SEUSL

Sri Lankan Journal of Technology

Research

SLJoT
2022 Sp Issue 39 - 43
ISSN 2773-6970

Development of Ambarella (*Spondias dulsis*) fruit pulp incorporated ice cream

B.S.G.M. Basnayake[1], M.B.F. Jemziya[1*], R.T.B. Rambodagalla[2] and A.M. Rikasa[1]

[1]Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka
[2]Milco Company Private Limited, Digana, Kandy
[*]Corresponding Author: jemziya@seu.ac.lk || ORCID: 0000-0001-8537-4535

Received: 05-10-2022 ∗ Accepted: 04-11-2022 ∗ Published Online: 30-11-2022

***Abstract*—**Ambarella (*Spondias dulcis*) is well known as a fruit in Sri Lanka. Due to the fruit's high dietary fiber content, ambarella, it is used to cure digestive issues, anemia, and control blood sugar levels. The present research aimed to study the development of ambarella pulp incorporated in ice cream and to determine the physicochemical characteristics of the best product. The ice cream was prepared according to the commercial criteria by incorporating ambarella and compared with the control treatment. A sensory evaluation was conducted using 30 untrained panelists to determine the optimum amount of ambarella pulp that could be used in ice cream. Further, all the samples were tested for titratable acidity (TA), keeping quality (KQ), overrun, moisture, protein, fat and ash content for the control and the selected sample. Based on the sensory analysis, ice cream with 8.5g ambarella pulp (T3 sample) was selected as the best treatment and there were significant differences (<0.05) observed in terms of the moisture (70.37%), fat (11.7%), fiber (0.08%) and ash content (3.85%) except the protein (7.48%) content compared to the control. Moreover, the T3 sample had acceptable TA, KQ and overrun properties. Conclusively, the ambarella extract can be added to the ice cream to enhance its nutritional and sensory properties with the minimum effect on the distinct quality parameters of the product.

***Keywords*—**Amberella pulp, Ice cream, Product development, Quality properties

I. Introduction

Ambarella (*Spondias dulcis*), synonym as golden apple is widely utilised as traditional medicine in Malaysia, Sri Lanka, India, and Vietnam (Mohammed *et al*, 2011). The ripe fruit is characterized by a pleasing sweet flavour, rich in minerals (phosphorous, sodium, magnesium, calcium, iron, zinc, and vitamin C (42 mg/100g). The raw pulp contains total solids (14.53-40.35%), sugar (8.05-10.54%), titratable acidity (0.47%), moisture (59.65-85.47%), fat (0.28-1.79%), protein (0.5-0.8%), crude fiber (0.85-3.6%), and 157.30 calories in a wet basis (Ishak *et al*., 2005).

Milk products are completely devoid of dietary fiber and concentrated sources of life-sustaining nutrients with great digestibility (Ambuja & Rajakumar, 2008). To enhance the healthiness or sensory benefits of milk and milk products, this dietary fiber can be added. Low-Density Lipoproteins (LDL), cholesterol, and insulin demand are decreased by eating fiber-rich foods including nuts, whole grain flour, and vegetables. These foods also increase stool size, soften fecal material, and improve laxative qualities (Ambuja & Rajakumar, 2008).

Ice cream is a popular frozen dairy dish with many different formulas. There are many flavors of ice cream available, including vanilla, chocolate, strawberry, butterscotch, and coffee (Goff *et al*., 2013). Today's local and global markets provide a variety of value-added culinary products made from ambarella fruit, such as juices, jams, pickles, and sauces. Ice cream with an amber flavor isn't often found, though. Ambarella was chosen as the significant source of protein and fiber that may be used as an ingredient in the creation of ice cream. The goal of the research was to create ice cream that included ambarella pulp and had higher fiber content, enhanced flavor, and nutritional value.

II. Methodology and Experimental Design

A. Location of Study

The research was conducted at the Milco Company Pvt LTD, Digana, Sri Lanka in 2021.

B. Raw Materials

Ambarella (Spondias dulcis) was purchased from the local orchads, and other ingredients were supplied from the Milco Dairy Products (Pvt) Limited, Digana. The good-quality homogenous ripe fruits were selected from a farmer. The row's milk was obtained after quality inspections of the industry.

