Shelf life of yam flour using two different packaging materials

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Citation

Abstract
This work investigates the shelf stability of yam flour packaged in Hessian bag. The proximate, physical and microbial properties of yam flour determined within 24 hours of production and packaged in Hessian bag and the polythene sample as control. These properties for the Hessian and polythene bag of yam flour were determined weekly for two months. The result showed that there were no significant difference (P≤0.05) between the crude fiber, crude protein, carbohydrate, ash, fat, density, bulk density, swelling capacity and pH for the yam flour packaged in hessian bag and the polythene bag. However, there were significant differences (p≤0.05) in the colour, water absorption capacity, moisture content, total viable bacterial and fungal counts at the end of storage. The moisture content of yam flour packaged in Hessian bag which was not significantly different from polythene bag showed that the Hessian bag is not moisture proof and will not be suitable for packaging yam flour. Also, less permeable plastic packaging materials such as polythen and polypropylene bags should be used for yam flour packaging to extent the shelf life of yam flour and ensures safety of the customers. It is therefore suggested that the use of Hessian bag for yam flour packaging should be discontinued and yam flour should not be stored unpackaged. The role of packaging in the food industry which includes protection, containment, preservation and advertisement is not attained in the use of Hessian bag for yam flour packaging.

1. Introduction

Yam is the common name for some species in the genus Dioscorea (family Dioscoreaceas). These are perennial herbaceous vines cultivated for the consumption of their starchy tubers in most of the world. Yam is primary agricultural and culturally important commodity in West Africa, where over 95 percent of world’s yam crop is harvested. Yams are still important for survival in these regions. Some varieties of these tubers can be stored up to six months without refrigeration, which makes them valuable resources for the yearly period of food scarcity at humid tropical countries as shown in Table 1.1.

This makes Nigeria the leading country in world’s yam production (FAO 2005). Yam tubers can grow up to 1500 m (4.9 feet) in length and weight up to 70 kg and 90 mm high. The vegetable has a rough skin which is difficult to peel, but which softens after heating. The skin varies in color from dark brown to light pink. Due to their abundance and importance to survival, the yam was highly regarded in Nigeria.
ceremonial culture and is part of many West African ceremonies (Jack Goody, 2000). The yam tuber, like other root crops is essentially a starch/carbohydrate food, its principal nutritional function being the supply of calories to the body. Yams are grown extensively in only three parts of the world; West Africa, The Caribbean, Island and Southeast Asia. The global production is over 25.5 millions tones. Yams with cassava provide a much greater proportion of carbohydrate intake in Africa, ranging from 6 percent in East and Southern Africa to about 16 percent in humid West Africa (Jack Goody, 2000). Traditionally, yam flour is prepared by slicing yam tubers to a thickness of about 1 cm after peeling, and then drying them in the sun until the moisture has been reduced to about 10 percent. In most cases the slices are parboiled before sun-drying which softens the tissues considerably and gives a more palatable product. Another method of consumption is to sundry the raw yam pieces when dry, the pieces turn a dark brown colour. This is then milled to create a powder known as “Elubo” in Nigeria. The brown powder can be prepared with boiling water to create a thick brown starchy paste known as “Amala” which also goes with local soups and sauces.

<table>
<thead>
<tr>
<th>Top yam producers</th>
<th>Quantity (million metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nigeria</td>
<td>26.6</td>
</tr>
<tr>
<td>Ghana</td>
<td>3.9</td>
</tr>
<tr>
<td>Australia</td>
<td>3.2</td>
</tr>
<tr>
<td>Cote devoir</td>
<td>3.0</td>
</tr>
<tr>
<td>Benin</td>
<td>2.3</td>
</tr>
<tr>
<td>Togo</td>
<td>0.6</td>
</tr>
<tr>
<td>Columbia</td>
<td>0.3</td>
</tr>
<tr>
<td>World total</td>
<td>39.9</td>
</tr>
</tbody>
</table>


1.1. The Nutritional Values of Yam

The predominant nutrient in yam is carbohydrates though carbohydrates are the most important elements in tubers. Yams are high in vitamin C, dietary fiber, vitamin B₆, potassium and Manganese, while being low in saturated fats and sodium. Vitamin C, dietary fiber and vitamin B₆ may all promote good health. Furthermore, the product is high in potassium and low in sodium is likely to produce a good potassium balance in the human body and so protect against osteoporosis and heart diseases. (Wikipedia, 2005).

