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Value Addition for Palmyra Palm Tender Fruit Endosperms Through Thermal Processing

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ABSTRACT

The objective of the study was to extend the shelf life of Palmyra palm tender endosperms through canning as there is a constant demand in domestic and international markets. Palmyra palm Tender Fruit Endosperm (PTFE) is a delicacy, highly perishable and seasonal. Canning the tender fruit endosperms of Palmyra palm at 121.1ºC at 15 psi, extended the shelf life period up to 6 months. Canning is one such promising technology that will fetch income to farmers who rely on seasonal earnings and obviously improve their food security. Various physico-chemical parameters such as, viscosity, colour properties, textural properties, moisture content and water activity and sensory studies, microbial analysis were determined throughout the storage period and found all comparable with freshly harvested endosperms. Overall acceptability score in sensory analysis was7.9±0.788 which was a good score in comparison with fresh ones. Microbiological quality was analyzed at different time intervals for commercial sterility. Total viable counts were 0.45±0.02 on 0^{th}d, 0.51±0.02 on 60^{th}d, 0.48±0.02 on 120^{th}d and 0.47±0.02 on 180^{th}d. *Clostridium spp, Staphylococcus, Salmonella* and *coli forms* were absent throughout the study period and therefore fit for consumption.

Key Words: Canning, Palmyra palm, Shelf-life extension, Thermal processing.

INTRODUCTION

A strong and dynamic food processing sector plays a significant role in diversification of agricultural activities, improving value addition opportunities and creating surplus for domestic markets and export of agro-food products. India can harness all the opportunities present in food processing sector only when its labor force is educated and skilled (Bhuyan *et al*, 2019).There always existed a gap between production and processing which was based on skill learning, and technology intervention. Palmyra palm is considered a celestial tree since all of its part is useful for the mankind. Palmyra palm (*Borassus flabellifer* Linn) is distributed in many tropical countries, but reaches its zenith, as a conspicuous feature of the landscape, where it is found in great groves on the coastline from Mumbai to Chennai and Coramandel coast. Palmyra palms have a long history of management for both subsistence and commercial products, many of which are deeply embedded in local cultures and naturalized throughout India, especially Tamil Nadu. Palm neera, palm candy, tender endosperms, palm fruits, haustorium, tuber shoots, even flowers and toddy are consumed by the people. Culturally Palmyra palm is embedded with the marriage and birth rituals and usage of its products in daily life of people of Tamil Nadu and that's why is conferred as the state tree of Tamil Nadu.

Nungu/ Taal, the soft jelly like endosperm obtained from the tender fruit of Palmyra is highly perishable due to its moisture content and seasonal oriented. During the peak season it gets wasted due to fermentation since it is procured at one place

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and marketed at urban areas. During transit of Palmyra palm Tender Fruit Endosperm (PTFE), is getting squandered due to improper storage facility and fermentation. There exists a constant demand for tender endosperm for its health benefits and delicacy throughout the year. To extend the shelf life and to enhance the remunerative income per rupee of investment to the farmer, canning technology was standardized for Palmyra palm Tender Fruit Endosperms as a post farm gate value addition using mini retort designed at College of Food and Dairy Technology, TANUVAS, Chennai.

MATERIALS AND METHODS

Palmyra palm tender fruit samples were collected from Alamathi location, Tiruvallur district, Tamil Nadu throughout the study period to avoid biasedness due to geographical variations. Freshly harvested samples were procured every time, washed and peeled for the white skinny layer and sorted according to weight and processed further.

Three pieces round Open top sanitary (OTS) cans with EOE lids (from Metcan Pack Ltd, Mysuru) of 200 ml capacity chrome coated juice cans were used for canning the PTFE. Pre-sterilized cans were filled with PTFEs and sugar syrup (45º Bx) was standardized based on consumer preference mapping studies) at 2:3 ratio (Mathanghi *et al,* 2020). Sealed using a can double-seamer and arranged those cans in mini retort for heat sterilization at 121.1ºC at 15 psi pressure. Heat penetration studies were also conducted to define the sterility of the product using thermocouple fitted to cans at the cold spot. Sterility was expressed as an F_0-value were determined using improved general method called as trapezoidal integration method given in (Holdsworth and Simpson, 2016), as in

$$F_0 = \int 10^{(T-Tref)/Z}.dt$$

Where, F_0 is the heat required for the commercial sterilization process, which is expressed as the equivalent heating time (in minutes) at a constant temperature of 121.1°C to inactivate *Clostridium botulinum* spores. *T* is the temperature at any given time; *T*ref is a reference processing temperature (121.1°C or 250°F), and *z*-value is 10°C.

