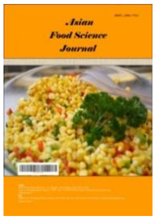

Asian Food Science Journal

17(2): 36-42, 2020; Article no.AFSJ.59182
ISSN: 2581-7752

Effects of Packaging Materials on Sensory Quality and Vitamin A Retention in *Chin-Chin* from Orange Fleshed Sweet Potato [*Ipomoea batatas* L. (Lam)] and Red Bambara Groundnut [*Vigna subterranean* (L) Verdc.] Flour Blend

A. A. Obomeghei[1] and P. A. Ebabhamiegbebho[2*]

[1]Department of Food Technology, University of Ibadan, Ibadan, Nigeria.
[2]Food Science and Human Nutrition Unit, Department of Animal Science, Faculty of Agriculture, University of Benin, P.M.B., 1154, Benin City, Nigeria.

Authors' contributions

This work was carried out in collaboration between two authors. Author AAO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AAO and PAE managed the analyses of the study and managed the literature searches. The two authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2020/v17i230189
Editor(s):
(1) Dr. Uttara Singh, Panjab University, India.
Reviewers:
(1) P. R. Davara, Junagadh Agricultural University, India.
(2) R. Premavathi, Tamil Nadu Agricultural University, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/59182

Original Research Article

Received 08 May 2020
Accepted 14 July 2020
Published 30 July 2020

ABSTRACT

Sensory quality and vitamin A retention in chin-chin stored using different packaging materials were evaluated. The Orange Fleshed Sweet Potato (OFSP) and Red Bambara Groundnut (RBG) flours were blended in ratio 50:50 for chin-chin production. Sensory quality, β-carotene and vitamin A contents of the *chin-chin* were analyzed using standard methods. Storage stability test of β-carotene and vitamin A retention were investigated using plastic bottles, high and low densities polyethylene packaging materials at ambient conditions (29.95±5.00°C, relative humidity 68.32±3.55%). The total vitamin A µgRAE retention in the chin-chin was estimated every week for four weeks and after twelve months. Moisture was least absorbed by chin-chin packaged in plastic

**Corresponding author: Email: peter.ebabhamiegbebho@uniben.edu;*

bottles. The Vitamin A retentions were about 80 percent, 74 percent and 72 percent for plastic bottles, high density polyethylene and low density polyethylene, respectively after twelve months of storage. Texture, taste and overall acceptability were better retained when packaged in either plastic bottles or high density polyethylene. The *chin-chin* produced was able to store for up to twelve months when packaged in plastic bottles or high density polyethylene.

Keywords: Packaging materials; orange fleshed sweet potato; bambara groundnut; chin-chin; flour blends; sensory qualities.

1. INTRODUCTION

Sweet potato is considered the sixth most useful food crop in the world [1] and will play a role in solution of world problems of energy, food and natural resources and the environment of 21st century [2]. Often called "almost perfect nourishing food" sweet potato contains vitamins, minerals, and many other nutrients in favourable ratios [3]. People have a great need to improve and maintain their health through the foods they eat every day. The three most important causes of death in Japan and other developed countries, cancer, heart diseases and cerebrovascular diseases, are said to be closely related to hypertension. To prevent and alleviate these diseases, studies are exploring the health-promoting functions of various agricultural products. However, there are only a few studies concerning the sweet potato components that contribute to maintenance and improvement in health [4]. In the recent decade, active researches have been carried out regarding its health-improving functions. These functions are important factors when developing new processing methods of sweet potato [5]. Aside the possession of vitamins and minerals, sweet potatoes also possess some phytochemicals that has antioxidant properties, especially carotenoids and anthocyanins with radical scavenging activities. About 400 years ago, Chinese medical report shows that consumers who do not eat rice, barley, and beans, but eat sweet potato roots have long life [5]. Orange fleshed sweet potato clones contains high amount of β (beta)-carotene that is known to be a precursor of vitamin A [6,7,8]. The amount of β-carotene contained in sweet potato varies with the varieties and about 20 mg out of 100g fresh weight of sweet potato can be obtained [6,7]. It has four times United States Recommended Dietary Allowance for beta-carotene if it is eaten with the skin [9,10].