1.2. Economic Importance of Yam

*Yam tubers are eaten boiled, roasted, fried and pounded

2. Materials and Methods

2.1. Materials

The instruments used for the proximate analysis are:

Weighing balance, fiber cap, filter paper, spatula, crude fiber capsule, posthine mortal, crucible, measuring cylinder, beaker, stirrer, spectra-photometer, soxhlet extractor, electric oven, muffle furnace, and desiccator.

2.2. Methodology

2.2.1. Crude Fiber

2g of the sample were measured into crude fiber capsule and 6.25ml of diluted conc. H₂SO₄ were prepared and distilled water were added to make it up to 500ml and diluted H₂SO₄ were poured into the fiber flask, condenser take place and running water was passed to it which is heated for 30 min. The sample and the capsule holder were rinse together after 30 min and NaOH (550 ml) were introduce into the fiber flask for another 30 min. it was remove and place inside an oven for drying and desiccators for cooling and weighed immediately. The experiment were repeated thrice and record was noticed.

2.2.2. Protein Content

0.5g of each sample, were measured into the digestion tube, 10ml of H₂SO₄ with a digestion tablet were added to facilitate the rate of the digestion and transfer into the digestion block. The sample was removed when the clear solution was observed and transfer into the round bottom flask, which were read in an atomic absorption spectrophotometer. The experiment were repeated thrice and record was noticed.

2.2.3. Fat

2g of the sample were measured and sealed with a filter paper which was transfer into a soxhlet extractor byusing n-hexane and round bottom flask for 72 hours. The sample were removed and placed inside an oven for drying and desiccators for cooling and weighed. The experiment were repeated thrice and record was noticed.

2.2.4. Moisture Content

2g of the sample were measured into each crucible, which were transfer into electric oven and place it on desiccators for cooling. Both the sample and the crucible were weighed. The experiment were repeated thrice and record was noticed.

2.2.5. Carbohydrate

With the results from the protein, crude fiber, fat and moisture content, the carbohydrate content were calculated. The experiment were repeated thrice and record was noticed.

2.2.6. Ash Content

2g of the sample were transfer into the crucible and placed in a furnace which set at 500°C temperature for 5 hours and ash is obtain which appear to be free from carbonous parts and transfer into the desiccators for cooling. The experiment was repeated thrice and record was noticed.
2.2.7. Density
Kerosene were introduce into the measuring cylinder, which were marked and the sample. The filter paper and the sample were and then differences were calculated (mass). Density was pipetted into the measuring cylinder which increased the volume \( p = \frac{m_1}{m_2} \). The experiment was repeated thrice and record was noticed.

3.2.8. Bulk Density
Empty beaker was weighed and water was added to fill it up (200ml). The beakers were rinse, the sample is introduced into it and then measured.

2.2.9. Colour
The colour was determined using colour meter at wavelength 570nm of model CIBA CORNING 252.

2.3. Sample Preparation and Experimental Set-Up

The yam was processed into yam flour, peeling was done manually. The peeled yam was parboiled in hot water for a period of 12hours, after it has been sliced into chips. Yam chip were sun dried until the moisture content has been reduced to about 10%. The dried yam chips were then grinded using hammer mill and burr-mill. The grinded flour was sieved with a wooden polyester sieve to separate the fibrous material over size and also to ensure uniformity in particles sizes. It was then divided into two samples. The first sample was packaged in Hessian bag while the remaining sample was packaged in polythene bag. The two samples were then stored at room temperature, with the initial proximate, physical and microbial properties of the yam flour determined. The temperature and relative humidity were taken at 24hours intervals.

2.3.1 Proximate and Physical Analysis

The proximate and physical analysis of yam flour was determined after two months of its production. The crude protein in the yam flour sample was determined by the routine semi-micro field procedure/technique, crude fiber, fat, ash, and moisture, \( p^H \), and carbohydrate contents as described by Association of Analytical Chemists, AOAC (2002). The swelling capacity, density, bulk density water absorption capacity was determined by prescribed by Abbey and Ibeh (1999). Colour was determined as a function of absorption using colour meter at wavelength 570nm of model CIBA CORNING 252.

