JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2016, 22(4), 286-291

Journal of Agroalimentary Processes and Technologies

Study on physico-chemical property and Shelf-life of watermelon jam under ambient Storage

Samuel Olufemi Owolade*, Sadiat Oyenike Babalola, Folake Olabimpe Popoola, Adebisi Omolola Akinrinola, Isaac Abioye Olabode

National Horticultural Research Institute, P.M.B. 5432, Idi-Ishin, Ibadan.

Received: 15 September 2016; Accepted: 30 November 2016

Abstract

The study was to evaluate the physico-chemical properties and shelf-life of watermelon jam under ambient storage. Also, economic prospect for watermelon jam under scale production was considered. In the study, eighteen (18) pieces of watermelon fruits with average weight of 3.85kg/fruit were washed under tap water and peeled and the pulp was mixed with sufficient quantity of sugar (500g/kg) and the mixture was boiled until reasonable thick consistency was achieved. Shelf life of the jam stored at room temperature was monitored for 90 days by determining TSS, TA, pH and vitamin C. Sensory evaluation and microbiological changes of the jam was performed to assess consumers' likeness and safety for human consumption. Cost and return structure analysis was used to determine the economic prospect of watermelon jam production and strawberry jam obtained from supermarket was used as control. Results of this study reveal that, TSS for watermelon and strawberry jams ranged from 65.00% to 65.50% and 80.00% to 80.50% respectivelly.The pH of watermelon jam was 3.70 to 3.80. The total viable count (TVC) for watermelon jam raged from $0.01*10^3$ to $0.8*10^3$. The gross margin analysis showed estimated production cost of ₦ 7,120.00, total revenue was N11, 520.00, while profit margin of ₦ 4,400 was generated. This suggested that processing of watermelon fruits into jam could generate adequate income for prospective small scale processor and also reduce losses.

Keywords: Watermelon, jam, income, Gross Margin

1.Introduction

Fruits and vegetables are of great nutritional value. They play important roles in the diet of most people in the tropics, providing essential minerals and vitamins [1]. Fruits and vegetables are abundant during their various seasons, with over 50% lost to wastage due to deterioration under tropical conditions of high ambient temperatures and humidities, pest and disease infestations, poor handling and storage facilities [2]. To reduce this seasonal huge loss, processing of fruits and vegetables into valued-added products like preserves and juices with increased shelf-life remains a strategically valid approach.

Jam is prepared by boiling the fruit pulp with sufficient quantity of sugar to a reasonable thick consistency. The concentrated pulp is then cooled and packed in a well sterilized bottles secured with air- tight cap to ensure a longer shelf-life of the product.

Watermelon (*Citrullus lanatus*) is a tropical fruit widely consumed around the world and among Nigerian populace. It enjoys worldwide popularity for its aesthetic tastes and nutritional compositions [3]. Water melon was reported to contribute to the proper functioning of the kidney [4]. Nutritionally, watermelon contains essential vitamins and minerals necessary for healthy growth [5].

Corresponding author: *e-mail:* obfem@ yahoo.com

In Nigeria, Watermelon production has increased significantly in the last one decade with major production areas in the northern part of the country [6,7]. However, watermelon is seasonally available and highly perishable. As a result, watermelon can better used as raw material that could be processed and preserved into value-added product (jams) to make them available and sell outside of harvest time and perhaps at higher price for human consumption. The present study was carried out therefore to assess the suitability of watermelon fruit for jam preparation, to investigate the storage stability of the jam at ambient temperature and evaluate its economic prospect for small scale processor for income generation.

2.Materials and Methods

2.1. Sample collection

Firm and fully matured watermelon fruits were purchased from Bodija market in Ibadan. Oyo-state, Nigeria and processed into jam.