Bambara groundnut (*Vigna subterranean* L.) is among the major crops cultivated in Africa but it has low recognition as it is considered a snack food or a supplement and not a high-paying crop [11]. Bambara groundnut seed is described as a standard food, since it possesses enough quantities of protein, carbohydrate and fat [12,13]. According to [14], the oil from Bambara groundnut is composed of predominantly unsaturated fatty acid and of high iodine value index. The seed calorific value is far higher than the values for other common pulses like black-eyed pea, pigeon pea and lentil [4]. On an average, bambara seed is composed of approximately 19 percent protein, 63 percent carbohydrate, and 6.5 percent fat. Bambara groundnut has a higher quantity of lysine than all other legumes and the seed possess higher amounts of methionine than all other grain legumes [15]. Lower levels of phenolic compounds and trypsin inhibitor was found in bambara seed [12,16,17]. Nigeria is considered a major producer of bambara groundnut in Africa [14]. The red Bambara groundnut seed contain some appreciable amount of β-carotene [18]. Despite all the advantages of Bambara groundnut in the area of food security and its industrial potentials, its use as an industrial raw material is still very low [14].

Chin-chin is a traditional Nigerian snack prepared using flour, butter, milk and eggs from which a stiff paste is made which is then deep fried until golden brown colour and crispness is developed. According to [19], *chin-chin* is a likable West African pastry product that can serve both as a snack and a sweet, depending on the way it was prepared. There are about as many recipes for *chin-chin* as there are ethnic groups in Nigeria [19], and the ingredients and variations are endless. Some persons may like it hard and crunchy while others will prefer the light and softer ones. Shaping is a personalized preference; it can be in square, round, or cylindrical shape. Some may have a hole poked at the center of flattened dough already cut to size and pulling one end through to form a knot. Wheat flour has been used over the years for the production of snack foods. The new snacks processing trend now is nutritional enhancement through combining or replacing an ingredient or some ingredients to enhance their nutritional status and for cost reduction.

Protein-enriched and pro-vitamin A fortified *chin-chin*, has been produced from orange fleshed sweet potato and red Bambara groundnut [18]. Literatures on storage conditions of this snack are scarce. One of the most important factors which determine sensory and nutritive quality retentions of food products is packaging. The objective of this study is to investigate the effects of different packaging materials on sensory and vitamin A retention in *chin-chin* stored at ambient conditions.

2. MATERIALS AND METHODS

2.1 Procurement and Preparation of Materials

Fresh Orange Fleshed Sweet Potato (OFSP) Umuspo 3 clone were obtained from an experimental farm of the Nigerian Root Crops Research Institute (NRCRI), Umudike, while Red Bambara Groundnut (RBG) were purchased from Uchi market in Auchi, Edo State, Nigeria. Cholesterol-free “Grand pure soya” oil of UAC was also purchased from Uchi market, Auchi. The method of [18] was used to produce flours from OFSP and RBG. The OFSP and RBG flours were blended in ratio 50:50. A modified method of [18] was used to produce *chin-chin*. In the mixing bowl was added 350 g of the flour blends, 50 g sweet potato starch, 50g sugar, 5g baking powder, 0.25 g nutmeg, and .5g salt. The margarine (50 g) was rubbed into the ingredient in the bowl. No egg was whisked into the mixture as this was replaced by the protein source (Red Bambara groundnut flour). The starch was cooked in 200 ml water until it has properly gelatinized. The gelatinized starch was then mixed manually into the rest of the ingredients and continued the mixing until a stiff pastry was formed. It was then rolled on a wooden board on which some flour have been added using the rolling pin. The rolled paste was then cut in beats, 1.90±0.23 mm x 1.20±0.23 mm x 0.58±0.04 mm (LxBxH). These were then deep-fried using the method of [18] at a temperature of 181.67±12.58°C for 5 minutes in a restaurant type deep-fat fryer (Hobart Frymaster MJ1CF) of Hobart Cooking Solutions, Peterborough, UK. About 3 L of “Grand” cholesterol-free refined vegetable oil of UAC were used at a time. Batches of approximately 130 g were added at a time to minimize temperature drop during frying until the *chin-chin* became brown and crispy and having dimension 1.93±0.28 mm x 1.53±o.31 mm x 1.23±0.36 mm (LxBxH). The flow chat for *chin-chin* production is depicted in Fig. 1.

