PHYSICOCHEMICAL EVALUATION IN THE DEVELOPMENT OF PALMYRAH AND PINEAPPLE MIXED FRUIT TOFFEE

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Abstract
Palmyrah fruits have excellent chemical and physical properties for the development of food and beverages. Unfortunately, Palmyrah fruit pulp contains slightly bitter taste. Pineapple contains slightly acidic pH and emits a sweet aroma which has the ability to mask the bitterness of Palmyrah fruit pulp. The toffees are highly acceptable confectionery products preferred by almost all the age groups as a snack for quick energy. Therefore the main objective of the investigation was to a method to produce a consumer acceptable Palmyrah and pineapple mixed fruit toffee. Five different compositions of toffee were developed by using Palmyrah and pineapple pulp at 100:0, 80:20, 60:40, 40:60, and 20:80 ratio respectively. Two different types (Hard toffee and Soft toffee) were developed by adjusting the ingredients and Brix value. The final formulations were evaluated by using 20 sensory panelists using 5 points hedonic scale. The hard toffee and soft toffee which contained 60 % Palmyrah fruit pulp and 40% Pineapple pulp were selected. Controls for both toffee types were developed by using only pineapple pulp and all the toffee types were evaluated for proximate composition, physicochemical, functional properties and microbial count. It was observed that the developed hard toffee and soft toffee were found better quality with respect to nutritional content and organoleptic quality parameters than the pineapple toffees without Palmyrah fruit pulp.

Keywords: Hard toffee; mixed fruit toffee; Palmyrah; Preserved pulp; Soft toffee

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1. INTRODUCTION

Palmyrah is a tropical palm which belongs to the family Arecaceae and genus Borrasus. Borrasus flabellifer is the most widely distributed Palmyrah palms in Sri Lanka. The distribution of the palm is greater in the Northern Province. Nearly 8% of the world distribution of this palm is found in Sri Lanka (Jansz, 2002). As almost every part of the plant is utilized it is called 'tree of life'. Palmyrah fruit has a great demand in the world due to its medicinal and nutritive values. About 1500 tons of fruits are annually available in Sri Lanka during its seasons (Theivenndirarajah, 2008). Palmyrah pulp, which is obtained from the ripe fruits, has several desirable physical and functional properties such as bright yellow colour, a considerable amount of pectin, fiber, protein, sugar, iron, magnesium, phosphorous, and vitamin C. Moreover, Palmyrah fruit pulp is nutritious and has a yellow colour due to carotenoids which are precursors of vitamin A and therefore it had the potential of being as a source of vitamin A and giving attractive yellow colour to foods. In addition to that, it is revealed that pulp is rich in antioxidant activity and a good source of pectin which could be used to process the fruits into various products (Theivendrarajah, 2008). However, a major portion of the production of the fruits remains underutilized during peak season. The fruit pulp has the potential for value addition and new product development will increase the utilization of the pulp. There are several possibilities to produce a variety of products using the pulp. The fresh fruit has limited shelf life therefore, it is necessary to utilize the fruit for making different products to increase its availability over an extended period and to stabilize the price during the glut season. The blending of different fruit pulp/juice not only

increases the palatability but also improves the quality of beverages. Moreover, there is always a demand from the consumer all over the world for a new product, which should be nutritious and delicacy flavored. The objectives of blending may include the increase in acceptability of product by providing good taste and flavor and up gradation of nutritional quality. Many workers have reported that two or more pulp/ juices may be mixed in various proportions for the preparation of nutritious beverages. Besides, the demands for value-added products of fruits are also increasing worldwide. The confectionery products are highly popular among the children throughout the world due to their taste and flavor. The toffees area popular and highly acceptable confectionery products liked by almost all age groups as a snack for quick energy. Toffees are one of the sugar-based products which are largely consumed by the children. The conventional toffees are generally made from sugar, skim milk powder and other synthetic colors and flavors. Fruit toffee is a nutritional product, has the chewy texture and is a good source of dietary fiber and natural sugar. The toffees can be better utilized as a vehicle to promote consumption and utilization of such fruits that have otherwise less market demand and quite limited shelf life. Palmyrah and Pineapple are important fruits of tropical and subtropical countries of the world. Both the fruits are available in plenty during the winter season. Unfortunately, Palmyrah fruit pulp contains slightly bitter taste, has not fetched higher income as its bitterness is not highly appealing which limits its commercial exploitation both at the consumer as well as processing level. But pineapple contains slightly acidic pH and emits a sweet aroma which is pleasant and refreshing acidic in flavour. Therefore, the blending of both Palmyrah pulp and pineapple pulp product could be an economic proposition to utilize them profitably as pineapple is one of the common fruits with characteristics taste.

