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Preservation of Palmyrah Haustorium, Young Fruit Kernel and Boiled Tuber with Lengthen Shelf-Life Consisting their Native Characters

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ABSTRACT

Though Palmyrah haustorium, young fruit kernel and boiled tuber are known as the important sources of nutrition and anti-oxidants to humans, these are seasonable products. To ensure the availability of these products in the international market throughout the year, they must be preserved with lengthen shelf life. When different concentrations of preservation media, chemical preservatives and different pasteurization temperatures were used at room temperature, sucrose media at isotonic level to their tissues showed better performance with 120 days shelf life at pasteurized temperature 90°C with 15 °Brix medium of Palmyrah haustorium whereas at pasteurized temperature 80°C with 10 °Brix medium in young fruit kernel. But boiled tuber sample preserved in pure 1% sodium chloride solution at both pasteurized temperature 80°C and 100°C were selected as better with respect to overall acceptability for 90 days at room temperature.

Keywords: Palmyrah, Haustorium, Tuber, Young fruit kernel, Preservation

INTRODUCTION

Palmyrah (*Borassus flabellifer*) is an ancient palm belonging to the family Palmae and sub family Boracidae. It possesses a great capacity to yield several products of economic importance and hence it is called “Wishing tree” which means a palm that yields anything and everything. Almost every part of the palm is utilized [1].

Palmyrah fruit has a great demand in the world due to its medicinal and nutritive values. Around 1500 tons of fruits are annually available in Sri Lanka during its seasons when inflorescences of the female palm become mature, they start to bear fruits. A palm may give 200-300 fruits for a season. The fruiting season is between September and October [2]. The fruit is large, fibrous and usually contain three nuts like portion with a seed enclosed in each of them. The palmyrah young fruit kernel contains a lining of gelatinous endosperm or kernel with some sweet tasting water inside a hard shell. The endosperm is known as “Nungu”, the Tamil word for palmyrah young fruit kernel. In mature fruits the endosperm becomes harder under favourable conditions.

Palmyrah fruits mature during the month of August and the ripened fruits fall from the tree during September and October. After utilization of palmyrah fruit pulp the seeds along with the remaining fruits are collected then beds are made with 3 or 4 tiers of seeds and their moisture level is maintained adequately [1].

During germination shoot-root axis of the seed goes to the ground and the distal portion which remains within the seed develops into the haustorium during and following germination.

Palmyrah haustorium which is a delicious white, spongy edible part and the seed produces a shoot which gives rise to the product palmyrah tuber. This shoot grows to 20-30 cm in height before it is harvested. As a general practice, palmyrah tubers are harvested at their full maturity stage [3].

Palmyrah young fruit kernel, haustorium and fresh boiled tuber are full of nutrition [2]. In addition to nutritional importance, they are also being recognized as having total phenolic content and vitamin C which show anti-oxidant properties [4].

Therefore increasing consumption of these palmyrah products will help the people to maintain their dietary requirements and prevent the chronic diseases such as cancer, cardiovascular diseases, age-related pathologies and promote overall health [3].

However, palmyrah young fruit kernel, haustorium and fresh boiled tuber are available for particular season. These seasonable palmyrah products are consumed in raw and fresh form and the consumers who enjoy those products are expecting throughout the year. Therefore preservation method was adopted to lengthen the shelf life of these seasonable products.

Consumers increasingly require food products that preserve their nutritional value, retain a natural and fresh colour, taste, flavour and texture and contain fewer additives such as preservatives. Canning may be considered as one of the preservation tools to preserve the nutritional and sensory qualities demanded by consumers.

MATERIALS AND METHODS

Materials

Sodium metabisulphite-Food grade (E223), Sodium benzoate-Food grade (E211) and Citric acid-Food grade (commonly available in local market) and glass bottles.

Equipments

Water bath (GEMMYCO), Refractometer (HSR500, Japan), pH meter (Sension PH 31-Spain).