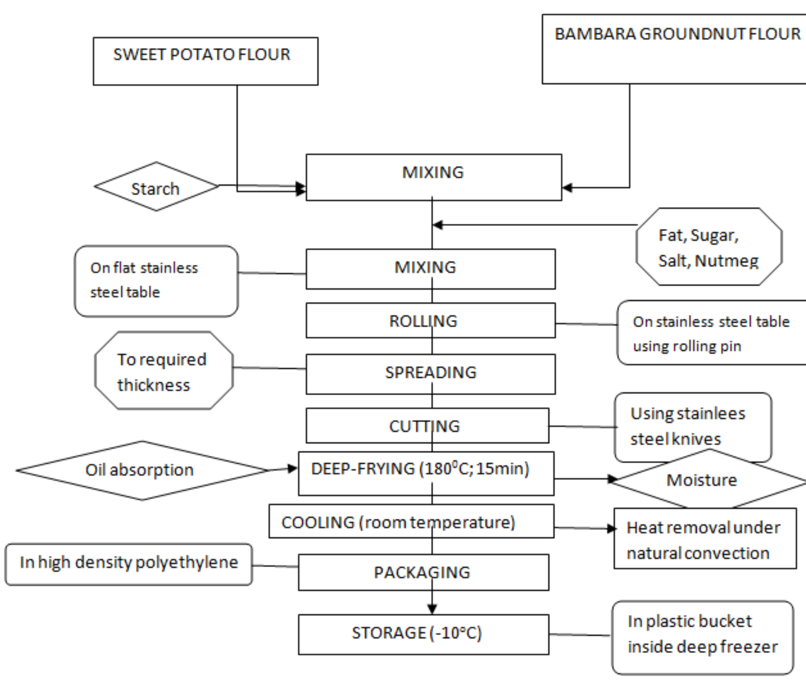

Fig. 1. Unit operation for the Chin-chin production

2.2 Moisture Content Determination

Moisture content was determined as described in [20].

2.3 Sensory Attributes Analysis

Sensory attributes of the *chin-chin* were analyzed using the method of [21]. The quality of the sensory attributes were determined using a panelist of 20 food professionals employing a 9-point Hedonic scale whereby 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislike moderately; 2 = dislike very much; 1 = dislike extremely. Quality parameters analyzed for sensory evaluation are; appearance, aroma, flavor, taste, texture, and overall acceptability. The data obtained were evaluated for significant differences in their means using analysis of variances (ANOVA) at $p \leq 0.05$. These were computed using the scores allocated by the panel members using statistical package for social science (SPSS) software version17.0

2.4 Determination of Beta-carotene

β-carotene contents were estimated by the method described by [22] which were converted to vitamin A using [23].

2.5 Storage Stability Test

Storage stability test of β-carotene retention was investigated using plastic bottles (PB), High and Low Densities Polyethylene (HDP and LDP) packaging materials at ambient conditions (29.95±5.00°C, relative humidity 68.32±3.55%). This was carried out to see the trend of vitamin A depletion with period of storage and to find out their state of storability and palatability after long period of storage. Storage studies was conducted on the *chin-chin* produced by subjecting it to storage for twelve months storing 100 g of *chin-chin* in each packaging materials (1) Plastic bottles, 0.28 mm thick (2) High Density Polyethylene, 0.08 mm thick and (3) Low Density Polyethylene, 0.01 mm thick. After the expiration of the twelve months period, the samples of packaged *chin-chin* were subjected to moisture absorption determination and sensory analyses and the analysis of variance (ANOVA) was evaluated using SPSS version 17.0 software. The total vitamin A µgRAE retention in the *chin-chin* was estimated every week for four weeks and after twelve months. The β-carotene contents were estimated as described earlier and converted to vitamin A µgRAE using the method of [23].

3. RESULTS AND DISCUSSION

3.1 Moisture Content

The increase in moisture contents (M.C.) obtained after the storage period are shown in Table 1. Significant differences exist among all the samples. The value for low density polyethylene was significantly higher followed by the high density polyethylene and then the plastic bottle.

3.2 Sensory Scores

The results of the sensory ratings for taste, flavor, colour, texture and overall acceptability after twelve months of storage at ambient conditions (29.95±5.00°C, relative humidity 68.32±3.55%) are presented in Table 2. Significant differences ($p \leq 0.05$) did not exist in all the parameters tested for *chin-chin* packaged with plastic bottles and high density polyethylene. Also significant differences were not observed in flavor and colour, among *chin-chin* packaged in all the three packaging materials, but significant differences existed in texture, taste, and overall acceptability ($p \leq 0.05$) between the samples.