2.2. Jam preparation

The watermelon was processed into jams according to the Food and Agriculture Organization's guidelines with slight modifications [8]. For every 1kg of fruit pulp was mixed with 500 g of sugar, 2g of citric and 1g of sodium benzoate acid. The mixture was boiled until jam thick consistency was formed .The produced jams were hot filled into sterilized glass bottles, closed and stored at room temperature (25-30^{O}C).

2.3. Analysis

Physico-chemical analysis. Total soluble solids (Brix %) was determined using a sugar refractometer. pH was determined using a digital pH meter (Model PHS-2F). The $_{P}$H was determined by $_{P}$H meter while the Titratable acidity (TA) was measured by titration with sodium hydroxide and values expressed as citric acid equivalent [9]. The values observed from watermelon jam were compared with strawberry jam obtained from supermarket.

Determination of Vitamin C. Ascorbic acid was determined by the 2, 6-dichlorophenol indophenol titration procedure [10]. Ascorbic acid was extracted using an acetic acid and metaphosphoric acid solution. The extracts were transferred with distilled water into a 50 ml volumetric flask and made up to the mark with more water and filtered rapidly. The filtrate was run from a burette into a test tube containing one drop of dilute acetic acid and 1ml of the dye, 2,6 dichlorophenol indophenol solution. The volume of extract required to decolorize the dye was noted. The titration was repeated using standard ascorbic acid solution (1 mg pure vitamin per 100 ml).

Ascorbic acid per 100g of jam or pulp is calculated as:

$$\% \text{ ascorbic acid} = \frac{w \cdot 100}{100}$$

w= volume of dye

Sensory evaluation. Simple paired comparison between watermelon jam and commercially available strawberry jam using a 7-point hedonic scale was carried out by untrained panelists. The scale ranged from like extremely (7) to dislike extremely (1). The parameters evaluated were colour, taste, flavour, and over- all acceptability

Determination of microbial load. The microbial load of stored jam samples was determined by the enumeration of total viable count as reported by Anila and Radha [11].total coliform count (TCF) and Total fungus count (TFC) at different storage intervals as described by compendium of methods for the microbial examination of foods [12]. Nutrient agar (Oxoid, UK) was used for periodical determination of total viable count in the stored watermelon jam samples. Nutrient medium was suspended/litre of distilled water, mixed thoroughly, pH adjusted at 7.2 (25°C), heated with frequent agitation and boiled for 1min to completely dissolve the ingredients and autoclaved at 121°C for 15 min. One-gram sample was taken from each jam sample using aseptic techniques, placed in labeled sterile dilution bottles and made into a volume of 100 ml by distilled water to achieve suspension under sterile conditions. The contents were mixed thoroughly and aliquots were serially diluted and enumerated onto Nutrient agar. Plates were subsequently incubated (Binder, Germany) for 48h at 37°C and colonies formed on the surface and medium were counted using colony counter (FunkeGerber, Germany) similarly MacConkey agar (Fluka) was used for

coliform count, Sabouraud- Dextrose agar (Fluka) for fungal count. Plates were counted.

Economics. The cost and return analysis was carried out to evaluate the economic prospect of the production of watermelon jam on small scale using method similar to [13].

3.Results and discussions

Table 1 represents the result of the physico-chemical properties of watermelon jam and that of strawberry jam which was used as control. The total soluble solid (TSS) for watermelon jam range from 60.00-60.50% and strawberry jam 80-80.20%.There is no significant difference in the TSS value of watermelon jam for the period of 90days.However,there is a significant difference between the TSS of watermelon jam and strawberry at ($p \leq 0.05$). The variation may be due to inherent characteristics such as sugar content and maturity of fruits use in the making of both jams. The result of evaluation shows that the qualities of watermelon jam was maintained for period of 90 day for which the study was covered. The retention of qualities may be due to the positive role of sugar in maintaining the chemical composition of jam products over a period of time as reported by [14]. The pH for watermelon jam was ranged between 3.75-3.80 and strawberry 5.60-5.70 respecively.