There is a good possibility of enhancing the flavour and acceptability of the Palmyrah product by diversification i.e. by using blending technology. As the pineapple fruits have soft pulp to melting while the flavour is very pleasant with excellent quality can be mixed with the pulp of Palmyrah fruit having orange-red colour to give a quality product after blending. This shows the pulp compatibility and suitability for blending and making mixed fruit toffee product not only have chemical but physical characters too. The mixed fruit toffee of these fruits has high nutritive value, good taste, appearance, and liking for the children, women, and others. Thus the preparation of pineapple and Palmyrah pulp with simple technology and its utilization in the form of mixed fruit toffee have the great scope. Therefore in the present study efforts were made to develop nutritious and palatable Palmyrah and pineapple mixed fruit toffee and to evaluate its quality.

2. MATERIALS AND METHODS

Palmyrah fruits were collected from Manipay area which is located about 15 km distance from Palmyrah Research Institute and stored in laboratory refrigerator for further use. Pineapple fruits were obtained from a local market in Tirunelveli, Jaffna. Cane sugar, margarine, salt and milk powder were purchased from a local market in Jaffna and stored in airtight bags in ambient temperature and humidity.

2.1 Extraction of Palmyrah fruit pulp

Black skinned Palmyrah fruit variety was selected for the toffee preparation. Fruits were visually observed for any pest attacks, debris or deterioration. Fresh, well ripe pest attack free fruits were selected, washed well in running tap water and dipped in warm water at 80oC for 10 minutes to remove the pathogenic microbial load. Then the outer cover was peeled off and the pulp was extracted by squeezing manually and strained through a sieve to separate it from the fiber parts.

2.2 Extraction of Pineapple fruit pulp

Fully matured Pineapples were selected for toffee preparation. Fruits were visually observed for any pest attacks, debris or deterioration. Fruits were washed in running water. Then they were manually peeled and cut into small pieces then ground. The pulp was squeezed and sieved by muslin cloth.

2.3 Standardization of Palmyrah, Pineapple mixed fruit toffee.

A formulation was done according to the Sri Lanka Standards. Five treatments were formulated by changing the ratio of Palmyrah pulp: Pineapple pulp such as 100: 00, 80: 20, 60: 40, 40: 60, and 20:80. Two types of toffees, such as hard toffee and soft toffee were developed according to the above formula. Sensory evaluation was conducted to select most preferred formulation for hard toffee and soft toffee separately.

2.4 Preparation of Mixed Fruit Toffee

Table 1: Ingredients levels in toffee formulations

Ingredients	Soft Toffee (%)	Hard Toffee (%)
Palmyrah fruit pulp	36.28	24.96
Pineapple fruit pulp	24.18	16.64
Sugar	30.23	41.60
Milk powder	3.02	16.24
Margarine	6.35	-
Salt	0.24	0.17

2.5 Preparation of Mixed Fruit Hard Toffee

Palmyrah and pineapple pulp were mixed according to the formula. The pulp mixture was heated until concentration became 1/3 of its original volume. Then sugar (100g) was added and concentrated up to Total Soluble Solids (TSS) reached 650–700. Milk powder (40g) was dissolved in little quantity water and made a thick paste. Milk paste was added to the pulp and sugar mixture. Salt (0.4g) was mixed with small quantity of water then added to the mixture. The mixture was heated up to TSS reached 900 –920. Then heated mass was spread a thin sheet of 1cm to a 2cm thickness stainless steel plate, which was already smeared with fat. This was allowed to cool and set for 2 to 3 hours. The solid sheet was cut into cubes of 1.5cm to 2.5cm with a stainless steel knife and wrapped in butter paper and store in polyethylene pouches.

2.6 Preparation of Mixed Fruit Soft Toffee

Palmyrah and pineapple pulp were mixed according to the formula. The pulp mixture was heated until concentration became 1/3 of its original volume. Then sugar (50g) was added and concentrated up to Total Soluble Solids (TSS) reached 650 – 700. Milk powder (5g) was dissolved in little quantity water and made a thick paste. Milk paste was added to the pulp and sugar mixture. Then 10g of margarine was added to the mixture and salt (0.4g) was mixed with small quantity of water then added to the mixture. The mixture was heated up to TSS reached 830 – 850. Then heated mass was spread a thin sheet of 1cm to the 2cm thickness in stainless steel plate, which was already smeared with fat. This was allowed to cool and set for 2 to 3 hours. The solid sheet was cut into cubes of 1.5cm to 2.5cm with a stainless steel knife and wrapped in butter paper and store in polyethylene pouches.