Table 1. Moisture content of 50:50 Chin-chin stored in different packaging materials after 12 Months

Packaging material	M.C (%) fresh	M.C (%) 12 months	M.C increase
Plastic Bottle	6.07±0.04	7.36±0.08^{c}	1.29±0.04 (21%)
High Density Polyethylene	6.07±0.04	7.59±0.04^{b}	1.52±0.00 (25%)
Low Density Polyethylene	6.07±0.04	8.92±0.13^{a}	2.85±0.09 (47%)

Mean with same superscript in a column are not significantly different ($p \leq 0.05 \pm SD$)

Table 2. Mean sensory attributes of 50:50 chin-chin after storage

Parameter	Before storage	After Storage		
		PB	HDP	LDP
Taste	7.80±0.42	7.70±0.95[a]	7.95±0.84[a]	6.00±1.05[b]
Flavour	7.10±0.31	8.30±0.82[a]	8.10±0.74[a]	7.60±0.84[a]
Colour	7.90±0.22	7.80±0.79[a]	7.60±0.52[a]	7.70±0.68[a]
Texture	8.20±0.29	8.10±0.88[a]	8.10±0.57[a]	6.40±0.52[b]
Overall acceptability	8.60±0.27	8.20±0.79[a]	7.70±0.68[a]	5.80±0.63[b]

Means with same superscript in a row are not significantly different at P≤0.05±SD, Key: PB (Plastic bottle), HDP (High Density Polyethylene), LDP (Low Density Polyethylene), SD=Standard deviation

Table 3. Vitamin A (µgRAE) and β-carotene (mg) percent retention in chin-chin during four weeks and 12 months of storage

Packaging material	PB	HDP	LDP
Week 1	432.83 (5.17)	432.83 (5.17)	432.83 (5.17)
Week 2	426.13 (5.09) (98.45%)	414.05 (4.95) (95.66%)	405.23 (4.84) (93.62%)
Week 3	416.01 (4.97) (96.11%)	400.89 (4.79) (92.62%)	393.42 (4.50) (90.20%)
Week 4	402.67 (4.81) (93.03%)	392.23 (4.69) (90.62%)	386.55 (4.62) (88.62%)
12 Months	343.89 (4.11) (79.45%)	317.98 (3.80) (73.47%)	309.72 (3.70) (71.56%)

Key: PB (Plastic Bottle), HDP (High Density Polyethylene), LDP (Low Density Polyethylene)

3.3 β-carotene Retention in Chin-chin

The β-carotene contents and vitamin A retention in chin-chin after four weeks and twelve months of storage is shown in Table 3. The vitamin A dropped from 432.83 µg RAE at end of week one to 402.67 µg RAE at end of week four for plastic bottles indicating 93.03 percent retention after four weeks of storage. For the high density polyethylene, the vitamin A decreased from 432.83 µg RAE at end of week one to 392.22 µg RAE at end of week four indicating vitamin A retention of 90.62 percent after 4 weeks of storage. While for the low density polyethylene, the vitamin A content decreased from 432.83 µg RAE at end of week one to 386.55 µg RAE at end of week four, indicating vitamin A retention of 88.62 percent after 4 weeks of storage.

At the end of twelve months period the vitamin A had dropped from 432.83 µg RAE at end of week one to 343.89, 317.98 and 309.72 µg RAE respectively for plastic bottle, high density polyethylene and low density polyethylene indicating vitamin A retention of 79.45 percent for plastic bottle, 73.47 percent for high density polyethylene and 71.56 percent for low density polyethylene. In general there is a gradual decrease in vitamin A for all packaging materials tested, but vitamin A retention is highest in plastic bottles, followed by high density polyethylene and lastly by low density polyethylene. Decreasing amount of vitamin A in storage might be explained as a result of degradation of carotenoids due to biochemical and enzymatic activities during storage. Also β-carotene is sensitive to high temperature.

