



Effect of Different Preservation Techniques on Chemical, Microbial and Functional Properties of Palmyrah Dried Seed Shoot Flour

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ABSTRACT

Palmyrah (Borassus flabellifer) seed shoot flour has many nutritional values and it contains a high amount of starch. It is widely utilized in the preparation of starch based food products. Since these are seasonal products, most of them are spoiled and wasted due to microbial and insect damage. The aim of this research was to increase the shelf life by using suitable preservation methods. Vacuum packaging, roasting (180°C, 10 min), fumigation using phosphine gas (1 gm⁻³, 4 days) and addition of preservative (Sodium Metabisulphite, 200ppm) were the treatments done to increase the shelf life of dried seed shoot flour. Microbial stability was compared through variations in Total Plate Count and Yeasts and Molds count for control and all treated seed shoot flour for one year. Chemical (Moisture, Ash and Starch) and functional properties (Water absorption capacity, Bulk density, Foaming capacity, Foam stability and Swelling power) were tested to assess the effect of different treatments. Among the treatments, vacuum packaging contains the less Total Plate Count (6.83±0.01 log CFU/g) and Yeasts and Molds count (3.0±0.1 log CFU/g) after the storage period of one year compared to other treatments. Bulk density was affected by all the treatments applied and compared with control. Fumigation had a significant effect on moisture content (10.76±0.45 %) and Roasting affected the water absorption capacity (219.21 ± 0.42 %) and swelling power (3.82 ± 0.02) of flour positively and forming capacity (54.12 ± 0.04 %) negatively. Based on the results observed vacuum packaging was identified as the best method for preservation of Palmyrah dried seed shoot flour.

KEYWORDS: *Fumigation, Palmyrah dried seed shoot flour, Preservative, Roasting, Shelf life and Vacuum Packaging*

1 INTRODUCTION

Borassus flabellifer L. (Palmyrah palm) belongs to the family Arecaceae, It is a native plant of tropical Africa (Gummadi et al., 2016). Palmyrah palms are distributed in the drier tropical regions such as Africa, South and Southeast Asia (Kurian et al., 2015). More than 11 million Palmyrah palms are distributed in Sri Lanka and it is clear that Palmyrah based products have a high impact on the national economy if it could be exploited properly (Naguleswaran et al., 2010).

Palmyrah is called the tree of life which provides nearly 800 benefits including edible and non-edible products. Edibles of the palmyrah include inflorescence sap, fruit pulp, tubers and kernel (Vengaiah, 2014; Naguleswaran et al., 2010)

The Palmyrah seed-shoot contains high starch, and it is widely utilized in the preparation of starch based products. The palmyrah seed shoot flour contains a high amount of Na, K, Ca and Mg and another previous study state that it contains other essential minerals and vitamins as well (Jansz et al., 2002). As a result, Palmyrah tubers are highly valued by the local people as an energetic food resource; tubers are processed into flour and used for the preparation of porridge and local foods (Naguleswaran et al., 2010). As these are seasonal products, the majority of them are spoiled and wasted due to microbial and insect attack within a short period. This research study intends to increase shelf life by using different preservation methods to overcome the

deterioration of quality. This study focuses on the effect of the different treatments such as vacuum packaging, fumigation, the addition of preservatives and roasting on its shelf life.

Vacuum packaging is a technique where the product is packed in a package made of a material having low oxygen permeability and is sealed air tightly after evacuating the air. This will restrict the metabolic activity of organisms in the product. (Purushotam and Subha, 2014).

During the storage of flour, to get rid of the pest and insect infestations, the implementation of proper pest management technique is crucial to ensure the quality of stored flour. Gas-phase fumigation is a process to suffocate or poison pests inside the enclosed area. EPA (Environmental Protection Agency) has registered phosphine gas as one of the fumigants and EPA has classified phosphine as not associated with human carcinogenicity (Penchalaraju and Lavanya, 2018)

Chemical preservatives such as Sorbates and Sulphites can be used to preserve the flour. According to the food regulation of Sri Lanka, the maximum limit of sodium metabisulphite (SMS) that can be added to flour is 200 mg/kg (Sri Lanka Food Act, 1980).