2.7 Physico-chemical, antioxidant and microbial analysis

The toffees prepared with a various combination of Palmyrah and Pineapple pulp were evaluated for various physicochemical properties like moisture, TSS, pH, acidity, reducing sugars, total sugars, ascorbic acid, crude protein, crude fat and crude fiber according to the Official Method of Analysis of AOAC International (2016). Total plate count and yeast and mold were tested for selected toffees according to Sri Lankan Standard (516 Part 1: 1991). Water activity was determined by using water activity meter. Total phenolic content and the DPPH radical scavenging was determined according to the method described in Gunathilake and

Ranaweera (2016) with some modifications described in Gunathilake et al. (2018).

2.8 Sensory evaluation of toffees

The sensory evaluation of Palmyrah and Pineapple mixed fruit toffees were carried out according to the method described by Larmond (Larmond, 1977). The mean score of minimum 10 semi-trained judges for each quality parameter viz., colour and appearance, texture, taste, flavour and overall acceptability was recorded.

2.9 Statistical analysis

The data obtained in the present investigation was analyzed using Minitab 13 software at 95% confidence interval and pairwise compared by using LSD (Least Significant Difference) test. For all the analyses, the alpha error was set at 0.05%.

3. RESULTS AND DISCUSSION

3.1 Sensory quality

Sensory evaluation results revealed a selection of the best composition of Palmyrah: pineapple for the development of mixed fruit toffee. The data presented in Figure 1 indicated the first sensory evaluation for the selection of appropriate composition for the development of hard toffee.

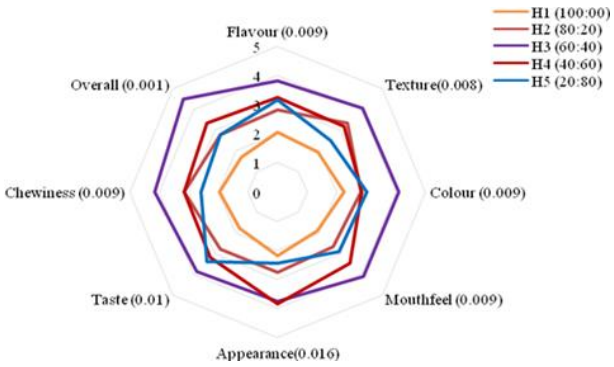

Figure 1. Spider-web analyses of sensory attributes median score for pulp combinations to select best hard toffee type

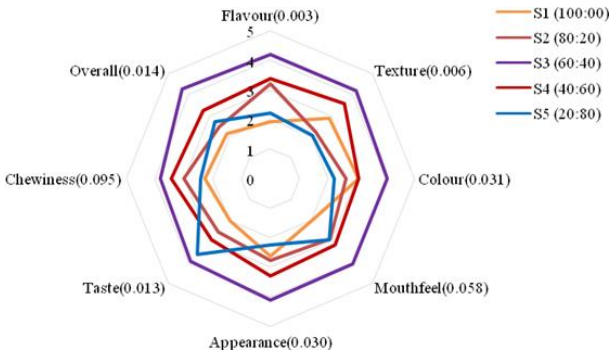

Figure 2. Spider web analyses of sensory attributes median score for pulp combinations to select best soft toffee type

The flavor, mouthfeel and overall acceptability scores of mixed fruit toffee prepared by a composition of Palmyrah: pineapple at 60:40 was comparatively higher than other composition.

The data presented in Figure 2 indicated the sensory evaluation for the selection of appropriate composition for the development of soft toffee.

According to the results of sensory evaluation Palmyrah: pineapple at 60:40 mixed fruit toffee was selected as best composition because it was scored the highest average ranking score for their all the sensory attributes.

Table 2. Proximate composition of developed fruit toffees

Composition (%)	Hard toffee	SD	Hard toffee control	SD	Soft toffee	SD	Soft toffee control	SD	p-value
Total Sugar	63.51	2.64	67.46	1.99	42.45	1.01	11.70	0.21	0.000
Reducing Sugar	6.49	0.05	6.83	0.82	5.21	0.19	5.12	0.13	0.002
Moisture	6.26	0.09	7.31	0.10	9.35	0.19	11.70	0.21	0.000
Protein	4.40	0.03	4.35	0.07	1.77	0.02	3.23	0.07	0.000
Fiber	1.53	0.23	0.92	0.10	1.94	0.23	1.01	0.12	0.001
Ash	1.43	0.07	0.97	0.10	1.75	0.07	1.39	0.27	0.002
Fat	8.61	0.25	7.99	0.10	14.43	0.06	14.60	0.26	0.001

Potassium	0.29	0.00	0.33	0.00	0.28	0.00	0.18	0.00	0.000
Sodium	0.21	0.00	0.32	0.01	0.35	0.01	0.17	0.00	0.000
Phosphorous	0.18	0.00	0.17	0.01	0.10	0.02	0.10	0.01	0.000
Iron	0.34	0.04	0.41	0.04	0.38	0.04	0.40	0.00	0.116