C. Preliminary trials

Trials were done to figure out the ideal amount of ambarella pulp to add to the ice cream. Table I shows the quantities of various ice cream mixtures and ambarella pulp used in the study's preliminary experiments and Table II shows the ingredient quantity for making CT ice cream

Table I: Treatments used in the preliminary trials

Treatment	Amount of Ice Cream (g)	Amount of Ambarella pulp (g)
CT	85	0 (control)
T1	81.6	3.4
T2	80.75	4.25
T3	76.5	8.5
T4	74.8	10.2

Table II: The quantity of additional ingredients used to make the control ice cream mixture

Materials	Quantity
Sugar	160 g
Processed milk	650 g
Milk powder	70 g
Glucose	5 g
Flavors	0.3 ml

mixture. With increasing ambarella pulp in the mixture the milk quantity is changed.

D. Preparation of pulp and extract of ambarella fruit

The fruits were washed using chlorinated water in order to reduce microbial load and impurities from the fruit. The blanching temperature was 100°C for 5 min. Peeled fruit was cut into pieces (2cm), placed in clean plastic containers and then allowed for grinding.

E. Preparation of ambarella fruit pulp incorporated ice cream

All the ingredients in the preparation of ice cream were identified and formulated a new recipe based on different compositions.

F. Addition of ambarella fruit pulp

After stabilizing, the ambarella pulp was added to the ice cream mixture with sugar, according to the recipe. Then, it was gently mixed with the ice cream mixture using the hand mixer followed by increasing the temperature at 45-55°C. Homogenized the mixture using high-pressure homogenizer (H-2002, India). Then the mixture was aged at 4°C for 12hrs followed by frozen at - 18°C (Figure 1).

G. Sensory analysis

Sensory evaluation was conducted using 30 untrained panelists both male and female with age ranged 27-50 years. For the sensory evaluation 9-point Hedonic scale was used over appearance, colour, texture, aroma, taste, mouth feel, and overall acceptability. After the sensory evaluation, the best level of incorporation of ambarella pulp was determined.

H. Physiochemical analysis

Titratable acidity was determined by the titration method by taking 9 g of samples homogenized for 30 seconds with 12–15 ml of distilled water using a vortex machine (F202A0270). Then, 1 ml of 1% phenolphthalein solution was added to the homogenized sample. Then, it was titrated with 0.1 M NaOH solution until pink color appeared

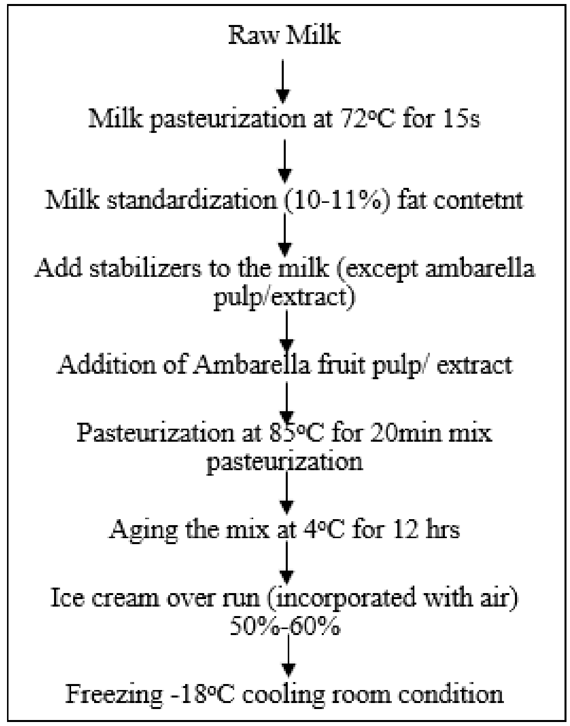

Figure 1: The production process of ambarella incorporated the ice cream

(Priyadarshani *et al*., 2018). The equation of TA is given below.

$$TA = \frac{M \times V \times W \times 100}{1000} \quad (1)$$

where:

M = Molarity of NaOH
V = Volume of NaOH
W = Molecular weight of lactic acid

To determine the keeping quality (KQ test) of ice cream, one part of the ice cream mixture was diluted with nine parts of water to make the testing solution (10 ml). Five testing solutions for each treatment were prepared in test tubes. Then 1 ml of Resazurin chemical was introduced to each test tube and stoppered. The samples were then held at 37 °C for three hours and observed the colour changes at hourly intervals (Kroll & Rodrigues, 1986).