Roasting is one of the ways to reduce the moisture content and increase the shelf life of flour. Higher temperature and longer roasting time have a significant

effect on colour and sensory acceptability of the product (Veena *et al.*, 2013).

2 MATERIALS AND METHODS

2.1 Preparation of plant material

Preparation of palmyrah dried seed shoot flour (PDSSF) was done according to the method Piratheepan *et al.*, (2017). The procedures were sorting, cleaning, peeling, splitting into two halves, sun drying at a temperature of about $30 \pm 2^\circ\text{C}$ for 5 days until reaching the moisture content of 10.0%, then milling the dried tuber and sieving.

2.2 Studying the effect of different treatments

PDSSF was subjected to different treatments to determine the effect on shelf life. The methods selected are vacuum packaging, fumigation, roasting and addition of preservatives. PDSSF was packed in vacuum packaging using low-density polyethylene as the packing material. According to the FAO report, PDSSF was fumigated using phosphine (PH_3) gas at the standard dose of 1 gm^{-3} for 4 days in a fumigation chamber. PDSSF was subjected to roasting in the oven at 180°C for 10 minutes (Veena *et al.*, 2013; Azhar, & Saini, 2016). Sodium metabisulphite was used as the preservative at the rate of 200mg/Kg concentration (Food Act No. 26 of 1980). All these treatments were tested with the control sample to evaluate their effect on these treatments. All treated and control samples were packed using low-density

polyethylene and stored separately in room temperature up to one year for further analysis.

2.3 Microbial stability of PDSSF during storage

Total Plate Count (TPC) and Yeast and Molds (Y & M) Count analysis were done for control and all treated flour for one year quarterly according to the method given in ISO 4833-2:2013 and ISO 21527-2:2008 standards respectively.

2.4 Analysis of chemical properties

Parameters of Moisture, ash, starch were analysed for control and all treated flour immediately after one month of treatments. Moisture and ash content determination was carried out using the procedure mentioned in SLS 913: 1991. Starch content was determined according to the method of Wijesinghe *et al.* (2015).

2.5 Analysis of Physical Properties

Bulk Density

For bulk density measurement, an empty measuring cylinder was filled with 20g flour and the volume of the flour was measured. Finally, the bulk density was calculated using the mass and volume of flour (Wijesinghe *et al.*, 2015).

Water Absorption Capacity

Water Absorption Capacity (WAC %) of the flour was measured by the centrifugation method of Azhar, & Saini (2016) with a slight modification. The sample (3.0 g) was mixed with 25 ml of

distilled water in a centrifuge tube. The dispersion was kept for 30 min while stirring frequently. The supernatant was discarded after centrifugation for 25 min at 3,000 xg and the remains in the tube was dried in a hot air oven for 25 min at 50°C. Then the solids that remained after drying was weighed. The water absorption capacity was expressed as gram of water-bound per gram of the sample.

Foaming Capacity and Foaming Stability

Foaming properties were determined according to the method discussed by Azhar, & Saini (2016) with a slight modification. One gram of flour was mixed with 50 ml of distilled water into a capped 250-ml graduated cylinder, followed by shaking vigorously for 5 min. The volume of the foam formed was then recorded as the foaming capacity (%). A final observation was made after 60 minutes for recording the foam stability (%)

Swelling Power

Swelling power was determined with the method described by Vengaiyah *et al.* (2013). One gram of the sample was dispersed in 10 ml distilled water in a 50ml centrifuge tube and heated at 80 °C for 30 min while shaking. It was centrifuged at 1000 xg for 15 min after cooling to room temperature. The supernatant was decanted and the

swelling power was calculated using the weight of the paste taken.