Methods of analysis

Determination of total soluble solids (TSS)

Total soluble solids of the sample were determined directly by using Refractometer at room temperature and expressed its value in ˚Brix.

Determination of pH

The pH of the preservation medium was determined by using a calibrated digital pH meter at room temperature.

Sensory evaluation

The method described by Larmond [5] was used to evaluate the sensory characteristics such as firmness, flavour, appearance, colour, mouth feel, texture and overall acceptability using a scale from 1 to 5, where 1 represented extremely disliked and 5 represent extremely liked.

Determination of microbial count

The method of Sri Lankan Standard: 516 Part 1: 1991 was used.

Statistical analysis

All data obtained were subjected to statistical analysis (ANOVA), 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%. Friedman non-parametric statistical method was also used to analyse the sensory evaluation data based on 5-point hedonic scales.

Preservation method

The current study aimed to optimize the effect of soluble solid of medium for preservation, chemical preservatives such as sodium benzoate and sodium metabisulphite and different pasteurization temperature on the keeping quality of Palmyrah haustorium, young fruit kernel and boiled tuber.

Preservation of palmyrah haustorium

Determination of total soluble solid (°Brix) of cellular extract of fresh haustorium

Cellular extract of the haustorium was taken by manual gentle squeezing and the °Brix value was determined directly by using Refractometer.

Preparation of the medium for preservation

Sugar solutions at two different concentrations were prepared for comparison of the effect on preservation. Sucrose was dissolved in distilled water to make the medium for preservation with desired °Brix values and then the pH was adjusted to 3.8 by using citric acid.

Comparison the effect of preservatives in the preservation of palmyrah haustorium

Sugar solutions were prepared with fixed concentration of sodium benzoate or sodium metabisulphite separately in to sterilized glass bottles. Fresh haustorium (140 g) removed from seeds were transferred into the sugar solution (300 ml) to cover them fully and pasteurized at 80°C for 30 min and stored at room temperature. Control sample was not treated with any preservative. After the treatment, observation was made on the samples at fixed time interval.

Effect of different pasteurization temperature in the preservation

Fresh haustorium (140 g) was transferred into the sugar solution (300 ml) containing fixed concentration of selected preservative to cover them fully and pasteurized at different temperatures (70°C, 80°C and 90°C) separately for 30 min, sealed with parafilm and stored at room temperature. Control sample was not undergone pasteurization treatment. pH of the media, microbiological observation, physicochemical characteristics analysis and organoleptic evaluation were made on sample in 30 days interval.

Preservation of palmyrah young fruit kernel

Total soluble solid of the fresh young fruit kernel (°Brix)

By gentle pressing the fruit kernel, fluid was taken and the °Brix value was determined directly by using Refractometer.

Preparation of the medium for preservation

Same preparation technique was followed as indicated in the preservation of haustorium.

Effect of pasteurization temperature in the preservation of palmyrah young fruit

In the case of young fruit kernels, same procedure was followed up as described above.

Preservation of palmyrah boiled tuber

Preparation of the medium for preservation

Common salt (sodium chloride) was dissolved in distilled water to make medium for required concentration then the pH was adjusted to 3.8 by using citric acid. Preservative was added to reach the required concentration.

Effect of pasteurization temperature in the preservation of palmyrah boiled tuber

The prepared salt solution (300 ml) was taken in each sterilized clear glass bottles and boiled tubers (150 g) were immersed in to the medium for preservation in each bottle then pasteurized at different temperature (70°C, 80°C, 90°C and 100°C) separately for 30 min. Then sample were sealed with parafilm and stored at room temperature. Control sample was not treated with heat. The analysis of organoleptic, microbiological and physicochemical was done in prior at 30 days interval.

RESULTS AND DISSCUSSION

Palmyrah edible raw products are full of nutrition and medicinal value. Increasing consumption of these palmyrah products will help the people to maintain their dietary requirements and prevent them from chronic diseases, cardiovascular diseases and age-related pathologies and promote overall health [4]. However these products are available for particular season. Therefore it is necessary to preserve these seasonable palmyrah products over the year.