Using the equation provided by MartinouVoulasiki & Zerfiridis (1990), over-run was estimated using a standard plastic cup.

I. Proximate analysis of the product

The Gerber method was used to determine the mixture's fat content. The butyrometer was ran with 10 ml of sulfuric acid and a tilt measurement. Then, 10.75 ml of the milk sample was carefully added by the butyrometer's side. The range of the temperature was 15–21°C. Using a tilt measure, a precise 1 ml of amyl alcohol was poured. With the use of a lock stopper and regulating/guiding pins, the butyrometer was stopped. The tube was thoroughly (mixed) shaken to produce a mahogany red color. The butyrometer was then spun at 1100 rpm for 4 minutes in a centrifuge after being placed in a hot water bath for 15 to 21°C. The readings were then taken (AOAC, 2016). Moreover, other proximates including, moisture, crude protein, fiber and ash content were determined based on the AOAC (2016) techniques.

J. Statistical analysis of the data

All the data were collected as triplicates with Standard deviation values. The completely randomized design (CRD) using One-way ANOVA technique was used to analyse the proximate data. Sensory mean scores were subjected to Friedman's non-parametric test with 95% confidence. Minitab® statistical software package and Microsoft® Excel software package were used for the data analysis.

III. Results and Discussion

Sensory evaluation results revealed that the sensory attributes were significantly affected by the amount of added ambarella. There was a significant difference between different samples related to sensory attributes such as taste, mouth feel, texture, colour, and overall acceptability ($p<0.05$). However, appearance and aroma were not significantly different ($p>0.05$) between treatments (Table III).

The most desirable appearance was shown by the T3. The aroma of all treatments was not representing a significant difference. Therefore, aroma was not affected by ambarella pulp addition. Priyadarshani *et al*., (2018) reported that the mouthfeel of milk products is responsible for consistency and viscosity (texture), which are affected by enrichment. A significant difference in acceptability for mouthfeel was evident among different levels of ambrella pulp.

Treatment 3 (T3) was selected as the best during the preliminary analysis. Therefore, T3 ambarella pulp incorporated treatment and the control sample was selected for further proximate analysis.

Analysis of the physicochemical parameters of the samples was done for the five treatment samples including the control. When considering the acidity of the ambarella incorporated ice cream samples, the highest acidity level was measured in the T1 sample and the lowest acidity represents in the T4 sample. TA values of each sample were lower than the control (Table IV). It shows that with the increasing amberella pulp incorporation the acidity was reduced. The pH reduction may be because the ice cream mix containing the ambarella has a higher buffering capacity (Guner *et al*., 2007).

All the treatments showed the same keeping quality, by showing the Resazurin 05 blue level but in control, it shows the R-06 level with excellent quality. But with lower acidity levels of the T3 sample can ensure the KQ of ice cream (Indika *et al*, 2010).

A volumetric increase in ice cream that surpasses the amount of mix used to manufacture it by a specific percentage is referred to as overrun. In another way the volume has increased by 50%, if a batch of mix is used to make 1.5L of ice cream.

In order to maintain stable air cells during the frozen storage, higher overrun values are anticipated (Sofjan *et al*., 2004).

T1, T2, T3 and T4 represent 50% overrun, the control had 60% overrun. But lower over run values are expected to have in the formulations of ice cream regarding the higher shelf life qualities(Sofjan *et al*., 2004). Normally the overrun ranges between 50% - 80% for good quality products. When the ice cream was incorporated with ambarella, it had a low overrun compared to the control sample, the incorporation removed the air from the mixture. It caused the deduction of overrun in the ice cream mixture respect to the T1, T2 and T3. Sofjan (2004), reported that the heat transfer rate may influence the reduction of the overrun in the treated samples.

Analysis of the proximate composition of the selected product (T3) was done for the selected samples including control. Even though there is good nutrition, water content has a greater impact on the physical features of ice cream (Syed *et al*., 2018). Typical ambarella fruit contains a range of 89-90 of moisture content (Ishak *et al*., 2005). But when creating Amberella ice cream, the moisture content ranged from 70% - 71%, depending on earlier research on high-quality ice creams (Murtaza *et al*., 2004). The moisture content of the T3 sample was lower than the control sample in values (Table IV) and those two samples showed significant ($p>0.05$) differences.