4. CONCLUSION

This study has shown that **t**he *chin-chin* produced from 50% OFSP and 50% RBG was able to store for up to twelve (12) months when packaged in plastic bottles or high density polyethylene. The Vitamin A retentions were about 80% and 74% for plastic bottles and high density polyethylene respectively after 12 months of storage at ambient conditions of 29.95±5.00°C and relative humidity of 68.32±3.55%. Moisture was least absorbed by chin-chin packaged in plastic bottles. Texture, taste and overall acceptability were better retained when packaged in either plastic bottles or high density polyethylene.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. IPC International Potato Center. Sweet Potato Facts and Figures; 2010. Available:http://cipotato.org/crops/swetpotato/sweetpotato-facts-and-figures/
2. Yamakawa O. Development of new cultivation and utilization system for sweet potato towards the 21st century. In: Proc. Of Intl. Workshop on sweet potato production system toward the 21st century. Miyakonojo, Miyazaki, Japan. 1997;1-8.
3. USDA. United States Department of Agriculture Research Service. Unit Conversions. A US Government Initiative by the Office of Dietary Supplements and US Department of Agriculture; 2016. Available:http://dietarysupplementdatabase.usda.nih.gov/conversion.php.
4. FAO. Plant Production and Protection papers. Soybean production in the tropics. Food and Agric. Organization, U. N. Rome; 1982.
5. Makoto Y. Physiological functions and utilization of sweet potato. In; ray RC, Tomlins KI. (Eds) Sweet Potato: Post harvest Aspects in Food, Feed and Ind. Nova Science Pub. Inc. New York; 2010.
6. Rodriguez-Amaya DB, Kimura M, Washington DC. Harvest plus Handbook for carotenoid Analysis, Copyright Harvest Plus, 2004;1-63.
7. Woolfe JA. Sweet potato: an untapped food resource. Cambridge University Press. Cambridge CB2 1RP. 40 West 20th Street, New York, NY 10011-4211, USA; 1992.
8. Akoroda MO, Egeonu IN. Orange-fleshed sweet potato selection and duplication Efforts in Southern Nigeria. Proc. Of the first National Sweet Potato Conf. University of Ibadan, Nigeria. 2009; 89-93.
9. Ray RC, Tomlins KI. Sweet Potato: Post Harvest Aspects in Food, Feed and Industry. Nova Science Publishers, Inc. New York; 2010.
10. Antonio GC, Takeiti CY, Augustus de Oliveira R, Park KJ. Sweet Potato: Production, Morphological and Physicochemical Characteristics, and Technological Process. Fruit, Vegetable and Cereal Science and Biotechnology 5 (special Issue 2). Global Science Books. 2011;1-18.
11. Ezeaku CA. Fracture characteristics of Bambara groundnut in compressive loading. M.Sc. Engineering Thesis, University of Nigeria, Nnsukka; 1994.
12. Brough SH, Azam-Ali SN. The effect of soil moisture on the proximate composition of Bambara groundnut (Vigna subterranean L. Verdc). .J. Sci. Food and Agric. 1992;60:197-203.
13. Brough SH, Taylo AJ, Azam-Ali SN. The potential of Bambara groundnut (Vigna subterranean) in vegetable milk production and basic protein functionality systems. Food Chem. 1993;47:277-283.
14. Ibrahim HD, Ogunwusi AA. Industrial Potentials of Bambara Nut. Journal of Poverty, Investment and Development, 2016;22:12 – 18.
15. Addo A, Oyeleke OA. Nutritional Evaluation and Organoleptic Properties of Biscuits Supplemented with Bambara Groundnut Flour. A seminar paper. 1986;1-10.
16. Poulter NH. Properties of some protein fractions from Bambara Groundnut. Journal of Science and Food Agriculture. 1981;32:44-50.
17. Bamshaiye OM, Adegbola JA, Bamishoriye EI. Bambara groundnut: an under-utilized nut in Africa. Advances in Agricultural Biotechnology. 2011;1: 60-72
18. Obomeghei AA. Quality attributes of chin-chin from blends of bambara groundnut (Vigna subterranean (L.) verdc.) and pro-vitamin A fortified sweet potato (Ipomoea batatas (L) Lam). PhD Thesis of the University of Ibadan, Ibadan, Nigeria; 2019.
19. Quinn E. Chin Chin; 1998. Available:www.africanchop.com/chinchin.htm.
20. AOAC. Methods of Analysis of Association of Official Analytical Chemists, 18th Edition. Washington DC, USA; 2010.
21. Larmond E. Methods for sensory evaluation of food. Food Research Central Experimental farm, Canada department of Agriculture, Ottawa. 1977;1-13.
22. Eijckelhoff C, Dekker JP. A routine method to determine the chlorophyll a, pheophytin

a and β-carotene contents of isolated Photosystem II reaction center complexes. Photosynthesis Research. 1997;52(1):69-73.

23. Sakamoto S, Maurine S, Ide Y, Yamakawa O. 'Benihayato': a new sweet potato cultivar registered. Bull. Natl. Agric. Res. Cen. Kyushu Okinawa Region. 1987;24:255–277.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/59182