2.6 Statistical analysis

Data were analyzed using One Way - ANOVA and statistical tests were carried out using the Minitab 17 package.

3 RESULTS & DISCUSSION

3.1 Microbiological analysis

Figure 1 shows the effect of different treatments applied with storage time on TPC and roasted flour sample was identified with low TPC (6.01 ± 0.1 log CFU/g) just after the treatment but vacuum packed flour samples contain less TPC (6.83 ± 0.01 log CFU) after one year of storage period. This may be due to the shortage of air inside during the storage period of one year. Control, roasted and preservative added flour samples were identified with the increasing TPC value with time.

Since the palmyrah seed shoot flour processing deals with manual handling such as cleaning, peeling and cutting and through the sun drying method it may contain high TPC compared to other types of flours. According to previous researches on fresh cassava seed shoot flour, the microbial count at the first week (5.6 ± 0.04 log CFU/g) was higher than the day just after processed flour (5.4 ± 0.0 log CFU/g) (Amarachi *et al.*, 2015)

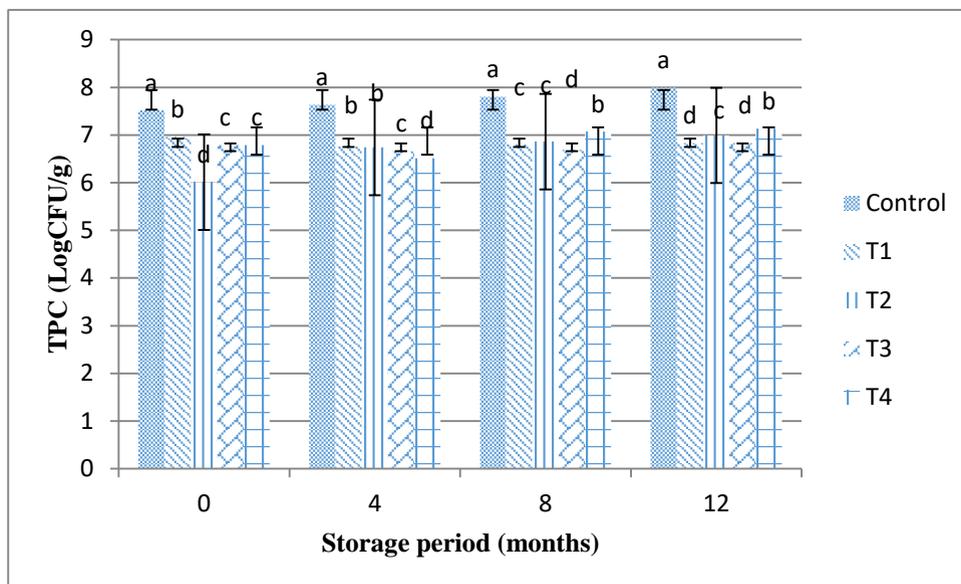


Figure 1: TPC for dried Palmyrah seed shoot flour during storage

Here CFU stands for colony forming unit. Similar letters in superscript are not significantly different between data points ($p < 0.05$) Control – PDSSF without any treatment, T₁ - Vacuum packed, T₂ - Roasted, T₃ - Fumigated, T₄ - Preservative added dried seed shoot flour.

Figure 2 explains how the applied treatments affect the Y & M count with a set storage period of one year and it is observed that the roasted flour contains less Y & M count (4.59 ± 0.01 log CFU/g) just after the treatment by the effect of heat treatment applied. But after one year

storage time count for Y & M for vacuum packed sample was identified as 3.0 ± 0.1 log CFU/g. Y & M count decreases with the storage time for all treated samples with time perhaps due to the insufficient air in the package.