The pH recorded were within the range observed by [15] in their study of effective jam preparation from watermelon waste. The pH of preserved products plays a dual role by acting as flavor promotion and also as preservatives [16]. The mean vitamin C content for watermelon jam ranged between 1.70-2.25mg/100g and strawberry was 1.80-2.25mg/100g.There was no significant difference in the mean vitamin C content of watermelon jam from 0^{th} to 75^{th} day but a significant reduction at ($p<0.05$) at the end of 90^{th} day. The decrease in ascorbic acid was observed by [17] in the study of storage of papaya chutney. This loss was likely due to oxidation or exposure to atmospheric oxygen during the preparation [18].

Table 2. Shows the results of sensory evaluation of watermelon and strawberry jam. Sensory evaluation were conducted on the jams at with respect to colour, taste, aroma and overall acceptability There is no significant difference in mean score in the sensory properties of both jam up to 75^{th} day under the room temperature storage. However, there was a slight decrease in mean score at 90^{th} day with respect to aroma. A gradual decrease in the sensory evaluation mean score was also reported by [19] during the storage evaluation of amia jam.

Table 1. Physico-chemical property of watermelon and strawberry jams

Products	No of days	TSS (%)	PH	TA	VitaminC mg/100g
Watermelon jam	0	65.00±0.00	3.80±0.00	0.28 ±0.21	2.25±0.00^{b}
	15	65.00± 0.00	3.80 ±0.00	0.28 ±0.21	2.25±0.00
	30	65.00±0.00	3.70±0.10	0.27 ±0.20	2.10±0.00
	45	65.50±0.00	3.70±0.10	0.27±0.10	2.10±0.00
	60	65.50±0.00	3.70±0.10	0.27±0.10	2.10±0.00
	75	65.50±0.00	3.70±0.10	0.27±0.10	2.10±0.00
	90	65.50±0.00	3.70±0.10	0.27±0.10	1.70±0.00^{a}
Strawberry jam	0	80.00±0.00^{a}	5.70±0.00	0.48±0.21	2.20±0.00^{c}
	15	80.00±0.00	5.70± 0.00	0.48±0.21	2.20±0.00
	30	80.00±0.00	5.70 ±0.10	0.48±0.21	1.80±0.00^{b}
	45	80.00±0.00	5.70 ±0.10	0.48±0.21	1.80±0.00
	60	80.50±0.00	5.70±0.10	0.47±0.10	1.80±0.00
	75	80.50±0.00	5.60± 0.10	0.47±0.10	1.80±0.00
	90	80.50±0.00^{b}	5.60±0.10	0.47±0.10	1.80±0.00^{a}

Data are average value of duplicate ± standard deviation. Values in the same Colum with different superscripts are statistically significant ($p<0.05$).

Table 2. Organolptic assessment of watermelon and strawberry jams

Product	Days	Color	Taste	Aroma	Over all acceptability
watermelon jam	0th	6.53±0.52[b]	6.38±0.50[b]	6.13±0.35[b]	6.50±0.53[b]
	15th	6.53±0.52	6.38±0.50	6.13±0.35	6.50±0.53
	30th	6.53±0.52	6.38±0.50	6.13±0.35	6.50±0.53
	45th	6.53±0.52	6.38±0.50	4.13±0.35	6.50±0.53
	60th	6.53±0.52	6.35±0.35	6.13±0.35	6.50±0.46
	75th	6.53±0.52	6.35±0.35	6.13±0.35	6.50±0.46
	90th	6.25±0.36[a]	6.25±0.35[a]	6.00±0.00[a]	6.25±0.46[a]
strawberry jam	0th	6.25±0.52	6.38±0.52[c]	6.25±0.46[b]	6.50±0.53[b]
	15th	6.25±0.52	6.38±0.52	6.25±0.46	6.50±0.53
	30th	6.25+0.46[b]	6.25±0.46[b]	6.25±0.46	6.50±0.55
	45th	6.25±0.46	6.25±0.46	6.25±0.46	6.50±0.55
	60th	6.25±0.46	6.25±0.46	6.25±0.46	6.50±0.46
	75th	6.13±0.25[a]	6.25±0.46	6.25±0.46	6.50±0.46
	90th	6.13±0.25	6.13±0.25[a]	6.13±0.30[a]	6.25±0.46[a]

Data are average value of duplicate ± standard deviation. Values in the same Colum with different superscripts are statistically significant ($p<0.05$).

