Formulation and Development of Palmyrah(Borassus flabellifer L) Fruit Pulp based milk drink

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Abstract - Palmyrah (Borrasus flabellifer L) fruit is a nutritious and functionally beneficial fruit with unique organoleptic properties. Wastage of this seasonal fruit is prominent in Sri Lanka during peak season due to less industrial utilization. The availability of ready to serve drinks using fruits like Palmyrah gives a good option to consumers who prefer nutritional and healthy drinks. This study was conducted to give value addition to Palmyrah fruit pulp in the form of fruit pulp based milk drink to promote its utilization. Acid application and heat treatment were done to fruit pulp prior to incorporation in order to reduce and mask its bitterness. Pulp was extracted manually from well ripen fruits and treated with 0.2% of citric acid which was found to be the optimal percentage for this product, considering the pH change of pulp and heat- treated at 85oC for 30 minutes to achieve bitterness reduction. The formulation of pulp based milk drink included twelve treatments with three levels (12%,15%,18%) of fruit pulp, two types of stabilizers [Pectin and Carboxy Methyl Cellulose(CMC)], and two types of sweeteners (Cane sugar, Palmyrah sugar). Each sample was heated at 85oC for 20 minutes. The best formulation was selected through sensory evaluation by performing 9- point hedonic scale test using 20 semi-trained panelists and the results were statistically analyzed. The most preferred sample among the twelve treatments contained 15% of fruit pulp, 6% of Palmyrah sugar and 0.2% of CMC stabilizer. Homogenization was done at 10, 000 rpm for 7 minutes for the developed formula to prevent sedimentation and layer separation. The proximate analysis revealed that developed formula is nutritionally superior than commercial sample. The finalized product contained 4.4% of protein, 3.2% of fat, 0.78% of ash, 10.11% of total sugar, 0.29g/100ml of vitamin C and 15.98 GAE mg/L of total phenolic content. The developed product did not show any microbial growth in the analysis of total plate count throughout 4 weeks of storage in the refrigerator.

Keywords: Bitterness reduction, Fruit pulp based milk drink, Palmyrah fruit pulp, Palmyrah sugar, Value addition

I. INTRODUCTION

Palmyrah fruit pulp has been consumed by Asian people in the form of their traditional food items. Palmyrah fruit is a good source of fiber, carotenoids, vitamin C, iron, magnesium, phosphorous, calcium and antioxidants. Another main component of this fruit is flabelliferin which possesses antimicrobial, diuretic and antichloristic activities. Presence of natural color pigments and volatile substances in it eases the formulation of food products with characteristic color and unique flavor. Consumption of fruit pulp helps to control blood glucose level and has cholesterol lowering effect, and anti-cancer effects. As it is a seasonal fruit major fraction of the fruit pulp is wasted annually even though it holds many nutritional and health benefits. Therefore it is essential to find a way to decline the wastage during peak season and preserve the fruit pulp in an efficient manner. There are several ways to utilize the Palmyrah pulp. Production of pulp based milk drink is appealing as there is a growing demand for fruit and milk based products. According to a survey conducted in the year of 2012, 82% of Sri Lankan people consume sugar-sweetened soft drinks once a week or more frequently [2]. Soft drink consumption is increasing and becoming a serious public health issue. It leads to increased energy intake and obesity condition which particularly prevails among children. Soft drink consumption reduces the intake of milk and important nutrients. Soft drinks contain phosphates whereas milk based drinks are good source of calcium. Consumption of phosphate more than calcium will have negative impacts on the bone health. Therefore Consuming adequate calcium during childhood and adolescent period is crucial. Therefore there is a need to reducethe soft drink consumption in order the reduce the health risks. Milk not only provides calcium but also proteins, vitamins A,D,E, B6, B12, thiamin, riboflavin, folate, niacin, biotin and minerals. Fruit based milk drink is a good choice for breakfast as it can be consumed within a few minutes before leaving to school or work. Therefore the development of Palmyrah pulp based milk drink product will be beneficial in terms of improving the nutritional level of people by increasing the consumption of milk based products rather than consumption of unhealthy soft drinks.

II. MATERIALS AND METHODOLOGY

All studies were carried out at Palmyrah Research Institute, Kaithady, Jaffna.

