

PRODUCTION OF A NOVEL FRUIT-YOGHURT USING DRAGON FRUIT (*HYLOCEREUS UNDATUS L.*)

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Abstract

Dragon fruit (*Hylocereus undatus L.*), which is rich in vitamin C, fiber and natural antioxidants, is one of the most popular commercial fruits available in Sri Lanka. However, dragon fruit is still an underutilized fruit in Sri Lanka as its high price and exotic taste don't warrant consumption of the fruit by average Sri Lankan consumers. The present study investigated the possibility of developing a novel fruit-yoghurt incorporated with white dragon fruit and evaluated its eating quality parameters. An initial survey was conducted to find out the consumer preference for value-added dragon fruit products in Sri Lanka. Pasteurized dragon fruit juice enriched yoghurt (5%, 7.5%, 10% and 12.5% w/w) were prepared with the suitable concentrations of sugar and gelatin and sensory properties, pH, titratable acidity, total solid, fat, solid-non-fat (SNF) and microbiological properties of the product were determined. Sensory results were analyzed by Kruskal-wallis non-parametric one way ANOVA method using STATISTIX software (ver 2.0) for windows. Survey results showed that 90% of individuals were eagerly waiting for the new product from dragon fruit in the near future. Sugar (10%), gelatin (0.8%) and dragon fruit juice (10%; w/w) added yoghurt mix was selected as the best product considering its highest mean rank values recorded for sensory properties. The titratable acidity and pH of the developed product during the storage period ranged from 0.8 to 1.0 % and 4.08 to 3.9, respectively. Yeast and mould count did not exceed the Sri Lanka Standards Institute (SLSI) recommended values during the 15-day storage period. It can be concluded that dragon fruit can be successfully

used to develop a fruit-yoghurt with improved sensory and nutritive properties.

Keywords: Fruit-yoghurt, health benefits, dragon fruit, sensory properties, shelf-life

Introduction

Yoghurt is defined as a fermented milk product obtained from coagulation of milk by the agency of organisms of types *Streptococcus thermophilus* and *Lactobacillus bulgaricus*, *Lactobacillus acidophilus* may be present (SLSI, 1989). It is one of the most popular dairy products available in Sri Lanka and the statistical evidences show that the daily market requirement of yoghurt exceeds one million cups (Kanakaratne, 2012). Fruit yoghurt is a product which is made by adding fruits, their nectars, jams, marmalade, fruit jellies, fruit drinks, fruit syrups and concentrated fruit drinks to yoghurt or cultured pasteurized milk. Moreover, it is reported that incorporation of fruits can effectively enhance the taste and the therapeutic properties of the plain yoghurt (Zainoldin and Baba, 2009).

The dragon fruit is the fruit of several cactus species, especially of the genus *Hylocereus*. They are widely planted and consumed throughout the world as a fruit crop. In Sri Lanka, it is cultivated in low country wet zone, intermediate zone and dry zone with irrigation facilities. There are three main types of dragon fruit species available for commercial cultivation, namely, *Hylocereus undatus* (white flesh with pink skin), *Hylocereus polyrhizus* (red flesh with pink skin) and *Selenicereus megalanthus* (white flesh with yellow skin). The fruit weighs 150-600 g and the raw flesh is mildly sweet and low in calories (Zainoldin and Baba, 2009). The dragon fruit pulp contains 82.5-83% moisture, 0.16-0.23% protein, 0.21-0.61% fat, 0.7-0.9% fiber, 6.3-8.8 mg calcium, 30.2-36.1 mg phosphorous, 0.5-0.61 mg iron, 8-9 mg vitamin C (Islam *et al.*, 2012). Dragon fruit is reported to have health benefits including prevention of memory losses, prevention of cancer, control of blood glucose level in diabetic patients, prevention of oxidation, aiding in healing of wounds etc. In addition, it has the ability to promote the growth of probiotics in the intestinal tract (Zainoldin and Baba, 2009).