2.3.2. Microbial Analysis
The total fungal and bacterial plate counts were determined using the methods of Holding Collee (1971). 0.2ml of each dilution of the sample was pipette into the center of the appropriate dishes containing the Maconkey, potato dextrose and nutrient agar in duplicate. The dishes in which the solution was placed were allowed to set, inverted and incubated at 37°C for 72h. The colonies that developed on the plate were counted and recorded after the incubation period.

2.3.3. Statistical Analysis
The data obtained were subjected to statistical analysis using SPSS 16.0. A one way analysis of variance (ANOVA) was carried out to determine differences and Duncan’s multiple range tests to separate means.

3. Results and Discussion

3.1. Result
3.1.1. The Initial Properties of Yam Flour Sample before Packaging. The results showed that the yam flour has an initial crude fiber content of 1.80 %, crude protein of 1.91 %, fat content of 0.90 %, moisture content of 3.50 %, ash content of 1.10 % and carbohydrate content of 75.30 %. The sample has a \( p^H \) of 4.5, density of 1.05g/cm\(^3\), swelling capacity of 30.40 %, bulk density 2.20 g/cm\(^3\) and water absorption capacity of 3.90 g/g at the commencement of the experiment. The crude fiber, crude protein, fat, ash and carbohydrate contents are within the same range with Akindahunsi. (1991); Oboh and Akindahunsi (2003); Ikhu- Omorhaye, 2008 and Opara, 1999 reported for cassava, yam product (“gari”, lafun”, yam flour) in Nigeria. The overall physical and chemical properties of yam flour samples were within the FAO recommended standard for yam flour quality (FAO/WHO, 1991).

The average temperature and relative humidity of the storage environment obtained during the storage period ramped between 16.0-33.5°C and 48.6-75.5% respectively this spanned through the dry and wet season. These temperature and relative humidity ranges for the storage environment are within those ranges reported for Oyo state, Nigeria (FAO, 2002) being the location of this experiment. These environmental conditions also exist in different parts of Nigeria at different times of the year. The temperature and relative humidity of the environment plays an important role in the stability of stored dehydrated food products.

3.1.2. The Effect of Hessian Bag on the Shelf Stability of Packaged Yam Flour
The weekly average properties of the yam flour package in Hessian bag stored at a temperature and relative humidity range of 16.0 - 33.5°C and 48.6 - 75.5% respectively are as presented in Table 3.1.

Statistical analysis showed that storage duration had no significant effect (\(p<0.05\)) on the crude protein, ash and density. There were significant (\(p<0.05\)) decrease from the initial values of the crude fiber form 1.80 to 1.15%, carbohydrate form 75.30 to 64.20% and bulk density form 2.20 to 2.02g/cm\(^3\), while there were significant (\(p<0.05\)) increases from the initial values of the fat from 0.90 to 1.04%, moisture form 3.50 to 12.70%, swelling capacity from 30.40 to 48.83%, water absorption capacity from 3.90 to 4.20g/g, colour from 2.10 to 2.21 and \( p^H \) from 4.50. Table 4.1.

The variation in the properties of yam flour packaged in Hessian bag were compared with the properties of yam...
flour in open container (Table 3.2) to evaluate the effect of Hessian bag on the quality of yam flour during the storage period.

Table 3.1. The weekly mean proximate and physical properties of yam flour packaged in Hessian Bags.