Raw materials

Red skinned Palmyrah fruits were collected from Manipay area which is located about 15 km distant from Palmyrah Research Institute and stored in laboratory refrigerator for further use. Milk was purchased from Yarlco which is the only dairy production unit located in Jaffna. Cane sugar,

Palmyrah sugar, pectin and Carboxy Methyl Cellulose (CMC) were purchased from local market in Jaffna and stored in air tight bags at ambient temperature (27-31oC) and humidity (70-90o).

Preparation of Palmyrah fruit pulp

Red skinned Palmyrah fruit variety was selected for the drink preparation. Fruits were visually observed for any pest attacks, debris or deterioration. Fresh, well ripen fruits free from pest attack were selected, washed well in running tap water and dipped in warm water at about 80oC for about 10 minutes to remove the pathogenic microbial load. Then they were manually peeled off and 100 ml amount of water per seed was added. Then the pulp was extracted by squeezing manually and strained through a sieve to separate it from the fibre parts.

Reduction of bitterness

1. Heat treatment

The strained pulp was heated at 85oC for 30 minutes and foams were eliminated while heating.

2. Acid application

Pulp was treated with different percentage of citric acid to select the most appropriate percentage of acid, taking into consideration the pH level to prevent milk coagulation while preparing the drink. Ten (10) g of pulp was taken in each of five labeled beakers and citric acid was added in the percentage of 0.2, 0.4, 0.6, 0.8, and 1% respectively. pH was measured using portable pH meter (Hach, Germany). According to the readings of pH the pulp was treated with 0.2% of citric acid.

Formulation of Palmyrah pulp based milk drink

Formulation was done with reference to the SLS Standard 917: 1991 specification formilk added drinks. A total of twelve treatments were formulated by changing pulp percentage in three levels (12%, 15% and 18%), adding two types of sweeteners (Cane sugar and Palmyrah sugar) and two types of stabilizers (Pectin and CMC).

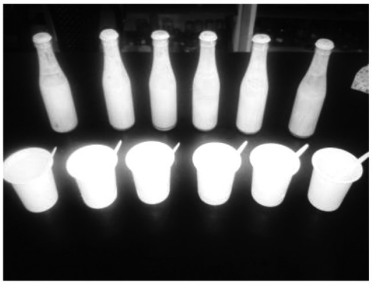

Fig.1: (a) First set of six samples for sensory analysis (b) Finalized sample

Table 1:Formulation of different treatments for the preparation of Palmyrah pulp based milk drink

Treatment No.	Pulp	Milk	Sweetener		Stabilizer	
			Cane Sugar	Palmyrah-Sugar	Pectin	CMC
1	12%	70 ml	5.5 g	-	0.3%	
2	15%	70 ml	5.5 g	-	0.3%	
3	18%	70 ml	5.5 g	-	0.3%	
4	12%	70 ml	5.5 g	-		0.2%
5	15%	70 ml	5.5 g	-		0.2%
6	18%	70 ml	5.5 g	-		0.2%
7	12%	70 ml	-	8.23 g	0.3%	
8	15%	70 ml	-	8.23 g	0.3%	
9	18%	70 ml	-	8.23 g	0.3%	
10	12%	70 ml	-	8.23 g		0.2%
11	15%	70 ml	-	8.23 g		0.2%
12	18%	70 ml	-	8.23 g		0.2%

Development of Palmyrah pulp based milk drink

Each treatment mentioned in the above formulation was prepared according to the following method. Appropriate amount of pre-heated (72oC) milk was taken into a beaker and mixed with Palmyrah fruit pulp. Then sugar and stabilizer were added to it and mixed well. Then the mixture was subjected to homogenization at 10000 rpm for 7 minutes. Then it was heated to 85oC for 20 minutes in a water bath. The temperature was measured using a thermocouple during heating. Meanwhile, 200 ml glass bottles were placed in the oven(Thermo Fisher) and sterilized at 160oC for two hours. After the completion of heat treatment of the sample it was filled into the sterilized bottles and lidded with capping machine. Then it was stored in refrigerator at 4oC.

Selection of most preferred treatment

The most preferred treatment among those 12 treatments was selected through two sets of sensory evaluation. Samples were subjected to sensory evaluation by twenty semi-trained panelist. Nine (9)- point hedonic scale test was carried out for the parameters such as color, flavour, texture, mouthfeel, aftertaste and overall acceptability. The sensory evaluation results were analyzed using SPSS 16.0 software and the best two samples were selected from the two sets considering the mean score for each parameter. Then those two samples were subjected to sensory evaluation by twenty semi-trained panelists using 9- point hedonic scale test to select the best product among those 12 samples.