The dairy sector is a promising sector to ensure the protein resource to the consumers in palatable products such as ice creams. The protein content of ice cream ranges and can be possible to produce at higher levels (Patel *et al*., 2006). Researchers are expected to develop ice creams with a protein level of 6–11%, with T3 samples falling into that range (Daw and Hartel, 2015). The protein level of the ambarella integrated sample was higher than the control, at 7.48%, and there was no significant difference between the treatments ($p>0.05$). However, the findings show that the protein content of the treated sample somewhat increased (Table V).

The total fat content of the T1 has the highest percentage of 12.5% and CT has the lowest percentage of fat content at 11% (Table IV). Fat content of the T3 treatment significantly differentiated ($p>0.05$) from the CT sample (Table V). Hence, the inclusion of ambarella pulp may have affected all of the integrated treatments, which all had greater values than the control sample. Fat destabilization has a positive effect on increasing fat content and there is no significant influence on consumer acceptability of the ice cream with increasing fat content (Rolon *et al*., 2017). But with commercial standards, the lower fat content of 4 - 5% is accepted for production (Indika *et al*., 2010).

To strengthen the functional properties of the ice cream wheat, oats like grains and apple dates like fruits and raw fibers like inulin are added (Soukoulis *et al*., 2009; Goraya Bajwa, 2015). Compare to the control sample T3-amberella added ice cream had some additional values of fiber that

Table III: Sensory evaluation scores of preliminary product

Sensory attributes	CT	T1	T2	T3	T4	p-value
Appearance	7.1±0.04	6.6±0.00	7.0±0.12	7.2±0.13	7.1±0.00	0.059
Aroma	7.0±0.11	7.0±0.10	7.0±0.02	7.0±0.11	7.0±0.10	0.164
Taste	6.9±0.06	6.4±0.00	7.0±0.03	7.1±0.21	7.1±0.10	0.018
Mouthfeel	7.0±0.04	6.2±0.00	6.6±0.17	7.2±0.07	7.0±0.11	0.007
Texture	6.6±0.01	6.0±0.31	6.2±0.12	7.2±0.13	7.0±0.15	0.000
Color	7.3±0.13	6.5±0.14	7.0±0.10	7.3±0.20	7.4±0.20	0.012
Overall Acceptability	7.1±0.14	6.2±0.16	7.0±0.01	7.7±0.10	7.0±0.16	0.000

P-value<0.05 representing that significant differences between the samples for the respective row sensory parameters

Table IV: Physicochemical results of the ice cream samples

Experiment	Control	T1	T2	T3	T4
TA	6.5	4.4	6	5.7	5.5
KQ test	R- 06	R-05	R- 05	R- 05	R- 05
Over run (%)	60	50	50	50	50
Geber test (%)	11	12.5	11.5	11.7	12

The "R" represents "Resazurin"

Table V: Proximate compositions of the control and T3 samples

Proximate Quality Parameter	Control Sample	T3 Sample	p-value
Moisture (%)	71.15 ± 0.01	70.37 ± 0.14	0.005
Crude Protein (%)	7.36 ± 0.12	7.48 ± 0.11	0.509
Fat (%)	11.00 ± 0.41	11.7 ± 0.22	0.009
Crude Fiber (%)	0.00 ± 0.00	0.08 ± 0.00	0.003
Ash (%)	3.55 ± 0.00	3.85 ± 0.07	0.014

Mean ± Standard deviation. The p<0.05 shows the significant differences to the respective same row parameter.

improves the probiotic and intestinal health of the consumers (Currò *et al*., 2017). This study confirms earlier observations that the crude fiber content changed significantly (p<0.05) with the addition of fruit pulp.

Ambarella fruit species contain microelements phenolics, potassium, calcium, sodium, phosphorus, magnesium, etc (Koubala *et al*., 2018). The total ash content of the ambarella incorporated treatment (3.84% ± 0.07) had a higher value than the control sample (3.55% ± 0.03), and had a significant difference between the two treatments (p<0.05).