This chapter deals with the results obtained and discussions made on the effect of concentration of preservation medium, chemical preservatives and pasteurization temperature on lengthening the shelf life of Palmyrah haustorium, young fruit kernel and boiled tuber. The results obtained from the analysis of pH, TSS, microbiological and sensory observations are tabulated, analysed statistically and discussed here in details.

Preservation of haustorium

Determination of total soluble solid (˚Brix) of cellular extract of fresh haustorium

The °Brix value 14.98 was obtained for the fresh haustorium.

Preparation of the medium for preservation

Sugar solutions of 10 °Brix and 15 °Brix were prepared for the medium for preservation. The reason behind this is to select 15 °Brix is to avoid either hypertonic or hypotonic effect in the haustorium where size and shape of haustorium might have been changed due to osmosis. But for comparison low brix medium was used. If there was any advantage in using low brix, which make the process is feasible in large scale and also suitable for people suffering from diabetes. But isotonic medium (15 °Brix) showed better effect for preservation rather than the other.

Comparison of the effect of preservatives in the preservation of palmyrah haustorium

Fresh haustoriums were immersed in sugar solution having 15 °Brix which contains 0.05%, w/v of sodium metabisulphite or sodium benzoate and then pasteurized at 80°C for 30 min. According to the observation control a sample which was free from preservative spoiled up within one week. Samples which were treated along with sodium benzoate were turned up to brown colour during 60 days of storage interval while sample treated with sodium metabisulphite was found unchanged. So it proved that the usage of latter was good to keep the samples with their original colour during the storage.

Sodium metabisulphite also has numerous functions such as antimicrobial agent, antioxidant, anti-browning agent and colour stabiliser. It helps to maintain the sample as fresh form [6].

Effect of different pasteurization temperature in the preservation of palmyrah haustorium

On the pH of medium for preservation

The results indicated the effect of the different pasteurization temperature on the pH value during the period of storage. pH of the control sample which was not under gone pasteurization changed from 3.92 to 2.66 within four days.

From the Table 1, it is observed that the pH of the medium containing the sample H1 dropped from 3.92 to 2.79 during two months storage. pH of the medium containing the samples H3, H4 and H5 decreased with three months of storage whereas pH of the medium containing samples H2 and H6 was about stable between 3.80 and 4.10 until the end of storage.

An ANOVA test was done; a p-value of less than 0.05 was obtained. This indicates that the pH of medium containing the different samples were significantly different from each other between the storage period. While in pair wise comparisons of the pH values of medium containing samples H2 and H6 were not significantly different from each other up to 120 days of storage.

Table 1: Effect of pasteurization temperature on pH of medium for preservation

Sugar concentration of preservation medium (°Brix)	Treatment	Pasteurization Temperature (°C)	pH			
			Period of Storage (days)			
10	H1	70	4.24	3.84	2.79	2.54
	H2	80	4.04	4.01	3.97	3.85
	H3	90	4.28	4.18	3.38	3.1
15	H4	70	3.87	3.9	3.64	3.34
	H5	80	3.89	3.74	3.59	3.4
	H6	90	3.9	4.01	4.02	4.03

On the total soluble solid, TSS of medium for preservation

Table 2 reveals that the TSS of the preservation medium of the containing samples H1, H2 and H3 were slightly increased up to a storage period of 120 days. Maximum increase in Brix was observed in medium containing sample

H2 when compared with others. This increase in TSS may be due to either diffusion of sugar molecules or water enters into haustorium on endosmosis in all treatments. An ANOVA test was done on °Brix value; a p-value of less than 0.05 was obtained. This indicates that the °Brix value for the different samples were significantly different from each other in medium containing sample H1-H3. While there is no significant changes were observed in samples medium of H4-H6 between storage days because of the effect of isotonic medium used.