In Sri Lankan, dragon fruit is not as popular as it is in the rest of the world due its bitter taste, unusual flavour as well as the high market price. Therefore, production of fruit-yoghurt incorporated with dragon fruit can be hypothesized to increase the consumer acceptability and palatability of dragon fruit. Further, consumers will have the reported health benefits of dragon fruit. Therefore, the objective of the present study was to develop a fruit-yoghurt incorporated with dragon fruit and to determine its quality parameters.

Materials and methods

Survey on consumer preference for dragon fruit

The study sample consisted of 120 adults from Matara, Kandy and Kalutara districts in Sri Lanka. The said three districts have a large number of dragon fruit cultivated farms. A pre-tested questionnaire that included questions on knowledge, consumption, preference and possibility of value-addition of dragon fruit was used to collect the information in the representative sample of 120 adults in the said three districts. Data were analyzed using Statistical Package for the Social Science (SPSS) for windows (version 18.0).

Development of dragon fruit-yoghurt

Plain set yoghurt samples were prepared with different sugar (5%, 7.5%, 10% and 12.5%; w/w) and gelatin (0.5%, 0.6%, 0.7% and 0.8%; w/w) contents and the best concentration of sugar and gelatin was determined based on taste and texture using a sensory analysis. Scooped dragon fruit flesh was blended (SHPEM1251, Singer international, Colombo, Sri Lanka) and pasteurized (70 °C for 30 sec) to obtain dragon fruit pulp. Yoghurts were prepared using standardized cow milk (3.5% fat and 6.5 pH) with the production steps of blending of milk, heating of milk at 85–90 °C for 30–40 min, addition of sugar and gelatin, inoculated with commercial yoghurt starter culture (Chr Hansen, Hoersholm, Denmark). Dragon fruit yoghurt with varying composition of fruit contents (A-5%, B-7.5%, C-10% and D-12.5%; w/w) was developed by adding dragon fruit juice into the above mix. After 5 h of incubation (IF30 plus, *memmert* gmbh and co. Kg, USA) at 41 °C, products were stored at 4 °C. Sensory evaluation of the five treatments including commercially available fruit yoghurt as the control treatment were carried out using 30 semi-trained panelists. Appearance, body and texture, taste, aroma and overall acceptability of the developed products were evaluated on a five-point headoinc scale.

Determination of quality parameters of dragon fruit yoghurt

The final product selected by sensory evaluation was subjected to physicochemical and microbiological analysis. Total solid percentage (gravimetric method), fat (gerber method), solid-non-fat percentage (titration with NaOH), pH and titratable acidity of the developed product were determined according to AOAC recommended test methods (AOAC, 1995). Moreover, enumeration of *E. coli* (Brilliant Green Bile Broth; Oxoid ltd, Basingstoke, UK) and yeast and mould count [Sabouraud's Dextrose Agar (SDA); oxoid ltd, UK] of the developed dragon fruit yoghurt were also determined in the beginning, 5, 10, 15 and 20 days after manufacture.

Analysis of data

Purposive sampling technique (Sumathy and Kumar, 2011) was used to select the individuals for the consumer preference survey. In conducting sensory tests, completely randomized design (CRD) was used as the experimental design and samples were completely randomized across all panelists in order to avoid or minimize the effect of erroneous results occurring due to the order of samples. Sensory data were analyzed using kruskal-wallis non parametric one way ANOVA using STATISTIX statistical software (ver 2.0) for windows. The duncan's multiple range test (DMRT) was used to analyze the difference between the individual means at the 5% significance level.

Results and discussion

The results of the consumer preference survey showed that more than 75% individuals were aware of the dragon fruit as an exotic fruit. Moreover, 65% of them consumed dragon fruit at least once in their life-time. However, 58% of the respondents were displeased to consume dragon fruit due to its inherent bitter taste and flavour. However, 90% of the respondents were waiting to try the new product from dragon fruit in the near future.

Physicochemical properties such as specific gravity, fat percentage and pH of the raw milk were 1.031gcm^{-1} , 3.5% and 6.5, respectively. The observations of the physicochemical properties of milk in the present study are in agreement with the findings of similar studies carried out on the development of yoghurt incorporated with strawberry, orange and grape-juice (Hossian *et al.* 2012) and on the physicochemical properties of cow milk samples (Mohammad *et al.* 2008).

