

## Development of a Ripened Jack (*Artocarpus heterophyllus*) Fruit Incorporated Set Yoghurt

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**Abstract:** Yoghurt is one of the most popular fermented dairy products widely consumed all over the world. In majority of the countries, the increase in the per capita annual consumption of yoghurt has been attributed to both the ever-increasing availability of fruit or flavoured yoghurt and to the diversity of presentations of the product. This study was conducted to develop a value added set type fruit yoghurt with the acceptable combination of milk and ripened jack fruit (*Artocarpus heterophyllus* Linn). Various levels of jack fruit chunks (3-5mm) viz. 3, 5, and 7 percentages (w/v) were used in the preparation of fruit yoghurt. On the basis of various sensory attributes, yoghurt containing 5% jack fruit chunks was selected as optimum. Selected yoghurt sample from sensory panel and control (Plain yoghurt) were analysed for proximate composition, *E.coli* count, shelf life and sensory attributes such as appearance, aroma, colour, fruit distribution, mouth feel, texture, taste, overall acceptability. The means for total solids, fat, protein and fibre percentage of the control samples were 19.73±0.12, 4.00±0.06, 3.30±0.02 and 0 respectively whereas for the 5% jack fruit chunks added yoghurt samples the means were 21.98±0.05, 4.11±0.03, 3.31±0.01 and 0.04±0.01, respectively. The products were packaged in plastic cartons and stored under refrigerated conditions at 4±1°C for a period of three weeks. The pH and syneresis decreased significantly (p<0.05) and titratable acidity increased significantly (p<0.05) with storage. *E.coli* was not detected on the first day of storage at 10<sup>-1</sup> dilution. The samples comply with the Sri Lankan Standards for solids- non-fat content (Minimum percentage by mass 8) and *E.coli* counts. The product was acceptable for a period of 14 days at 4±1°C. Yoghurt sample prepared by incorporating 5% jack fruit chunks resulted in superior organoleptic properties and nutritional qualities when compared to control sample, thus illustrating the sustainability of jack fruit incorporation in commercial yoghurt production at a low cost.

**Keywords:** Jack fruit, Milk, Shelf life, Yoghurt.

### I. INTRODUCTION

Yoghurt is becoming more popular cultured dairy product in most countries. Yoghurt is not only an easily digested food but also it has high nutritional value, and is a rich source of carbohydrates, protein, fat, vitamins, calcium, phosphorus and relatively an inexpensive food. Moreover people who conscious on their health are well aware about the nutritional values and the beneficial effect of yoghurt [1]. In general, the overall properties of yoghurt, such as free fatty acid content, acidity level, the production of aroma compounds (acetaldehyde, acetoin, diacetyl) as well as the nutritional value and sensory profile, are important traits of the product [5]. Current trend and changing consumer demand provide a great opportunity for innovations and developments in fermented milk products. In most of the countries, the increase in the per capita annual consumption of yoghurt has been attributed to both the ever-increasing availability of fruit or

flavoured yoghurt and to the diversity of presentations of the product. Fruit, preserved fruit, canned fruit, frozen fruit, and miscellaneous fruit products being used as flavouring material in yoghurt industry [10].

According to Sri Lankan Standard (SLS 824) [8] fruit yoghurt is a product which is made by adding fruit to yoghurt (fat level is 3.0% and above) or low fat yoghurt (0.5% < fat level < 3.0%) or non fat yoghurt (fat content < 0.5%). A recent development in fruit processing is the use of the "osmohydrofrozen" method which consists of osmotic treatment in sugar solution, limited air dehydration to reduce water activity, freezing and storage. Fruit which are processed using this technique require no preservatives, maintain their natural colour and flavour and have an acceptable texture. Furthermore, when such fruits or dried pieces are added to yoghurt, they have the tendency to absorb some of the free or unbound water from the yoghurt gel and hence help to reduce whey separation of the product during storage [13]. It is reported that the addition of fruit flavour has no significant effect on the coliform and total bacteria counts. It has been also reported that fruit-flavoured yoghurts, made using one-day old yoghurt as a starter culture, could be stored for up to seven days without losing its desired flavour qualities [16]. Zekai and Erodogan [16] analysed some kinds of fruit yoghurts for some chemical, physical, microbiological and sensory characteristics and concluded that the yoghurt containing morello and grape molasses obtained higher flavour scores in comparison to other flavouring agents.