Selection of homogenization condition

Finalized sample was subjected to homogenization(Homogenizer, Velp Scientifica-OV5)at 10000 rpm for different time periods in order to select most suitable condition in which sedimentation and layer separation is minimized. Four replicates of the finalized sample were subjected to homogenization at 10000 rpm for 1,3,5,7 minutes respectively. These samples were stored in refrigerator for one month and the visual layer separation was observed every week. The condition with which the sample showed least layer separation was selected as the best homogenization condition.

Proximate analysis

Proximate analysis for finalized milk formulation and flavoured milk commercially available in the local market were done to compare the nutritional composition of the two products. Moisture (AOAC 990.19), ash (AOAC 900.02), total sugar [Pearson(1976) and Miller(1959)], reducing sugar[Miller(1959)], fat (AOAC, 920.87), protein (AOAC,955.04), sodium, potassium (Flame photometric method), calcium(EDTA titration method), phosphorous (Spectrophotometric method), Vitamin C content (Redox titration method) and total phenolic content (Spectrophotometric method) were determined.

Microbial analysis

Total plate count (SLS 516 part 1:1991) and yeast and mould count (SLS 516 part 2:1991) were determined for finalized milk sample and flavored milk sample. All analyses were carried out in triplicates.

III. RESULTS AND DISCUSSION

Determining acid percentage for bitterness reduction

pH values for addition of 1.0, 0.8, 0.6, 0.4 and 0.2% citric acid were 4.53, 4.55, 4.59, 4.66 and 4.71, respectively. In order to prevent milk coagulation while adding the pulp, 0.2% citric acid application was selected in which the pH value of the sample was above 4.6 since milk coagulates at pH 4.6. Then the pulp was subjected to heat treatment at 85oC for 30 minutes to reduce the bitterness up to some extent with reference to a previous study in which degree of bitterness was determined by sensory evaluation [5]. Total elimination of bitter compound was not done as it possesses many health benefits.

Sensory evaluation

Table 2 shows the mean score value for the sensory evaluation for the first 6 treatments which have been formulated with pulp percentage as 13%, 15% and 18%, two different type of stabilizers and cane sugar sweetener.Fig. 1 shows the samples used for the first set of sensory evaluation.

Table 3 shows the mean score value for the sensory evaluation of treatments whichhave been formulated with pulp percentage and stabilizer same as in the first six treatments but with a different sweetener.The sample with 12% of pulp with pectin stabilizer was mostly preferred in the first set of sensory evaluation. There were significant differences between samples at 5% level of confidence for the attributes of flavour, appearance, taste, texture, aftertaste and overall acceptability.

Table 2: Sensoryevaluation results for the first set of six treatments

Treatment	Flavour	Appear-ance	Taste	Texture	Aftertaste	Overall acceptabil-ity
1	6.91±0.28	7.55 ± 0.25	7.64 ± 0.15	7.36 ± 0.30	7.73 ± 0.18	7.73 ± 0.18
2	6.55±0.24	6.09 ± 0.36	6.36 ± 0.24	6.09 ± 0.33	6.36 ± 0.26	6.45 ± 0.21
3	6.18±0.19	5.82 ± 0.41	5.91 ± 0.28	5.64 ± 0.41	5.64 ± 0.33	5.73 ± 0.26
4	6.27±0.37	5.91 ± 0.50	6.45 ± 0.31	5.91 ± 0.49	5.64 ± 0.38	5.82 ± 0.33
5	6.55±0.24	6.64 ± 0.24	6.64 ± 0.23	7.00 ± 0.15	6.82 ± 0.19	6.19 ± 0.19
6	7.36±0.28	6.91 ± 0.39	7.36 ± 0.41	7.00 ± 0.39	6.82 ± 0.27	7.18 ± 0.24

(Values are represented as Mean±SD,n=20,p=0.05)