Table 1 estimated mean rank values for sensory attributes of dragon-fruit incorporated yoghurt

Treatment	Aroma	Color	Taste	Texture	Overall acceptability
A	26.5 ^a ± 0.80	38.7 ^c ± 1.21	26.5 ^c ± 0.68	30.5 ^b ± 0.69	29.0 ^b ± 1.29
B	34.5 ^a ± 0.49	43.8 ^c ± 0.49	34.5 ^c ± 0.83	36.5 ^b ± 0.79	34.5 ^b ± 0.77
C	114.5 ^a ± 0.49	120.2 ^a ± 0.49	132.5 ^a ± 0.30	118.9 ^a ± 0.67	114.5 ^a ± 0.50
D	100.5 ^a ± 0.82	96.9 ^b ± 0.65	93.5 ^b ± 0.81	94.4 ^a ± 0.77	106.6 ^a ± 0.91
E	101.5 ^a ± 0.49	77.9 ^d ± 0.50	90.5 ^b ± 0.77	97.2 ^a ± 0.87	95.8 ^a ± 0.84

All values are the means ±SD of nine determination in triplicate experiments. A - 5% (w/w) dragon fruit juice, B - 7.5% dragon fruit juice, C- 10% dragon fruit juice, D- 12.5% dragon fruit juice and E- commercial fruit yoghurt. Means with different superscripts are significantly different at 0.05 significance level

Treatment C with sugar (10%; w/w) and gelatin (0.8%) was selected to develop the final fruit yoghurt considering the highest mean rank values recorded for its sensory attributes (table 1). The results show that the treatment C (10% dragon fruit; w/w) and control (plain yoghurt) were

significantly different ($p < 0.05$) in terms of color and taste but there were no significant differences ($p > 0.05$) between two products for aroma, texture and overall acceptability. In a similar study carried out by Zainoldin and Baba (2012) it was observed that the sweetness, taste and the appearance of red and white dragon fruit yoghurt showed significantly higher sensory properties ($p < 0.05$) compared to plain yoghurts. They further concluded that the dragon fruit can enhance the taste and the pigments of red dragon fruit gives improved visual appearance to the yoghurt. In the present study, there was a significant difference ($p < 0.05$) among treatment C and other treatments for color, taste, texture and overall acceptability apparently due to addition of high levels of dragon fruit juice. Considering the highest mean rank value for all sensory parameters (table 1) treatment C (10% dragon fruit juice) was selected as the best recipe for development of dragon fruit incorporated yoghurt.

The total solid, solid-non-fat (SNF), and fat contents of the developed product were 23.58%, 9.639% and 3.2%, respectively. These results are in agreement with the requirements prescribed under Sri Lanka standards for yoghurt (SLSI, 1989). Ehirim and Onyeneke (2013) reported that low percentage of total solids in yoghurt can lead to malfunction of starter culture. However, the results of the present study are in line with the findings of a similar study carried out to determine the physico-chemical, sensory and microbiological properties of set and fruit yoghurt in Sabaragamuwa province, sri lanka (De Silva and Rathnayaka, 2014). They observed that the fat content and total solid content of the set yoghurt ranged from 2.8 to 3.74% and 22.19 to 26.15%, respectively.

The developed product had a pH value of 4.05 and a titratable acidity value of 0.8% on the day of manufacture. The pH and titratable acidity together are a measure of the total organic acid content present in the yoghurt. These values are important because acidification is the key to the proper development of a yoghurt during the fermentation process. The decrease of the pH during fermentation was due to the protooperative action of two strains of bacteria i.e. *S. thermophilus* and *L. bulgaricus* (Brabandere and Baerdemaeker, 1999).

The changes in titratable acidity of the developed product during storage are illustrated in figure 1. According to SLSI standards (SLSI, 1989), the titratable acidity of a yoghurt should range from 0.8% to 1.25%. Titratable acidity of the developed product increased during the storage period due to the post process fermentation (fig 1).