Fig.1 Process of canning: a) preparation of PTFE, b) filling and double seaming, c) heat processing of cans, d) after canning and e) finished product at 180th day

Canned PTFE were immediately cooled after heat processing and stored at ambient temperature (approx. 30ºC) for 180d. The standardized, heat processed PTFE were studied for its physicochemical analysis such as moisture content, water activity (using Novasina water activity meter), viscosity of the syrup (Coleparmer viscometer), texture profile using TPA probe compression platen of P/75 (TA.XT*plus C* from Stable Micro Systems Ltd., England, UK), colour analysis **(**Colourflex EZ, Hunter Associates Laboratory, Inc, Reston, VA**)** and microbial analysis (Evancho *et al*, 2009) for its launch as commercially sterile product for 180 d of storage period at various time interval. Sensory analysis was conducted based on 9-pt hedonic scale rating through a set of 20 semi-trained panelists from the institute.

Cost analysis was also performed to clearly understand the remunerative worth of value addition of PTFE through canning. Data obtained were analyzed using IBM SPSS statistical package version XX (Phadke *et al*, 2020) and experimented results were expressed as mean ± standard deviation. Sensory scores differences were calculated based on a non-parametric test.

RESULTS AND DISCUSSION

Thermal processing studies of canned PTFE

Canned PTFE were processed at a suggested temperature for low acid foods (Holdsworth and Simpson, 2016), since the pH of PTFE is 5.2. At this process temperature of F value for canned PTFE was 10.2 min. Heat penetration characteristics of the thermally processed PTFE in cans are given in figures 2. To estimate the processing time for a given food, the rate of heat penetration and its effect on the lethality of microorganisms has to be calibrated (Al-Baali and Farid, 2006). The total process time of 34.5 min was sufficient to reach commercially sterile products in cans. From the graph (figure 2), core temperature values and corresponding retort temperatures can be ascertained. Cook value for the canned PTFE was 141.2°Cto attain the lethality and to increase the shelf life. Whereas the cook value CV represents the extent of cooking of the product at the hot spot, i.e, usually the periphery of the packaging material and it directly relates to nutrient degradation (Holdsworth and Simpson, 2016).

Physicochemical analysis of canned PTFE

Moisture and water activity plays an important role in determining the shelf life of any food (Ergun *et al*, 2010). There was a decreasing trend of moisture content and water activity was observed in canned PTFE over the storage of 180d. At the 0th day of canning, moisture content was 80± 1.19 % and it kept on decreasing to 67±1.23 % at 180thd. The water activity was reduced from 0.893±0.001 (0th day) to 0.85±0.011 (180thd). This phenomenon might be due to osmosis from fruit endosperm to sugar medium. This was explained by the viscosity values. Viscosity plays an important part in any industrial sector where liquid media are involved. 0th day viscosity value of the sugar syrup was 38.18±2.31centipoises and on the 180thd it was reduced to 34.75± 0.99 centipoises. It has direct relationship with the quality of food product and influences the appearance and the consistency of a product (Calderón-Alvarado *et al*, 2016). Free water present in the fruit endosperm got into sugar syrup and the flavour of Palmyra palm got infused into the sugar syrup.

Colour and texture analysis of fresh and canned PTFE

Colour parameters such as L-value, a*, b* were determined (Pathare *et al*, 2013). The degree of lightness (L*), degree of redness (+ve a*) or greenness (-ve a*), degree of yellowness (+ve b*) or blueness (-ve b*) values were obtained from the equipment and the average value was taken, the comparison was made with freshly harvested sample and different time interval of storage. There was a distinct change of colour from fresh ones to processed ones but in the acceptable range only. Over the time of storage the lightness property of the PTFE got reduced and so the hue angle got increased. Also over the time redness value and yellowness value got increased and it may be due to reduction of lightness property and hue angle. From the table it was evident that there is no much difference from 90thd sample and 180thd sample. Instrumental colour analysis showed similar results with that of subjective sensory evaluation.

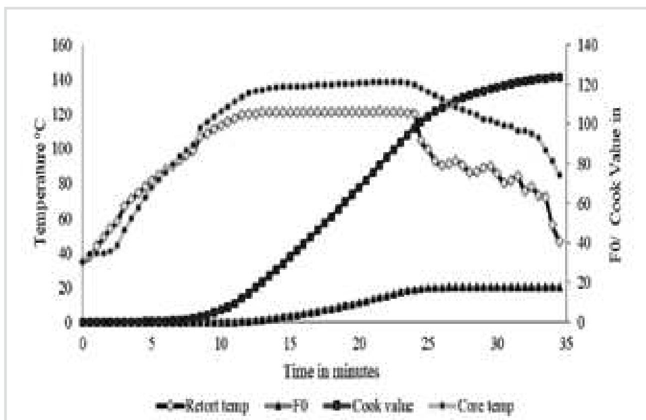

Figure 2. Heat penetration characteristics, cook value, and F0 value of Canned PTFE

Table. 1 Instrumental colour and texture analysis of fresh and canned PTFE.