In Sri Lanka numerous variety of seasonal fruits are available. It is possible to improve the nutritional value of yoghurt by adding seasonal fruits. Jack fruit is very popular fruit in Jaffna district. During the period of peak production, a huge amount of jack fruit undergoes spoilage. Therefore, an attempt was made to develop an acceptable combination of milk, and jack fruit chunks blend for the preparation of yoghurt and to study the nutritional composition of most preferred products. On this background experiments were conducted from March 2011 to August 2011 in laboratory of Department of Animal Science, University of Jaffna, Sri Lanka with the following objectives:

- a) Determine suitable percentage of jack fruit chunks to be incorporated into set type fruit yoghurt through organoleptic evaluation.
- b) Development of low cost and nutrient rich fruit flavoured set type yoghurt.

## II. MATERIALS AND METHODS

- 1) *Material collection*: Fresh cow milk was obtained from the Jaffna District Development Cooperative Society (JDDCS). Jack fruit (local variety) and other ingredient were bought from the local market.
- 2) *Preparation of fruit preserves*: Fruits were prepared by 'osmohydrofrozen' method using high fructose corn syrup.
- 3) *Production of Yoghurt*: Whole milk was pasteurised and heated to reduce about one-third of its original volume. Sugar was added to the milk at the rate of 10% for normal yoghurt and 8% for fruit yoghurt. While heating milk was stirred continuously with the help of stirrer to avoid the formation of cream layer. After (it attained the) desired (stage of) heating milk pan was taken out from the heater and allowed to cool. When the temperature of milk was about 40°C,

the starter culture (2%), which was collected from local market, was inoculated. The samples were incubated at 40°C until the yoghurt (3-4h) coagulated completely. The yoghurt samples were stored at about 4°C at refrigeration until used [8].

- 4) *Selection of suitable incorporation percentage of jack fruit chunks for fruit yoghurt*: Yoghurts were prepared with different percentage of jack fruit (3%, 5%, and 7%w/v) and cow milk combinations. All other ingredient levels were maintained as same as in the plain yoghurt except sugar content. Samples were subjected to a sensory panel of 30 untrained members for sensory evaluation.
- 5) *Proximate analysis of milk, jack fruit and yoghurt samples*: Total solids, fat, protein, sugar, fibre, ash, pH, and titratable acidity were measured by the methods described in AOAC [1] with three replicates.
- 6) *Determination of Syneresis*: A method of Wu *et al.*, [14] was used to measure the syneresis of yogurt samples. Syneresis was measured with two days interval up to 17 days. The analysis was done using a Whatman filter paper number 1 to cover a Buchner funnel. After that, 20g of the yogurt was spread in a thin layer to cover the surface of the filter paper. The funnel was then arranged on the top of an Erlenmeyer flask and the flask was connected to a vacuum pump. When all the system was set up, the yogurt was filtered under vacuum generated by water tap for 10 minutes. The liquid that passed through the filter paper was collected and recorded.

$$\text{Percentage of Syneresis} = \frac{\text{Initial weight of sample} - \text{Final weight of sample}}{\text{Initial weight of sample}} \times 100$$

- 7) *Escherichia coli* Counts: For *Escherichia coli* counts MacConkey's agar was used. Inocula (0.1ml) of diluted samples (9ml peptone water with 1ml sample) were applied directly to the MacConkey's agar plates and incubated at 37°C for 24 hours [13].
- 8) *Evaluation of cost of production*: Cost of production was evaluated for treatments separately.
- 9) *Experimental design and statistical analysis*:
  - a) Sensory analysis: Friedman non parametric statistical method was used to analyse the sensory evaluation data based on 5-point hedonic scales and analysis was done using Minitab software.
  - b) Proximate analysis: Data were analysed in a Complete Randomized Design (CRD) using the SAS statistical software package and data from experiments with Duncan's Multiple Range Test (DMRT) were analysed using PROC ANOVA.

### III. RESULTS AND DISCUSSION

- 1) Sensory scores of Jack fruit chunks incorporated (3%, 5%, and 7%) yoghurt samples (JY): Table 1 shows the median values of physical scores for different attributes of different treatments. Treatment-1 (3%) revealed highest median scores for appearance and colour. Highest median scores in fruit distribution, and aroma were showed by Treatment-3 (7%). Treatment-2 (5%) was most preferred for texture, taste, mouth feel, and overall acceptability. Statistically there was no significant difference in colour among treatments. Yoghurt containing 5% jack fruit chunks differed significantly in texture and taste from Treatment-1 and

Treatment-3. All the yoghurt samples were significantly differed in aroma and mouth feels from each others. According to the Sri Lankan Standard for fermented milk products, the fruit content of yoghurt must be at least 5% in all type fruit yoghurt [14].