Table 3: Sensoryevaluation results for the second set of six treatments

Treat-ment	Taste	Texture	Aftertaste	Overall acceptability
7	6.73 ± 0.27	6.91 ± 0.25	6.36 ± 0.23	6.64 ± 0.27
8	8.09 ± 0.21	8.18 ± 0.18	8.09 ± 0.53	8.55 ± 0.15
9	7.00 ± 0.30	7.09 ± 0.25	7.09 ± 0.28	7.00 ± 0.27
10	6.36 ± 0.43	6.91 ± 0.28	6.18 ± 0.44	6.55 ± 0.28
11	6.91 ± 0.28	7.00 ± 0.15	6.18 ± 0.51	6.55 ± 0.41
12	6.91 ± 0.39	7.00 ± 0.39	6.55 ± 0.54	6.64 ± 0.41

(Values are represented as Mean±SD,n=20,p=0.05)

In the other set of six samples, sample with 15% of pulp incorporation, CMC stabilizer and Palmyrah sugar was selected. There were differences between samples at 5% level of confidence for the attributes of colour, taste, texture, aftertaste and overall acceptability.

Mean scores for the attributes of taste, texture, aftertaste and overall acceptability were highest for the 8thsample. Mean score for the attribute of colour was highest for the 12thsample which is due to the incorporation of pulp at higher percentage rendering desirable colour to the drink. Taking into account the mean scores for the other four attributes, the 8th treatment was selected as the best sample in the second set. Then both samples which were selected as the best treatment in the two sets were subjected to sensory evaluation. According to the results of the statistical analysis, the sample which was incorporated with 15% of pulp, CMC stabilizer andPalmyrah sugar was selected as the best sample among the 12 treatments. Fig. 2 shows the best sample which has been selected. Here the experimental design helped to maintain a consistency among the samples. The most preferred sample scored higher mean value over the other samples

due to the exotic unique taste of Palmyrah sugar and pulp and also due to the desirable texture and taste formed by the combination of milk, CMC and Palmyrah sugar. It can also be assumed that Palmyrah sugar masks the bitterness which leads to the preference for 15% incorporation of pulp, since in the first set of six treatments 12% pulp incorporation was mostly preferred.

A previous study conducted regarding stabilizers also proved that the yoghurt drink treated with pectin was less preferred over the drink treated with CMC due to the chalky nature of the texture.

Selection of suitable homogenization condition

Four samples which were kept in stable condition were monitored every week for one month and the sample which was exposed to 10000 rpm for 7 minutes was selected by visual observation, as it was free from sedimentation or layer separation and contained a uniform texture. The degree of layer separation and sedimentation was gradually reduced in samples with the increment of time during which the sample was subjected to homogenization.

Physiochemical analysis

According to the results shown in Table 4,there is a significant difference in the pH between finalized milk sample and commercially available sample. This could be due to acid added to reduce the bitterness of pulp during the preparation of finalized sample.

Table 4: Physiochemical parameters of three different samples

Parameters	Finalized milk sample	Commercially available milk sample
pH	5.79± 0.01[b]	6.44± 0.01 [a]
Total soluble solids	17.65 ± 0.01[b]	17.76± 0.00 [a]
Titrable acidity	0.28 ± 0.01[b]	0.16± 0.02[a]
Total solids	22.44± 0.04 [b]	18.43± 0.00 [a]

The pH of the pulp was 4.7 after acid application whereas the pH of fresh milk lies between 6.5-6.7[6]. There is a significant difference in titratable acidity between finalized milk sample and commercially available milk sample. This is because the acidity is lower in commercially available milk whereas pulp itself contains acid and is also treated with citric acid prior to the drink preparation. It has been reported that the acid content of pulp is 0.33%. There is also significant difference in total soluble solid content between the samples. Addition of pulp into the milk could be the reason for the higher value of total soluble solids in finalized milk sample than that of commercially available milk sample as the total soluble solid content of pulp which is 16.5o contributes to the total soluble solids of the formulated drink. The total soluble solid content is lesser in commercially available milk sample perhaps due to some nutrient loss during higher heat treatment.

Proximate analysis

The results of the proximate analysis in Table 5show the finalized sample is significantlydifferent from the commercially available sample in the aspect of nutrient value.