Colour parameters	Fresh PTFE	Canned PTFE			
		0^{th} day	90^{th} day	180^{th} day	F-value
L-value	44.58±0.04	32.91±0.38	30.51±0.94	29.92± 1.55	13.0622*
Hue angle	-36.77±8.6	27.39±2.46	34.03±9.84	34.47±2.73	3.039^{NS}
Chroma	2.50±0.25	2.19±0.26	3.81±0.63	4.04±0.46	23.966*
Colour coordinate (a/b)	-1.4±0.08	1.94±0.20	1.60±0.59	1.46±0.14	3.3617^{NS}
Textural Parameters					
Hardness kgf	3.46±0.05	2.16±0.02	2.016±0.23	1.87±0.01	519.211**
Springiness mm	0.45±0.01	0.74±0.01	0.792±0.02	0.832±0.02	33.328*
Cohesiveness	0.29±0.01	0.6±0.01	0.68±0.1	0.71±0.01	145.35*
Gumminess kgf.mm	0.21±0.0	1.29±0.02	1.15±0.03	1.04±0.01	190.84*
Chewiness kgf.mm	1.28±0.04	0.95±0.03	0.94±0.02	0.92±0.02	1.635^{NS}
Resilience %	0.28±0.01	0.275±0.01	0.23±0.01	0.21±0.01	714.11*

Data are mean ± SD (n=6) * p-value<0.05; ** p-value <0.01

Instrumental testing of texture provide time-series data of product deformation thereby allowing a wide range of texture attributes to be calculated from force–time or force–displacement data (Chen and Opara, 2013). Texture profile results depicted the reduction in hardness over the storage whereas springiness and cohesiveness increased from 0^{th} day to 180^{th} day (Table 1). On the other hand secondary texture parameters such as gumminess and chewiness got reduced that was reflected in resilience percentage value where it showed a decreasing trend. But there was no much of the difference obtained in terms of cohesiveness. All the data showed statistically significant values at p-value <0.5.

Sensory analysis of fresh and stored canned PTFE

Organoleptic evaluation of the fresh ones and canned PTFE at different time intervals was carried out. The colour and appearance got a score of 7.95 ± 0.88 0^{th} day of canning and scored 7.5± 0.68 at end of storage. The whiteness value got slightly reduced and that was similar with the instrumental colour analysis. Sweetness score of the product was increasing from 7.65 ± 0.98 at 0^{th} d to 7.85±0.58 at 180^{th} d. Succulence was a measure of infusion of syrup into PTFE which was also increased over the storage. Similarly, the toughness score of PTFE was also increased from 7.8±0.77 to 7.95± 0.76. Comparable results with that of instrumental texture analysis were obtained. Even on the 180^{th} d of storage all the sensory score was not got beyond 6 that showed the product was liked by the most of people in the semi-trained sensory panel.

Cost analysis of canned PTFE

The cost analysis of the canned product was done based on capacity and functional ability of equipment's, total variable and total fixed cost involved. Fixed cost includes depreciation, of the equipment, interest on average investment including interest rate and salvage value, insurance and tax. Variable costs included were input cost, repair and maintenance, energy cost and labor cost. It was found that the cost of production per can of PTFE was Rs. 14.5 per 200 g.

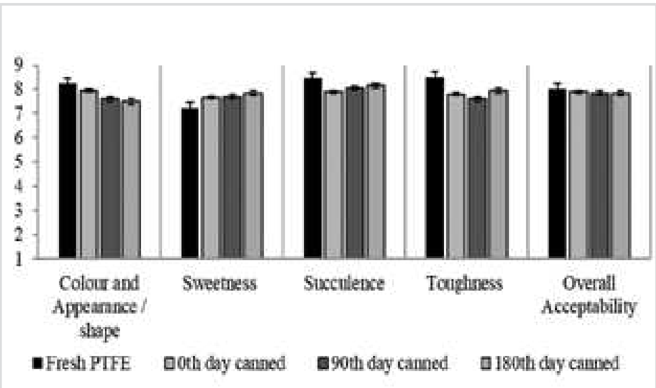

Figure 3.Sensory analysis of stored canned PTFE

Microbial analysis

There is always a chance that microorganisms may survive if the heat treatment is not proper thereby leading to spoilage of food. Hence the commercial sterility tests (Reddy *et al*, 2006) were performed for flat sour spoilage, Thermophilic anaerobic (TA) spoilage and putrefaction. It showed negative for *clostridium perfringens, staphylococcus and salmonella spp* throughout 180d of study. And the Total Viable Counts was 0.45 ± 0.02 cfu on 0^{th} day, 0.51 ± 0.02 cfu on 60^{th} d; 0.48 ± 0.02 cfu on 120^{th} d and on 180th d it was 0.47 ± 0.02 cfu. These results confirmed the safety of canned PTFE for consumption.

CONCLUSION

Canned PTFE were stored for 180d in room temperature without any physical damage and microbial contamination. It has passed the commercial sterility test also. This canning process has enhanced the shelf life of the produce and seemingly gives an appealing sense to the consumers who always think of quality and safety. Processed Nungu (PTFE) gives an enhanced value to the product and adds a craft explicit preferences for it among the consumers and it will undeniably promotes the farmers to remain in Palmyra palm tree business. Small scale preparation of canned PTFE (Nungu) will cost about Rs.72.5/Kg (pertaining on the availability of raw material during the season). At global markets value added PTFE are priced Rs.800 Rs.1000/Kg. Canning is a simple adoptable technology with a minimum investment and maximum return on investment can be achieved by processing PTFE.

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