Table3. Microbiological analysis of watermelon and strawberry jams

	Watermelons jam			Strawberry jam		
days	TVC (cfu/g)	TFC(cfu/g)	TCC(cfu/g)	TVC(cfu/g)	TFC(cfu/g)	TCC(cfu/g)
0	0.03×10^3	0.02×10^3	ND	0.03×10^3	0.01×10^3	ND
15	0.03×10^3	0.03×10^3	ND	0.04×10^3	0.02×10^3	ND
30	0.08×10^3	0.06×10^3	ND	0.09×10^3	0.04×10^3	ND
45	0.18×10^3	0.15×10^3	0.01×10^3	0.13×10^3	0.09×10^3	ND
60	0.29×10^3	0.27 x103	0.27×10^3	0.25×10^3	0.20×10^3	0.01×10^3
75	0.51×10^3	0.40×10^3	0.08×10^3	0.49×10^3	0.30×10^3	0.01×10^3
90	0.53×10^3	0.41×10^4	0.08×10^4	0.69×10^3	0.40×10^3	0.21×10^3

Key: **TVC** =Total viable counts; **TFC** = Total fungus counts; **TCC**= Total coliform count; **N.G** = no growth

Table 4. Cost and return structure analysis on small scale production of watermelon jam

A. Parameters on watermelon fruits

I	No of fruit used	18
II	Total wt. of fruit	69kg
III	Average wt. of fruit	3.85kg
IV	Total wt. of the pulp	48kg (68.97%)
V	Total wt of the peel	21.3kg (30%)
VI	Other remnants (seeds)	0.3kg (0.43%)

B. Gross margin analyses of watermelon jam production based on 36 bottles

S/NO	item	qty	price/unit	amount (₦)
I	Watermelon	18	250	4,500
II	Sugar	-	340	400
III	Preservative	-	200	250
IV	Bottles	-	20	720
V	Labour	2	500	1, 000
VI	Transport	-	250	250

Total: **₦ 7,120.00**

Total Variable cost: ₦ 7,120.00; Total revenue @ ₦ 320/bottle ₦ 11,520.00; Gross margin = total revenue-total variable cost ₦ 11,520- ₦ 7,120; Gross margin = **₦ 4,400.00**

Table 3 represent the result of microbial load evaluation. Microbial load of the jams were in range of $0.01*10^3$- $0.68*10^3$ thus within acceptable limit for human consumption [20].The presence of the low pH of the juice could be one the factors that account for keeping the microbial load in check within acceptable level the period of five weeks under which the study was conducted. However, the presence of relative microbial contaminants in some of the samples could be a reflection of the quality of the raw materials, processing equipment, environment, packaging materials and the personnel's in the production process.

The simple cost and return analysis structure of estimated cost of 36 bottles watermelon jam produced was represented in Table 4. This was to evaluate the prospect of watermelon jam production on small scale which can be a means of employment opportunity. The total revenue of 36 bottle at N320/jar was N 11.520 = and the total variable cost was N 7,120 =. The gross margin of ₦4, 400 = was obtained. This simple cost and return analysis shows a probable prospect that the processing of watermelon into value-added product like jam on small scale production could generate good income.

4.Conclusion

The study shows that good quality watermelon jam could be prepared and stored at ambient temperature for 90days with minimal decrease in quality. The study also present an opportunity of setting –up small scale fruit based jam industry in Nigeria, However, maintenance of proper hygienic condition is required during processing and storage.