Table 5: Proximate analysis of formulated and commercial samples

Compo-nents	Finalized	Commercial
Moisture	78.65 ± 0.13% [c]	83.58 ± 0.06% [a]
Ash	0.79 ± 0.02% [a]	0.53 ± 0.01% [b]
Fat	3.16 ± 0.02% [b]	3.29 ± 0.05% [a]
Protein	4.30 ± 0.01% [a]	3.31 ± 0.08% [b]
Total Sugar	10.11 ± 0.01% [c]	10.63 ± 0.02% [a]
Reducing sugar	4.73 ± 0.02% [a]	3.83 ± 0.03% [c]
Sodium	26.65 ±0.0mg/100g [b]	53.67 ± 0.02mg/100g [a]
TPC	15.89 ± 0.02 GAE mg/100g [b]	12.66 ± 0.03 GAE mg/1000g [c]
Vit C	298.73 ±.02 mg/100g [a]	99.17 ± 0.04 mg/100g [c]
TSS	17.65 ± 0.01[ob]	17.76 ± 0.00[oa]
pH	5.79 ± 0.01 [b]	6.44 ± 0.01 [a]
Acidity	0.28 ± 0.01 g/l [a]	0.16 ± 0.01 g/l [b]
P	112.57 ± 0.07 mg/100g [b]	86.75 ± 0.03 mg/100g [c]
Ca	281.58 ± 0.02 mg/100ml[a]	103.71 ± 0.15 mg/100ml[c]
K	150.31 ± 0.04mg/100g [c]	348.57 ± 0.04 mg/100g [a]
Total solids	22.43 ± 0.02% [a]	18.44 ± 0.01% [c]

(Means with same letters in the same raw are not significantly different. Values are expressed as mean of three replicates + standard deviation)

Ash, protein, reducing sugar, vitamin C, Total Phenolic Content (TPC), potassium, calcium, and phosphorous contents are higher in finalized sample than commercially available sample. . It is a valuable evidence to prove that the consumption of the formulated sample is far better than the consumption of commercially available artificially flavoured milk. The differences are mainly due to the incorporation of pulp and Palmyrah sugar and different heat treatment. The pulp contains 1.2g ash, 7.74 g of total sugar, 30.74 mg of sodium, 341.85 mg potassium, 266.83mg of phosphorous and 18.95 mg of calcium per 100 g. This enriches the nutrient value and causes the differences in the value when comparing with commercially available milk drink. Heat treatment at 85oC does not affect the protein value negatively. It has also been found that the degree of denaturation of protein is 10% and 70% during pasteurization and UHT treatment respectively [4]. According to Sharma (1980), there would be 6% of lysine loss, 14% of calcium loss and 20% of fat loss when the milk is heated above 100oC. These could be the reason for the significant differences obtained in the proximate analysis for calcium, protein, fat and total solids betweenthe formulated and commercial samples. Normally the heat treatment conditions the two different types of samples were subjected to, does

not bring significant difference in loss of sugar. However, there is significant difference in sugar content between the two samples and this may have resulted by the isomeration of little portion of lactose to lactulose [7]. Vitamin C content is higher in finalized sample than the commercial one. This loss in Vitamin C could be due to the heat treatment as it has been reported that 10-20% of Vitamin C of milk can be lost during UHT processing in a previous research work [4]. When considering the ash amount there was significant difference between the ash content of formulated sample and commercial sample. Ash content in the formulated sample was higher than in the commercial sample. This difference can be attributed to the considerable amount of ash present in the pulp.

Microbial analysis

Based on the results of the microbial analysis, the total plate count did not exceed 10/0.1 ml, up to 4 weeks of storage in the refrigerator, whereas the yeast and mould count was 0.Microbial growth was prevented by the preheat treatment of milk and pulp, heat treatment of the product at 85oC for 20 minutes, hot filling and keeping the conditions sterile during the entire preparation. Heat treatment at 85oC for 20 minutes will inactivate life threatening pathogens and their toxins[3]The microbial growth was not observed until 5thweek for commercially available milk and lesser microbial growth was observed when compared to the finalized sample as the spores of all the detrimental microbes are destroyed during heat treatment above 100oC. Thefinalized sample can be stored for four weeks in compliance with the SLS standard specification for milk added drinks.

IV. CONCLUSION

The present study developed a Palmyrah pulp based milk drink with comparatively higher nutritional value than commercial flavoured milk sample with minimum shelf life of one month. Therefore, this study concludes that value added Palmyrah based milk drink with superior nutritional quality could be produced from locally available, less expensive Palmyrah fruits.

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