According to the standard, SLS 913: 1991, the allowable maximum count shall be 4 logs CFU/g According to the previous researches on fresh cassava seed shoot flour, the Y & M count at the third month (2.5 ± 0.02 log CFU/g) was lower than the just after processed flour (5.0 ± 0.04 log CFU/g) (Amarachi *et al*, 2015)

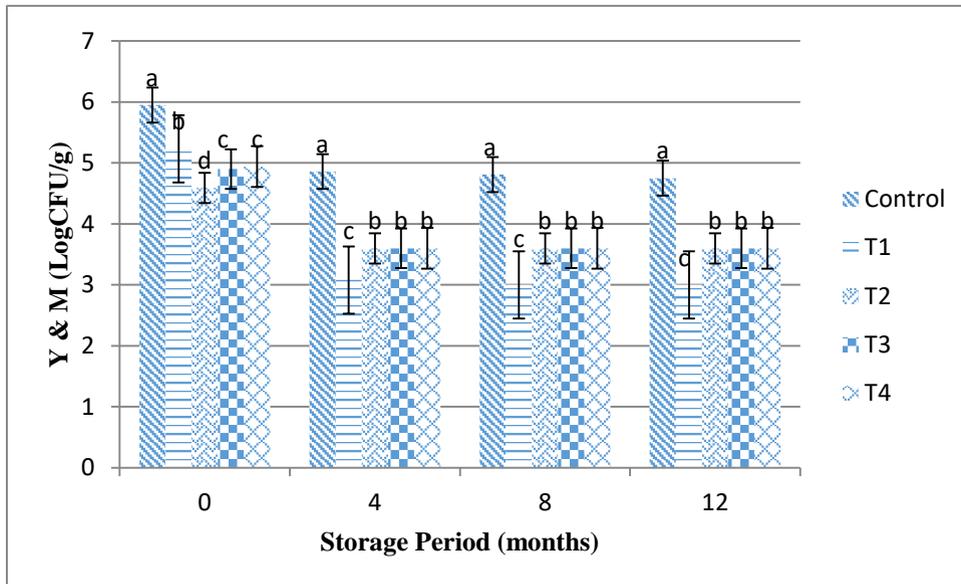


Figure 2: Yeasts & Molds count for dried Palmyrah seed shoot flour

Here CFU stands for colony forming unit. Similar letters in superscript are not significantly different between data points ($p < 0.05$) Control – PDSSF without any

3.2 Analysis of Chemical properties

According to Table 1, the Moisture content of fumigated flour sample contains significantly a high value compared with others. This may be due to the change in packaging during the fumigation process. Significant difference was not observed between the ash and

treatment, T₁ - Vacuum packed, T₂ - Roasted, T₃ - Fumigated, T₄ - Preservative added dried seed shoot flour.

starch content for control and all treated samples.

According to the standard, SLS 913:1991, the maximum moisture content and the minimum starch content shall be as 13%, and 80% respectively and the maximum total ash content shall be as 1.0%.

Table 1: Chemical analysis of PDSSF

Treatments	Moisture (%)	Ash (%)	Starch (%) (wet basis)
Control	10.15 ± 0.45 ^a	1.76 ± 0.35 ^a	71.69 ± 0.74 ^a
T ₁	10.08 ± 0.06 ^a	1.74 ± 0.21 ^a	71.70 ± 1.23 ^a
T ₂	10.09 ± 0.43 ^a	1.75 ± 0.21 ^a	71.70 ± 0.60 ^a
T ₃	10.76 ± 0.45 ^b	1.72 ± 0.08 ^a	72.71 ± 1.23 ^a
T ₄	10.17 ± 0.26 ^a	1.78 ± 0.54 ^a	72.73 ± 1.23 ^a

T₁ - Vacuum packed, T₂ - Roasted, T₃ - Fumigated, T₄ - Preservative added dried seed shoot flour.

3.3 Analysis of functional properties

Water Absorption Capacity, Bulk Density, Foaming Capacity, Foam Stability and Swelling Power were selected as the functional properties and Table 2 shows the results of the functional properties for all treated and control samples.