In addition, the results of organoleptic tasting panel agreed with the Sri Lankan standard recommendations. The highest median score for aroma was observed in yoghurt with 7% fruit chunks followed by 5% and lower score was observed for 3% fruit incorporated yoghurt sample. This is due to the fact that the acid development is a basic requirement for the characteristic aroma in yoghurt. This is in line with the findings of Desai and Toro [2] they reported that the addition of fruit is contributed to increase the acidity level of lassi.

Table 1: Median values for sensory scores in different percentage of jack fruit incorporated yoghurt samples (JY)

Attributes	Treatment-1 (3%)	Treatment-2 (5%)	Treatment-3 (7%)
Appearance	4.25 <sup>a</sup>	4.25 <sup>a</sup>	3.75 <sup>b</sup>
Colour	5.00 <sup>a</sup>	5.00 <sup>a</sup>	5.00 <sup>a</sup>
Fruit distribution	4.00 <sup>b</sup>	4.67 <sup>a</sup>	4.88 <sup>a</sup>
Aroma	3.67 <sup>c</sup>	4.33 <sup>b</sup>	5.00 <sup>a</sup>
Texture	5.00 <sup>b</sup>	5.00 <sup>a</sup>	5.00 <sup>b</sup>
Taste	4.00 <sup>b</sup>	5.00 <sup>a</sup>	4.00 <sup>b</sup>
Mouth feel	4.00 <sup>c</sup>	5.00 <sup>a</sup>	4.00 <sup>b</sup>
Overall acceptability	4.00 <sup>b</sup>	4.67 <sup>a</sup>	4.33 <sup>a</sup>

a-c values in the same row with the same letter of the alphabet do not differ significantly ( $p>0.05$ ). 3%, 5% and 7% Jack fruit chunks incorporated yoghurt from Treatments-1, 2 and 3, respectively.

- 2) Proximate analysis of cow milk and jack fruit: Quality of milk and jack fruit used in yoghurt production was analyzed before use. Moisture, total solid, fat, protein, lactose, fibre, ash, pH, titratable acidity and specific gravity were determined. The results of chemical analysis are shown in Table 2 and Table 3.

Table 2: Mean and standard deviation of chemical composition of cow milk

Constituents	Cow milk Mean $\pm$ SD
Water	87.39 $\pm$ 0.10
Total Solids	12.61 $\pm$ 0.10
Fat	4.07 $\pm$ 0.06
Protein	3.30 $\pm$ 0.05
Carbohydrate	4.51
Fibre	0
Ash	0.73 $\pm$ 0.01
pH	6.5 $\pm$ 0.26
Specific gravity	1.03 $\pm$ 0.00

The results of chemical composition of cow milk agree with several studies [7]. All the above mentioned parameters of cow milk samples were also within normal range.

The result of the chemical composition of jack fruit is in agreement with the report of Watt *et al.*, [13] except for average moisture 77.49 $\pm$ 0.15 (FM), and fat 0.94 $\pm$ 0.03 (FM) content. This is due to the varietal difference, and growing area of jack tree.

Table 3: Mean and standard deviation of chemical composition of jack fruit

Constituents	Wet weight basis	Dry weight basis
	Mean $\pm$ SD	Mean $\pm$ SD
Water	77.49 $\pm$ 0.15	0
Total Solids	30.30 $\pm$ 1.37	100
Fat	0.94 $\pm$ 0.03	3.16 $\pm$ 0.03
Protein	1.33 $\pm$ 0.05	4.41 $\pm$ 0.05
Carbohydrate	26.11 $\pm$ 1.29	86.16 $\pm$ 1.29
Fibre	0.96 $\pm$ 0.04	3.16 $\pm$ 0.04
Ash	0.96 $\pm$ 0.05	3.16 $\pm$ 0.05

- 3) Proximate analysis of the formulated yoghurt preparations: The average chemical composition of normal yoghurt, and jack yoghurt are shown in Table 4. The SNF (Solid Non Fat) (Normal yoghurt 15.73 $\pm$ 0.06%, Jack yoghurt 17.87 $\pm$ 0.02%) was in agreement with the standard [8]. A perusal data from Table 4 revealed that fruit type yoghurt samples had higher total solids content than that of plain yoghurt sample which could be easily justified by the incorporation of the fruit. The results obtained were in alliance with the results of Bakri and Zubeir [3] for chemical and microbiological evaluation of plain and fruit yoghurt in Khartoum States, Sudan. Addition of Jack Fruit Chunks (JFC) significantly increased the total solids content of yoghurt sample by 2.25%.

