preference showed in Amla juice added ice cream. And also, texture is one of the main characteristics that expresses the quality of ice cream and is effective on appearance, mouth feel and overall acceptance [25]. Scores for aroma ranged from 4.7 to 6.2 from that, higher acceptability observed by candy added ice cream and least acceptability observed by without Amla added ice cream. Flavors of ice cream are affected by all milk components and aroma compounds and volatile essential oil present in Amla.

TABLE III: NUTRITIONAL COMPOSITION, PH AND ACIDITY OF ICE CREAM DURING STORAGE

Treatments		Day 1	Week 1	Week 2	Week 3	Week 4
T1	TS	36.22±0.88 ^{ji}	37.49±0.66 ^h	38.36±0.29 ^g	39.21±0.60 ^f	41.30±0.45 ^d
	Ash	0.61±0.01 ^m	0.66±0.01 ^k	0.72±0.02 ^{hi}	0.73±0.01 ^{hgi}	0.74±0.01 ^{hgf}
	Fat	7.27±0.06 ^f	7.43±0.15 ^f	7.67±0.15 ^{ef}	7.70±0.10 ^{ef}	8.13±0.40 ^e
	TSS	28.62±0.57 ^h	31.90±0.43 ^g	35.60±0.61 ^e	38.66±0.60 ^{cd}	40.55±0.33 ^b
	pH	6.17±0.02 ^d	6.12±0.02 ^d	6.07±0.04 ^{ed}	6.03±0.03 ^{cd}	5.60±0.09 ^f
	Acidity	0.55±0.01 ^{def}	0.58±0.01 ^{de}	0.61±0.01 ^{de}	0.61±0.01 ^{cd}	0.63±0.01 ^{cd}
T2	TS	36.95±0.04 ^j	38.27±0.20 ^g	39.79±0.07 ^f	40.74±0.06 ^e	42.50±0.04 ^c
	Ash	0.69±0.01 ^l	0.77±0.01 ^j	0.80±0.01 ^{efg}	0.87±0.02 ^{edf}	0.91±0.01 ^d
	Fat	7.53±0.06 ^{ef}	7.70±0.10 ^{ef}	8.10±0.44 ^e	8.77±0.38 ^d	9.17±0.35 ^{cd}
	TSS	28.46±0.67 ^h	31.63±0.34 ^g	34.85±0.69 ^{ef}	38.19±0.28 ^{cd}	40.19±0.25 ^{ab}
	pH	6.20±0.04 ^{cd}	6.14±0.02 ^d	5.92±0.14 ^{ef}	5.73±0.11 ^g	5.63±0.11 ^g
	Acidity	0.32±0.01 ^{ab}	0.36±0.01 ^{ab}	0.37±0.02 ^{ab}	0.41±0.02 ^{ab}	0.43±0.05 ^a
T3	TS	36.77±0.10 ⁱ	38.42±0.17 ^g	39.73±0.15 ^f	41.65±0.19 ^d	43.91±0.06 ^b
	Ash	0.66±0.01 ^{def}	0.68±0.01 ^{ed}	0.75±0.01 ^c	0.76±0.03 ^b	0.78±0.02 ^d
	Fat	7.30±0.17 ^f	7.50±0.26 ^{ef}	7.67±0.15 ^{ef}	8.10±0.46 ^e	8.70±0.85 ^d
	TSS	28.70±0.31 ^h	31.91±0.28 ^g	34.86±0.83 ^{ef}	38.68±0.80 ^d	41.10±0.18 ^b
	pH	6.18±0.04 ^{cd}	6.14±0.03 ^d	6.09±0.03 ^d	5.66±0.31 ^g	6.34±0.72 ^h
	Acidity	0.23±0.01 ^g	0.23±0.01 ^{ef}	0.27±0.02 ^{efg}	0.41±0.11 ^{cd}	0.36±0.16 ^{cd}
T4	TS	37.78±0.02 ^{gh}	39.39±0.05 ^f	41.86±0.68 ^d	42.80±0.23 ^c	44.66±0.12 ^a
	Ash	0.62±0.01 ^j	0.72±0.01 ⁱ	0.73±0.01 ^{hgi}	0.75±0.01 ^{efg}	0.76±0.01 ^{edf}
	Fat	8.87±0.31 ^d	9.17±0.35 ^{cd}	9.73±0.45 ^{bc}	10.23±0.06 ^{ab}	10.40±0.20 ^a
	TSS	28.93±0.14 ^h	34.07±0.27 ^f	39.10±0.28 ^c	41.19±0.67 ^{ab}	41.72±0.23 ^a
	pH	6.58±0.01 ^a	6.54±0.01 ^a	6.49±0.03 ^{ab}	6.47±0.10 ^{ab}	6.72±0.06 ^{cd}
	Acidity	0.23±0.02 ^{ef}	0.21±0.02 ^{ef}	0.26±0.02 ^{efg}	0.32±0.11 ^{def}	0.34±0.10 ^{de}

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

The ice cream incorporated with Candy had the highest preference of overall acceptability characteristics based on the organoleptic point of view compared to other treatments. Ice cream without Amla got the lowest preference of the overall acceptability at day one sensorial evaluation. Most of the panelists preferred taste, color, texture and overall acceptability for Candy added ice cream and least panel preference observed in without Amla added ice cream. According to results revealed in day one up to four weeks, sensory evaluation preference in color, taste, flavor, and overall acceptability of ice cream slightly changed due to increase the pungency of Amla towards the end of the storage period.

IV. CONCLUSION

In the study, amla added ice cream was significantly influenced to composition and melting properties of the ice cream. During the storage total solid, ash, fat, titratable acidity, total soluble solid and dripping time were increased and moisture content, antioxidant, pH and melting rate were decreased gradually during the fourth week of storage period. The results revealed that, the 5% of candy incorporated ice cream had the higher dripping time and lower melting rate during the storage period compared to other treatments and melting resistance increased with all the Amla preparations added ice cream, compared to the without Amla added ice cream. Most of the panelists preferred overall acceptability using candy added ice cream and also 5% level of candy added ice cream obtained the highest overall acceptability throughout the storage period.

SUGGESTIONS

A future study should be carried out to develop the ice cream with adding dried Amla (Candy) with different concentrations. Study should be evaluated the acceptability of dried Amla-added ice cream among the consumer by survey. Further research should be conducted to help the ice cream industries to enrich commercial ice cream by adding processed Amla.

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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