Table 2: Effect of pasteurization temperature on TSS in the medium for preservation

Concentration of preservation medium (°Brix)	Treatment	Pasteurization Temperature (°C)	Total soluble solid (TSS)			
			Storage (days)			
			30	60	90	120
10	H1	70	10.02	10.14	10.28	10.4
	H2	80	10.03	10.15	10.23	10.8
	H3	90	9.98	10.08	10.16	10.2
15	H4	70	14.85	14.85	14.9	14.98
	H5	80	14.8	14.85	14.87	14.9
	H6	90	14.8	14.8	14.85	14.9

On color of preserved hastorium

Table 3 reveals that there was no remarkable colour change found in the all preserved haustoriums until the end of the storage days. Sulphur dioxide prevented enzymatic and non-enzymatic browning reactions resulting in retention of the white colour throughout the storage period.

Table 3: Effect of pasteurization temperature, on colour of preserved hastoriums

Concentration of preservation medium (°Brix)	Treatment	Pasteurization Temperature (°C)	Color Alteration			
			Storage (days)			
			30	60	90	120
10	H1	70	No change	No change	No change	No change
	H2	80	No change	No change	No change	No change
	H3	90	No change	No change	No change	No change
15	H4	70	No change	No change	No change	No change
	H5	80	No change	No change	No change	No change
	H6	90	No change	No change	No change	No change

Microbiological test

For the presence of thermophilic bacteria, yeast and molds test was carried out. The results indicated no growth of any type of microorganism above 80°C up to 120 days period of storage. This proved the effectiveness of the preservative and heat treatment applied.

Sensory evaluation

The analysis of the data showed in the Table 4 that storage period and treatments had a significant effect on overall acceptability (obtained from color, flavor, consistency and overall acceptability) of the preserved haustorium samples. Overall acceptability score for H2 and H6 are high when compared with other samples while H4 showed very less score. It was recorded that control samples were spoiled soon after storage and resulted in producing off

flavor, maximum loss in color and overall acceptability while the treated samples retained comparatively better quality for longer period.

Table 4: Different treatments and their median value of sensory analysis at 120 days of storage

Characteristics	Treatment					
	H1	H2	H3	H4	H5	H6
Firmness	3.8	4.4	3.9	3.1	3.9	4.6
Flavour	3	4.3	3.4	3	3.1	4.5
Appearance	3.2	4.5	3.3	3.3	3.3	4.3
Mouth feel	2.5	4	3	3	3	4.2
Texture	3.1	4.5	3.6	2.6	3.4	4.6
Colour	3.3	4	3.5	3.5	3	4.4
Overall acceptability	3.2	4.2	3.8	3.1	3.4	4.6

The experiment was successful in preserving the sample in sugar solution of 10 °Brix pasteurized at 80°C and sugar solution of 15 °Brix pasteurized at 90°C. However isotonic level preservation possess better natural taste and texture. It is proved that natural property cannot be changed in isotonic level preservation. Therefore isotonic level preservation is the most preferable in the preservation of palmyrah haustorium.

Preservation of palmyrah young fruit kernel

Total soluble solid of the fresh young fruit kernel

From the reading of the Refractometer °Brix value 8.92 was obtained for fresh young fruit kernel.

Preparation of the medium for preservation

Two different Sugar solutions (10 °Brix and 15 °Brix) were prepared as described in medium preparation of haustorium.

Effect of pasteurization temperature in the preservation of palmyrah young fruit kernel

pH of medium for preservation

Table 5 explained pH of medium for preservation of all samples were gradually increased during the 120 days of storage period. Due to the pH stabilization effect, this result might have been observed. Hydrogen ions penetrate inside the kernel therefore pH was increase in the immersion solution [7]. But it is proved that pH did not change beyond 5.90. Unpasteurized sample was spoiled up within four days.