Each value in the table is represented as mean ± SD (n = 3)

Proximate analysis was done to determine the nutritional value of toffee types. Hard toffee contains a significantly low amount of moisture than hard toffee control. That is may be due to the high moisture content of pineapple fruit. It was reported that the moisture content of commercial toffees ranged from 8.3 to 8.8 % (Jain et al, 1958). Hard toffee significantly differed from hard toffee control in crude fat and ash. Crude fiber content and ash contents were high in hard toffee due to the addition of Palmyrah pulp. But total sugar content and reducing sugar content were significantly not shown any difference. Both were high in hard toffee control.

When considering the soft toffee, the moisture content of soft toffee was significantly lower than the soft toffee control. Soft toffees significantly differed from soft toffee control in crude protein content also. Total sugar, reducing sugar, crude fat, crude fiber, and ash contents were not shown any significant difference between two toffee types. The ash content is inorganic residue remaining after the organic matter has been burnt away. It is not necessarily of exactly the same composition as the mineral matter present in the fresh Palmyrah pulp as there may be losses due to volatilization or some interactions between constituents. Mineral content of formulated toffee types was measured for potassium, sodium, phosphorus, iron. The ascorbic acid content of palmyrah pulp and pineapple pulp were 16 mg, 24 mg respectively (Murthy and Prasad, 2015; Hossain et al, 2015). But the ascorbic acid content of developed hard toffee and soft toffee were 0.09mg, 0.06mg respectively. Heat treatment of processed products may cause loss of vitamin C.

3.3 Anti-oxidant properties

The results for the anti-oxidant property of Palmyrah and Pineapple mixed fruit toffees are presented in Table 3.

Table 3. Total phenolic content and antioxidant activities of toffees

Antioxidant activity	Soft toffee	Hard toffee
Total phenol(mg/100g)	318.49±1.25	589.19±6.79
DPPH radical scavenging activity(mg/ml)	1.48±0.34	1.28±0.07

The antioxidant activities are different between the toffee types. DPPH is an extensively used substrate to evaluate antioxidant activity especially for investigating the free radical scavenging activities of biological as well as chemical substances (Gunathilake & Ranaweera, 2016). The total phenolic content of the developed hard toffee and soft toffee were lower than the controls.

3.4 Physico-chemical properties

The results for the physico-chemical composition of Palmyrah and Pineapple mixed fruit toffees are presented in Table 4. The pH of fresh Palmyrah fruit pulp ranged between 5.5-6.0 (Kerawala et al, 1993). The reduction in pH was mainly due to the addition of pineapple fruit pulp. TSS of developed hard toffee and soft toffee were o92 and o83 respectively. TSS content of developed toffee types indicated the sugar content of processed products in soluble form.

The water activity of developed hard toffees significantly differed from their controls. The water activity of soft toffee and soft controls showed no significant difference. aw of any product, if higher than 0.49, usually requires better packaging materials such as high water barrier materials. The water activity recorded for 6 weeks storage was too low for bacteria growth; however water activity of 0.6 and above can encourage the growth of some molds and yeasts. The salt and sugar contained in the toffees would have some influence on lowering

the water activity and tends to create conditions hostile to microbial growth (Jain et al., 1958). High sugar products are their low water activity (aw) will inhibit the growth of most spoilage and pathogenic (bacteria. Thompson, 2009)

Table 4. Physico-chemical properties of toffees

Physico-chemical properties	Soft toffee	Hard toffee
Total soluble solids%	83	92
pH	4.9	5.2
Total acidity%	0.43	0.54
Water activity	0.56	0.41
Ascorbic acid content %	0.01	0.08

3.5 Microbial analysis

This present study shows that there was no growth of bacteria, yeast, and mold during six weeks of storage where the product was kept in vacuum packaging at room temperature (30 ± 2°C). It is confirmed that the products are safe for human consumption.

4. CONCLUSION

The present study is developing palmyrah/pineapple mixed fruit toffee. In this study, pineapple pulp has been used as a masking agent for the bitterness of palmyrah pulp. In both hard toffee and soft toffee, Mixing of Palmyrah: Pineapple at 60:40 ratios were identified as the best method to produce a nutritious and consumer acceptable Palmyrah/pineapple mixed fruit toffee. Hard toffee and soft toffee significantly differed from the control toffees in the proximate composition, physicochemical parameters, and the functional properties. The products are safe from microbes until six weeks from the week when the product was developed. The developed toffee types have to be analyzed for its vitamin profile and further experiments are essential for the determination of the shelf life.

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