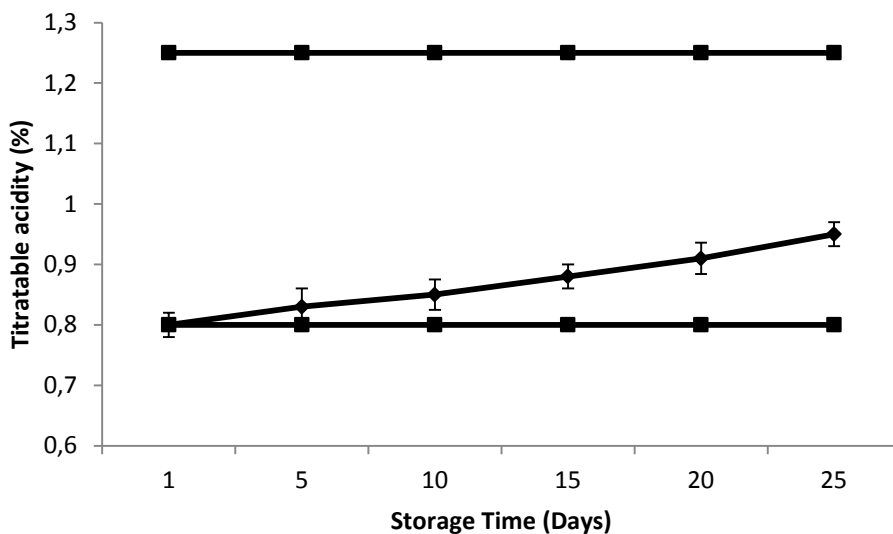


Fig 1 Changes in titratable acidity (♦) in developed dragon fruit yoghurt during storage. The SLSI recommended range (■) is also marked. Error bars indicate the standard deviation (SD) of the the mean of nine determinations in triplicate experiments

The observed results in the present study are in agreement with the findings of Zainoldin and Baba (2009) who observed that acidity of yoghurts increased over the storage period. Milk sugar and milk protein present in the medium together with the optimum incubation environment (pH 7 and 41°C) is believed to promote the growth of *S. thermophilus* rapidly. Culture bacteria convert the lactose into lactic acid, acetaldehyde, diacetyl and formic acid. All these accumulated fermented products are responsible for acid production during fermentation. The liberation of lactic acids reflects the high metabolic activity of the lactic acid bacteria (Zainoldin and Baba, 2009).

The pH values of dragon fruit yoghurt products in the present study decreased from 4.06 to 3.9 during the storage time period. Zainoldin and Baba (2009) studied the initial pH of dragon fruit yoghurts and reported that it ranged from 3.95 to 4.05. The results of the changes in pH in the present study were comparable with the above mentioned observations of Zainoldin and Baba (2009). The reduction of pH observed in the present study was due to the growth of acid forming bacteria during the storage period. The pH value of the drinking yoghurt products is important from the consumer point of view. A similar study carried out on yoghurts and food safety concluded that the pH is important with respect to public safety (Gohil *et al.*, 1995). Accordingly, pathogens such as *Listeria monocytogenes* die out rapidly in yoghurts at pH<4.2 and in mild yoghurts at pH values >4.5 (Gohil *et al.*, 1995). Further, a similar study reported the survival of *Salmonella* for up to

10 days and *Escherichia coli* 0157 for up to 7 days at high pH values in yoghurts (Massa *et al.*, 1997).

Yeast and mold populations in the developed dragon fruit yoghurts did not exceed 10^3 CFU/g until the 15 day of storage period which is the SLSI recommended value for yoghurts (SLSI, 1989). *E. coli* was not detected in all the yoghurts during storage, thus, showing hygienic production procedure. Moreover, the shelf-life of the dragon fruit yoghurt was 15 days under refrigerated conditions (4 °C).

Conclusion

Dragon fruit can be effectively used for the development of set fruit-yoghurts. The highest sensory properties were observed in the product which consisted of 10% dragon fruit juice, 10% sugar and 0.8% gelatin. Developed product had 23.58 % total solids, 9.64% solid-non-fat and 3.2% fat which complied with the sri lankan standards. Dragon fruit yoghurt can be stored for 15 days under refrigeration conditions (4°C) without changing its quality parameters.

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