IV. Conclusion

Ambarella (*Spondias dulsis*) fruit pulp can be incorporated as a food ingredient because of its nutritional value and appealing flavor. In this study, ice cream incorporated with ambarella pulp had significant differences from the typical ice cream and exhibited higher preference values. Sensory analysis results revealed that, the T3 sample with 8.5: 76.5 ambarella pulp: ice cream mixture showed a higher preference over the other treatments and the control sample. The best selected T3 ice cream sample showed a significant difference (p<0.05) for moisture, fat, crude fibre and ash content with acceptable KQ, TA and overrun values.

References

Ambuja, S. R. & Rajakumar, S. N. (2018). Review On "Dietary Fiber IncorporatedDairy Foods: A Healthy Trend". *International Journal of Engineering Research and Applications, 8*(2), 34-40.

Currò, D., Ianiro, G., Pecere, S., Bibbò, S., Cammarota, G. (2017). Probiotics, fibre and herbal medicinal products for functional and inflammatory bowel disorders. *British Journal of Pharmacology, 174*(11), 1426-1449.

Daw, E. & Hartel, R.W. (2015). Fat destabilization and meltdown of ice creams with increased protein content. *International Dairy Journal, 43*, 33-41.

Goff, H.D. & Hartel, R.W. (2013). Flavoring and Coloring Materials. In *Ice Cream* (pp. 89-119). Springer, Boston, MA.

Goraya, R.K. & 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*(12), 7861-7871.

Guner, A., Ardıc, M., Keles, A. & Dogruer, Y. (2007). Production of yogurt ice cream at different acidity. *International journal of food science technology, 42*(8), 948-952.

Indika, Y.G.C., Mudannayake, D.C., Abeysinghe, A.M.N.L.N., Vidanaarachchi, J.K. & Arsecularatne, D.A.M. (2010). Development of a Molded Sherbet Bar on a Stick with Frozen Yoghurt Core and lime (Citrus aurantifolia) Shell'. Proceedings of the Research Symposium of Uva Wellassa University, September 16-17.

Ishak, S.A., Ismail, N., Noor, M.A.M. & Ahmad, H. (2005). Some physical and chemical properties of ambarella (Spondias cytherea Sonn.) at three different stages of maturity. *Journal of Food Composition and Analysis, 18*(8), 819-827.

Koubala, B.B., Kansci, G. & Ralet, M.C. (2018). Ambarella—Spondias cytherea. In Exotic Fruits (15-22). Academic Press.

Kroll, R. G., & Rodrigues, U. M. (1986). Prediction of the keeping quality of pasteurized milk by the detection of cytochrome c oxidase. *Journal of applied bacteriology, 60*(1), 21-27.

Martinouvoulasiki, I.S. & Zerfiridis, G.K. 1990. Effect of some stabilizers on textural and sensory characteristics of yogurt ice-cream from sheeps milk. *J. Food Sci. 55*, 703–707.

Mohammed, M., Ahmad, S.H., Bakar, R.A. & Abdullah, T.L. (2011). Golden apple (spondias dulcis forst. syn. spondias cytherea sonn.)'. *Postharvest biology and technology of tropical and subtropical fruits*, 159-180e.

Murtaza, M. A., Huma, N. U. Z. H. A. T., Mueen-Ud-Din, G., Shabbir, M. A., & Mahmood, S. H. A. H. I. D. (2004). Effect of fat replacement by fig addition on ice cream quality. *Int J Agric Biol, 6*(1), 68-70.

Patel, M.R., Baer, R.J. & Acharya, M.R. (2006). Increasing the protein content of ice creal. *Journal of Dairy Science, 89*(5), 1400-1406.

Priyadarshani, W. M. D., & Muthumuniarachchi, M. A. M. R. (2018). Physico-chemical and sensory quality of mung bean (Vigna radiata) enriched stirred yoghurt. *International Food Research Journal, 25*(5), 2051-2055.

Rolon, M.L., Bakke, A.J., Coupland, J.N., Hayes, J.E. & Roberts, R.F. (2017). Effect of fat content on the physical properties and consumer acceptability of vanilla ice cream. *Journal of dairy science, 100*(7), 5217-5227.

Sofjan, R.P. & Hartel, R.W. (2004). Effects of overrun on structural and physical characteristics of ice cream. *International Dairy Journal, 14*(3), 255-262.

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.

Syed, Q.A., Anwar, S., Shukat, R. & Zahoor, T. (2018). Effects of different ingredients on texture of ice cream. *Journal of Nutritional Health and Food Engineering, 8*(6), 422-435.