The determination of bulk density for flour is an important parameter as it affects the capacity of storage, packaging, and transport systems (Azhar, & Saini, 2016). A significant reduction in Bulk Density was found in all treated samples compared to the control. Lower bulk density was observed for vacuum packed, roasted, fumigated, and preservative added samples as 0.52 g/cm^3 , 0.41 g/cm^3 , 0.51 g/cm^3 and 0.46 g/cm^3 respectively compared to the control (0.58 g/cm^3).

The ability of flour to associate with water under the limited supply of water is called Water Absorption Capacity (WAC). This parameter will help to test the ability of the flour to take up water and swell. This will help to decide the amount of water needed for the preparation of the dough (Belay *et al.*, 2020). The increase in the WAC has a positive effect on the ability of amylose leaching and solubility, and the loss of starch crystalline structure. Hydrophilic constituents such as polysaccharides are

the major reasons for the flour to contain high water absorption (Suresh *et al.*, 2014). Roasted flour (219%) contains a high - water abortion capacity compared to the normal (213%). Other treatments do not have any significant effects on the WAC of the flour. Azhar, & Saini (2016) mentioned that the water absorption capacity has been increased by roasting flaxseed flour.

Swelling Power is a parameter associated with starch hydration and is the interactive binding force within starch granules (Belay *et al.*, 2020). Roasting has increased the swelling power (3.82) compared to the control (3.62). The treatments other than roasting do not have any significant effects on the swelling power.

Foaming properties determine the texture and structure of food products like bakery and ice cream. The presence of flexible protein molecules determines the foaming ability of the flour by decreasing the surface tension of water (Azhar, & Saini, 2016). The foaming capacity of roasted flour was identified as 54.12%. The value is lower than the control (65.34%) due to the loss of surface protein whiles the use of high temperature on roasting. Other treatments were not identified with any significant effect on foaming capacity. No significant results were observed for forming stability.

Table 2: Analysis of functional properties of PDSSF

Treatments	Bulk density (g/cm ³)	Water Absorption capacity (%)	Foaming capacity (%)	Foaming stability (%)	Swelling power
Control	0.58 ± 0.09 ^a	213.60 ± 0.54 ^a	65.34 ± 0.15 ^a	0.00 ± 0.00 ^a	3.61 ± 0.02 ^a
T ₁	0.52 ± 0.06 ^b	213.61 ± 0.31 ^a	65.30 ± 0.04 ^a	0.00 ± 0.00 ^a	3.60 ± 0.08 ^a
T ₂	0.41 ± 0.02 ^c	219.21 ± 0.42 ^b	54.12 ± 0.04 ^b	0.00 ± 0.00 ^a	3.82 ± 0.02 ^b
T ₃	0.51 ± 0.05 ^c	213.60 ± 0.52 ^a	65.38 ± 0.08 ^c	0.00 ± 0.00 ^a	3.60 ± 0.03 ^a
T ₄	0.46 ± 0.03 ^d	213.59 ± 0.60 ^a	65.32 ± 0.54 ^a	0.00 ± 0.00 ^a	3.65 ± 0.06 ^a

4 CONCLUSION & RECOMMENDATIONS

Based on the results from this study, the bulk density and microbial stability was affected by vacuum packaging and can benefit the tuber industry positively with a prolonged storage period. This will lower the space available in between the flour particles and result in minimum usage of the packing material. None of the properties other than bulk density was significantly affected by all the treatments selected in this study. The use of thermal treatment in roasting increased the water absorption and swelling power meanwhile adversely affecting the forming capacity.

The surplus production of palmyrah seed shoot flour wastage can be avoided/reduced to a certain degree and can make sure the availability of the flour even in the offseason. This could be a better alternative way to sustain the palmyrah dependent farming communities

through the optimum usage of this underutilized seed shoot flour.

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