Table 5: Effect of pasteurization temperature in the pH of medium for preservation

Concentration of medium for preservation (°Brix)	Treatment	Pasteurization Temperature (°C)	pH			
			Period of Storage (days)			
10	H1	70	5.16	5.3	5.83	5.85
	H2	80	5.2	5.44	5.56	5.58
	H3	90	5.28	5.34	5.37	5.74
15	H4	70	5.42	5.48	5.79	5.8
	H5	80	5.28	5.3	5.51	5.54
	H6	90	5.3	5.32	5.35	5.9

While in the present study, to avoid the contamination, time for stabilization was not given. Otherwise contamination might have been not happened in the process. In future, it must be taken into consideration that the pH of the medium for preservation should be stabilized below 3.5 or little lower level in this type of research.

Further, an analysis of variance (ANOVA) was done to assess samples variation of the pH; a p-value of less than 0.05 was obtained, indicating that the pH values were significantly different for the different samples.

TSS in preservation medium

As shown in Table 6, TSS of all samples was gradually decreasing significantly up to a storage period of 120 days. According to the ANOVA test there was significant difference ($p<0.05$) for all different samples. This might be due to either movement of the sugar molecules to maintain the equilibrium stage of solute concentration or osmotic effect.

Table 6: Effect of pasteurization temperature on TSS in the preservation medium

Concentration of medium for preservation, (˚Brix)	Treatment	Pasteurisation temperature (℃)	Storage (days)			
			30	60	90	120
10	K1	70	9.98	9.86	9.43	9.04
	K2	80	10.02	9.86	9.28	9.19
	K3	90	10.04	10	9.34	9.15
15	K4	70	14.9	14.16	13.77	11.67
	K5	80	15.01	14.89	13.05	11.11
	K6	90	15.05	14.96	13.1	12.05

Color of preserved kernel

Table 7 reveals that there was no remarkable color change recorded in the preservation of kernel.

Table 7: Effect of pasteurization temperature on colour of the preserved kernel

Concentration of preservation medium (°Brix)	Treatment	Pasteurisation temperature (°C)	Storage (Days)			
			30	60	90	120
10	K1	70	No change	No change	No change	No change
	K2	80	No change	No change	No change	No change
	K3	90	No change	No change	No change	No change
15	K4	70	No change	No change	No change	No change
	K5	80	No change	No change	No change	No change
	K6	90	No change	No change	No change	No change

Microbiological test

Preservation of haustorium and young fruit kernel followed the same trend. No growth of any type of microorganism was found in medium at pasteurized above 80°C.

Sensory evaluation

Table 8 shows that during the sensory evaluation, samples H2 and H6 were appreciated by all the testers. Therefore, both sugar solutions were considered successfully in this experiment. However isotonic level of preservation is most favourable, to keep their sensory characteristics throughout storage in the preservation of palmyrah young fruit kernel.

Table 8: Effect of different treatments on median value of sensory analysis at 120 days of storage

Characteristics	Treatment					
	K1	K2	K3	K4	K5	K6
Firmness	4	4.6	3.9	3.1	3.8	4.4
Flavour	3	4.7	3.4	3.2	3.1	4.5
Appearance	3.2	4.3	3.3	3.3	3.3	4.3
Mouth feel	2.5	4.2	3	3	3.2	4
Texture	3.1	4.5	3.6	2.8	3.4	4.5
Colour	3.8	4.6	3.2	3.5	3	4
Overall acceptability	4	4.8	4	3.2	3.6	4.4

Preservation of palmyrah boiled tuber

Preparation of the medium for preservation

The tissue of the tuber is very stiff. It was unable to extract the fluid of the tuber. Therefore measuring the brix value is not easy in laboratory condition. Most of the people prefer less salt concentration for better palatability. Hence arbitrarily 1% of salt concentration medium was prepared to enhance the taste as well as to delay the detoriations. Nayak et al. [8] reported that Alona fruits were preserved successfully in 2% of salt solution. This study also followed the same trend but with reduced concentration.