Acknowledgements
The authors were grateful to management of National Horticultural Research Institute, Ibadan, Nigeria. We also appreciate Mrs. C.Y, Adigun, Mrs C.O, Ariyo and Mr. E.O, Egbufor for their support and encouragement.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Ragaert P., Verbeke W., and Debevere F. Consumer Perception and Choice of MinimallyProcessed Vegetables and Packaged Fruits. *Journal of Food Quality and Preference*. **2004**, *15*, 259 – 270.
2. Aworh O.C., and Olorunda A.O., Packaging and Storage Technology of Fresh Fruits and Vegetables with Special Reference to Tropical Condition, *Proceedings of National Workshop on Improved Packaging and Storage System in Nigeria*. **1988**,75 - 91.
3. Snowdon A.L., *In Color Atlas of Postharvest: Quality of Fruit and Vegetable*, (Nunes, Maria Cecilia do Nascimento eds.), Blackwell Publishing. **1990**, 207-209.
4. Roger G.D., *Healthy Foods, New Lifestyle*, 1st Edition. Safeliz, S.L., Spain. **2006**, 236.
5. Anon., *Listeria monocytogenes* causes problems in cattle and sheep in February, *Veterinary Record*, **2005**, *156*(13), 397-400
6. Charles F., *Watermelon breeder*. Cucurbit Breeding Horticultural Science. **2005**, Retrieved Jul. 17.2015
7. NIHORT. Guide to the production of watermelon, a publication of the national horticultural research institute, Ibadan. **2006**, 16-20
8. FAO. *Guidelines for small-scale fruit and vegetable processors*, FAO agricultural services bulletin 127, Peter Midway technology Ltd. St Oswalds Barn, Cifford Hay on Wye, Hereford. United Kingdom, **1997.**
9. Ranganna, S., *Manual of analysis of fruit and vegetable*. That Mac Grand Hill Company Ltd, New Delhi**. 1997**, 506-508
10. AOAC, Official Method of Analysis, Association of Analytical Chemists. Ed 16th, Arlington Virginia, USA**. 1990**.
11. Anila R., and Radha T. Physico-chemical analysis of mango varieties under Kerala conditions. *Journal of. Tropical Agriculture*. **2003**, *41*, 20-22
12. APHA, *American Public Health Association.Compendiun of methods for the microbiological examination of foods*. In: Downes, F.P. and Ito,K.(Eds.) 4th Edn., Washington. **2001,** 345-347
13. Mohammed A. B., Ayanlere A. F., Ekenta C. M. and Mohammed S.A., Cost and Return Analysis of Pepper Production in Ethiope West Local Government Area of Delta State, Nigeria. *International Journal of Applied Research and Technology*. **2013**, *2*(2), 3 – 7.
14. Cancela M.A. Ivarez E. and Maceiras R., Effects of temperature and carboxymethylcellulose with sugar rheology. *Journal of Food Engineering*, **2005**, *71*, 419-424,

15. Souad A., Jamal, P. and Olorunnisola K., Effective jam preparations from watermelon waste *International Food Research Journal*, **2012**, *19*(4), 1545-1549.
16. Akhtar S., Riaz M., Ahmad A., and Nisar A., Physico-chemical, microbiological and sensory stability of chemically preserved mango pulp. *Pakistan Journal of. Botany*, **2010**, *42*, 853-862.
17. Gupta. G. Standardization of recipe for preparation of Sweet papaya chutney. Indian Food, *Beverage Food World*, **2000**, *32*, 80-81.
18. Fennema F., Loss of Vitamins in fresh and frozen food". *Journal of Food Science and Technology*. **1977**, *31*(12), 32-33
19. Tripathi A., Diwate R., Kute L.S., and Chavan, J.K., Preparation of toffees from papaya pulp. *Beverage Food World*, **2004**, *31*, 65-66.
20. ICMSf,. *Microbial Ecology of Food Commodities*. Microorganisms in foods. Blackie Ackademic and Professional, London. **1998**, 50-58.