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 subterranea\ (L) \ Verdc.\]\) Flour Blend

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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.

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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.
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]. Literature 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±0.31 mm x 1.23±0.36 mm (LxBxH). The flow chat for chin-chin production is depicted in Fig. 1.

![Flow Chat](image-url)

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

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Footnotes:

18. [Ref to the specific method or reference for the production of chin-chin]
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 ≤ 0.05. These were computed using the scores allocated by the panel members using statistical package for social science (SPSS) software version 17.0

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≤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≤0.05) between the samples.

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

<table>
<thead>
<tr>
<th>Packaging material</th>
<th>M.C (%) fresh</th>
<th>M.C (%) 12 months</th>
<th>M.C increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Bottle</td>
<td>6.07±0.04</td>
<td>7.36±0.08</td>
<td>1.29±0.04 (21%)</td>
</tr>
<tr>
<td>High Density Polyethylene</td>
<td>6.07±0.04</td>
<td>7.59±0.04</td>
<td>1.52±0.00 (25%)</td>
</tr>
<tr>
<td>Low Density Polyethylene</td>
<td>6.07±0.04</td>
<td>8.92±0.13</td>
<td>2.85±0.09 (47%)</td>
</tr>
</tbody>
</table>

Mean with same superscript in a column are not significantly different (p ≤ 0.05 ± SD)
Table 2. Mean sensory attributes of 50:50 chin-chin after storage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before storage</th>
<th>PB</th>
<th>HDP</th>
<th>LDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste</td>
<td>7.80±0.42</td>
<td>7.70±0.95&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.95±0.84&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.00±1.05&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Flavour</td>
<td>7.10±0.31</td>
<td>8.30±0.82&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.10±0.74&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.60±0.84&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Colour</td>
<td>7.90±0.22</td>
<td>7.80±0.79&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.60±0.52&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.70±0.68&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Texture</td>
<td>8.20±0.29</td>
<td>8.10±0.88&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.10±0.57&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.40±0.52&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>8.60±0.27</td>
<td>8.20±0.79&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.70±0.68&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.80±0.63&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Packaging material</th>
<th>PB</th>
<th>HDP</th>
<th>LDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>432.83 (5.17)</td>
<td>432.83 (5.17)</td>
<td>432.83 (5.17)</td>
</tr>
<tr>
<td>Week 2</td>
<td>426.13 (5.09)&lt;sup&gt;(98.45%)&lt;/sup&gt;</td>
<td>414.05 (4.95)&lt;sup&gt;(95.66%)&lt;/sup&gt;</td>
<td>405.23 (4.84)&lt;sup&gt;(93.62%)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Week 3</td>
<td>416.01 (4.97)&lt;sup&gt;(96.11%)&lt;/sup&gt;</td>
<td>400.89 (4.79)&lt;sup&gt;(92.62%)&lt;/sup&gt;</td>
<td>393.42 (4.50)&lt;sup&gt;(90.20%)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Week 4</td>
<td>402.67 (4.81)&lt;sup&gt;(93.03%)&lt;/sup&gt;</td>
<td>392.23 (4.69)&lt;sup&gt;(90.62%)&lt;/sup&gt;</td>
<td>386.55 (4.62)&lt;sup&gt;(88.62%)&lt;/sup&gt;</td>
</tr>
<tr>
<td>12 Months</td>
<td>343.89 (4.11)&lt;sup&gt;(79.45%)&lt;/sup&gt;</td>
<td>317.98 (3.80)&lt;sup&gt;(73.47%)&lt;/sup&gt;</td>
<td>309.72 (3.70)&lt;sup&gt;(71.56%)&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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 the 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


22. Eijckelhoff C, Dekker JP. A routine method to determine the chlorophyll a, pheophytin