Table 4: Means and standard deviation of compositional contents of selected samples of yoghurt

Components	Trt-1(NY)	Trt-2(JY)
Water	80.27 $\pm$ 0.12 <sup>a</sup>	78.02 $\pm$ 0.05 <sup>b</sup>
Total solids	19.73 $\pm$ 0.12 <sup>b</sup>	21.98 $\pm$ 0.05 <sup>a</sup>
Fat	4.00 $\pm$ 0.06 <sup>b</sup>	4.11 $\pm$ 0.03 <sup>a</sup>
Protein	3.30 $\pm$ 0.02 <sup>a</sup>	3.31 $\pm$ 0.01 <sup>a</sup>
Sugar	11.91 $\pm$ 0.04 <sup>b</sup>	13.95 $\pm$ 0.04 <sup>a</sup>
Fibre	0.00 $\pm$ 0.00 <sup>b</sup>	0.04 $\pm$ 0.01 <sup>a</sup>
Ash	0.52 $\pm$ 0.02 <sup>b</sup>	0.56 $\pm$ 0.01 <sup>a</sup>

a and b values in the same row with the same letter of the alphabet do not differ significantly ( $p > 0.05$ ). Trt-1, Normal Yoghurt; Trt-2, Jack (5%w/v) yoghurt.

According to Sri Lankan standard specification for fermented milk products, Yoghurts are classified based on their fat contents. The full fat, low fat, and non-fat yoghurt must contain minimum 3, 0.5 and less than 0.5% milk fat respectively. According to the Table 4, all the treatments were declared as full fat yoghurt or fruit yoghurt depends on whether it contains fruit or not. The protein content increased slightly due to addition of jack fruit. Jack yoghurt samples showed a higher content of protein compared to normal yoghurt sample. Bakri and Zubeir [10] reported that fruit yoghurt contains higher protein than normal yoghurt. While most dairy products do not contain dietary fibre, there are a few dairy foods, which contain certain non-dairy ingredients contributing varying amounts of fibre. Incorporation of jack fruit can give variety as well as dietary fibre to the dairy products.

4) Shelf life study: Figure 1, 2, and 3 shows the changes of pH, titratable acidity, and syneresis of the samples respectively for a period of three weeks under refrigerated conditions at  $4\pm 1^{\circ}\text{C}$ .

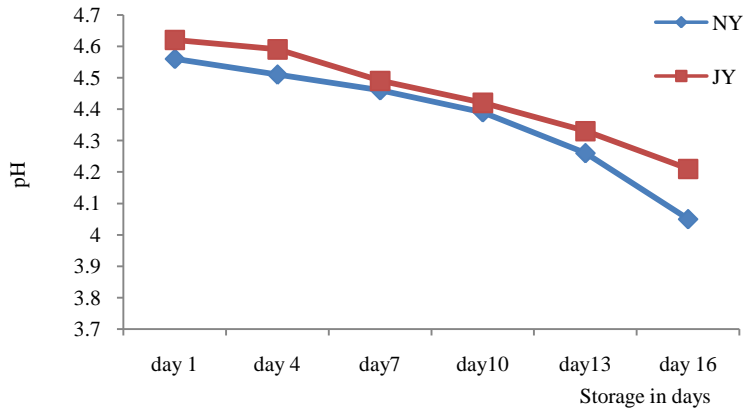


Figure 1: Changes in the pH of yoghurt samples during the storage time

The pH of all samples of yoghurt decreased throughout the period of storage. This is an agreement with the finding of Obi *et al.*, [6] who stated that the decrease in the pH of yoghurt samples could be attributed to the metabolic activities of the lactic acid bacteria in the yoghurt culture.

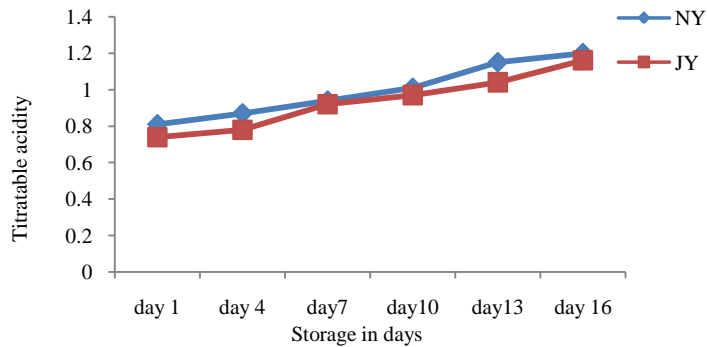


Figure 2: Changes in titratable acidity of yoghurt samples during the storage time

Titratable acidity values of all samples of yoghurt showed a significant increase throughout the period of storage. The increase in titratable acidity values could be attributed to the activity of lactic acid bacteria which usually converts lactose to lactic acid [6]. The acidity and level of proteolysis in yoghurt play important roles in the formation of yoghurt aroma. Therefore, the acidity is another quality criterion for yoghurt [4]. According to Sri Lankan standard for fermented milk products, the titratable acidity as lactic acid percentage by mass range from 0.8–1.25 [8]. Values for titratable acidity were in good agreement with the standard during first sixteen days.