Effect of pasteurization temperature in the preservation of boiled tuber

pH of medium for preservation

Table 9 shows, the pH of each sample was suddenly increased within one month then a gradual decreasing in pH level was observed during 120 days of storage. Sample T1 spoiled during 60 days of storage. Action of the preservative persisted below 4.5, which has been also been confirmed by several researchers. Most of the consumers appreciated the research work by this simple method which might be more applicable for the large scale application. It is better to repeat this experiment with an alternative method such as stabilizing the pH below 3.5. Stabilization of pH might improve lengthen shelf life.

According to the ANOVA test, p-value was obtained less than 0.05 indicating that the pH for the different samples was significantly different from each other. Least Significant difference (LSD) was further used for pairwise comparisons of the pH for the samples and it was observed that samples T2 and T4 were insignificantly different from each other.

Table 9: Effect of pasteurization temperature on pH of medium for preservation

Treatment	Pasteurization temperature, (°C)	Storage (days)			
		30	60	90	120
T1	70	5.35	5.24	3.39	2.84
T2	80	5.33	5.35	5.06	4.79
T3	90	5.31	5.31	5.15	4.49
T4	100	5.34	5.34	5.05	4.45

Color of boiled tuber

According to the Table 10 there was no particular change in the color of preserved tuber samples were observed. This might be due to presence of sulphur dioxide blocked the enzymatic and non-enzymatic browning reactions.

Table 10: Effect of pasteurization temperature and sodium metabisulphite on color of boiled tuber

Treatment	Pasteurization temperature (°C)	Storage (Days)			
		30	60	90	120
T1	70	No change	No change	No change	No change
T2	80	No change	No change	No change	No change
T3	90	No change	No change	No change	No change
T4	100	No change	No change	No change	No change

Microbiological evaluation

Microbiological test was carried out for the presence of thermophilic bacteria, yeast and molds. The result indicated unpasteurized sample was spoiled within four days of storage and no growth of any type of microorganism in glass bottles which were pasteurized above 80°C, up to end of storage. Sodium metabisulphite releases SO_2 gas when added to water, SO_2 kills yeasts, fungi and some bacteria and also it acts as an antioxidant. This indicated the advantages of the heat treatment and preservative applied too.

Sensory evaluation

The data presented in Table 11 indicated that treatments T2 and T6 have high score in all the sensory quality parameters than other. The taste, flavour, texture, mouth feel and overall acceptability of these preserved tubers were good. It was recorded that control samples were spoiled soon after beginning of storage while the treated samples maintain better quality for longer period. The preservation of tuber is quite successful only for 90 days. For further shelf life experiment should be repeated.

Table 11: Different treatments and median value of sensory analysis at 90 days of storage

Characteristics	Treatment			
	T1	T2	T3	T4
Firmness	3.9	4.5	4	4.4
Flavour	3	4.3	3.1	4.2
Appearance	3	4.1	3	3.9
Mouth feel	2.3	4.1	2.4	4
Texture	2.8	4.4	3	4.3
Colour	3.7	4.4	3.8	4.4
Overall acceptability	3.1	4.6	3.3	4.5

CONCLUSION

From this research, it was concluded that the isotonic solution was suitable for both Palmyrah haustorium (H6, 15 °Brix) and young fruit kernel (K2, 10 °Brix) as it successfully enhanced the organoleptic characteristics and shelf life of the product for 120 days at room temperature. In the case of boiled tuber, sample preserved in pure 1% sodium chloride solution at pasteurized 80°C and 100°C were selected as better with respect to overall acceptability for 90 days at room temperature.

It was found that isotonic level preservation with sodium metabisulphite and pasteurization technique effectively play a positive role in extending the shelf life and stabilizes the sensory quality of palmyrah product like Palmyrah haustorium, young fruit kernel. However it is recommended to repeat the experiment with stabilization of the pH.

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