The highest syneresis percentage was shown in normal yoghurt sample ( $44.28\pm 1.22$ ) compared to fruit incorporated yoghurt sample ( $33.11\pm 1.97$ ). Total solids content of the yoghurt samples

had significant effect on syneresis. The introduction of jack fruit increased the fiber and total solid in yoghurt, which can hold the water and thus decrease the syneresis. Mahdian and Tehrani [5] also reported that the reduction of free water and increasing the proportion of solids contents, are the two main factors decrease the rates of wheying off.

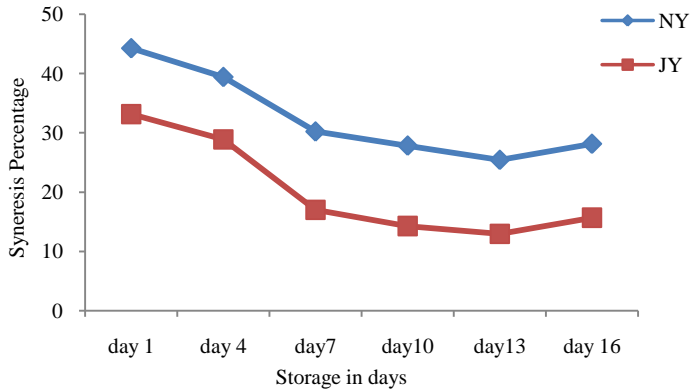


Figure 3: Changes in syneresis of yoghurt samples during the storage time

Based on the above results shelf life of the products were determined as 14 days. Usually shelf life of the yoghurt is two to four weeks.

- 5) Microbial analysis-Coliform screening test: For the Coliform test 1 ml of diluted ( $10^{-1}$ ) samples were used. All yoghurt samples showed negative results for Coliforms with  $10^{-1}$  dilution. This is due to the high hygienic conditions obtaining in the laboratory that prevented post-production contamination. This is in conformity with the work of Yaygin and Kilic [15] who reported that fermented milks are characterized by low levels of oxygen, high acidity, and production of antimicrobial compounds by the starter bacteria which prevent the survival of some pathogenic or spoilage organisms. Based on the Sri Lankan Standard for Yoghurt less than 1cfu/g Coliforms are allowable in yoghurt. The results of this study were in agreement with Sri Lankan standard [8].

Table 5: Cost of production for various types of yoghurts (cost/10 litre)

Ingredients	Unit price (LKR)	NY	JY
Cow milk	50.00 (1 litre)	500.00	500.00
Jack fruit	150.00 (1 kg)	-	75.00
Sugar	100.00 (1 kg)	100.00	60.00
Gelatine	80.00 (30g box)	186.66	186.66
Culture	50.00	50.00	50.00
Yoghurt cups	2.00 (1 cup)	180.00	200.00
Other costs	30% of costs of Ingredients	304.99	321.49
Total cost (for 10 litres)		1321.66	1393.16
Unit price (1 cup)		14.75	13.93

NY – Normal Yoghurt; JY – Jack (5%w/v) Yoghurt

- 6) Cost of production: Table 5 showed the cost of production of various types of yoghurts produced from 10 litres of milk. The cost of producing 1 Litre of normal yoghurt was less (Rs. 132.17), compared to the cost of producing same amount of jack yoghurt (Rs. 139.32). This is due to the higher market price of jack fruit. However cost of producing a cup (80g) of jack yoghurt was (Rs. 13.93) low than producing a normal cup of yoghurt (Rs. 14.75). This is due to the addition of fruit chunks which increase the volume of total mixture.

#### IV. CONCLUSION

From the analysis of the results it is clear that good quality fruit yoghurt could be prepared by incorporating 5% (w/v) of jack fruit in small chunks with milk and it has better nutritional value and acceptability than normal yoghurt. This new product will help to open new doors in the dairy industry in the island through the creation of an opportunity to offer comparatively low cost yoghurt with higher nutritional and sensory qualities.

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