<table>
<thead>
<tr>
<th>Week</th>
<th>Crude fiber</th>
<th>Fat content</th>
<th>Moisture content</th>
<th>Carbohydrate</th>
<th>Swelling capacity</th>
<th>Bulk density</th>
<th>Colour</th>
<th>P at 95%</th>
<th>Water absorption capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.80b</td>
<td>0.90b</td>
<td>3.50b</td>
<td>75.40b</td>
<td>30.40b</td>
<td>2.20b</td>
<td>5.50b</td>
<td>5.50b</td>
<td>3.90b</td>
</tr>
<tr>
<td>1</td>
<td>1.23a</td>
<td>1.05b</td>
<td>3.70b</td>
<td>71.20c</td>
<td>47.73c</td>
<td>2.17c</td>
<td>2.30c</td>
<td>6.42b</td>
<td>4.90d</td>
</tr>
<tr>
<td>2</td>
<td>1.30a</td>
<td>1.00b</td>
<td>5.50a</td>
<td>89.25c</td>
<td>37.44c</td>
<td>2.17c</td>
<td>2.30c</td>
<td>6.42b</td>
<td>4.75d</td>
</tr>
<tr>
<td>3</td>
<td>1.24a</td>
<td>1.01b</td>
<td>8.90c</td>
<td>86.65d</td>
<td>35.74d</td>
<td>2.14e</td>
<td>2.17e</td>
<td>6.41b</td>
<td>4.59d</td>
</tr>
<tr>
<td>4</td>
<td>1.16a</td>
<td>1.01b</td>
<td>10.00d</td>
<td>85.60e</td>
<td>37.33e</td>
<td>2.15e</td>
<td>2.14e</td>
<td>6.38b</td>
<td>4.17d</td>
</tr>
<tr>
<td>5</td>
<td>1.18a</td>
<td>1.02b</td>
<td>11.40e</td>
<td>84.11f</td>
<td>36.67f</td>
<td>2.13e</td>
<td>2.16e</td>
<td>6.35e</td>
<td>4.09d</td>
</tr>
<tr>
<td>6</td>
<td>1.15a</td>
<td>1.04b</td>
<td>13.70f</td>
<td>81.65g</td>
<td>38.83g</td>
<td>2.19f</td>
<td>2.29f</td>
<td>6.40g</td>
<td>4.20d</td>
</tr>
</tbody>
</table>

% variation 34.2  15.6  204.4  9.7  30.7  8.6  9.0  16.4  8.8

Means of three replicates, Means with the same letters for a particular measurement are not significantly different (p≤0.05).

Table 3.2. The weekly means ^1^ proximate and physical properties of yam flour packaged in polythene.

<table>
<thead>
<tr>
<th>Week</th>
<th>Crude fiber</th>
<th>Crude protein</th>
<th>Fat content</th>
<th>Moisture content</th>
<th>Carbohydrate</th>
<th>Swelling capacity</th>
<th>P at 95%</th>
<th>Water absorption capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.80b</td>
<td>1.91bc</td>
<td>0.90b</td>
<td>3.50b</td>
<td>75.40b</td>
<td>30.40b</td>
<td>5.30b</td>
<td>3.85b</td>
</tr>
<tr>
<td>1</td>
<td>1.10a</td>
<td>0.08a</td>
<td>1.10a</td>
<td>5.00b</td>
<td>71.21c</td>
<td>37.50c</td>
<td>6.50b</td>
<td>6.10d</td>
</tr>
<tr>
<td>2</td>
<td>1.11a</td>
<td>0.98e</td>
<td>1.90c</td>
<td>7.20c</td>
<td>88.54c</td>
<td>36.50c</td>
<td>6.50b</td>
<td>6.15c</td>
</tr>
<tr>
<td>3</td>
<td>1.12a</td>
<td>1.07bc</td>
<td>1.04c</td>
<td>8.50d</td>
<td>87.35d</td>
<td>34.10d</td>
<td>6.50b</td>
<td>5.63d</td>
</tr>
<tr>
<td>4</td>
<td>1.12a</td>
<td>1.07bc</td>
<td>1.04c</td>
<td>10.10c</td>
<td>85.55e</td>
<td>35.20c</td>
<td>6.50b</td>
<td>5.40e</td>
</tr>
<tr>
<td>5</td>
<td>1.14a</td>
<td>1.17c</td>
<td>1.04c</td>
<td>12.60f</td>
<td>83.05f</td>
<td>35.10c</td>
<td>6.48b</td>
<td>5.37e</td>
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<tr>
<td>6</td>
<td>1.15a</td>
<td>1.17c</td>
<td>1.03h</td>
<td>14.80g</td>
<td>80.73h</td>
<td>36.20d</td>
<td>6.49b</td>
<td>5.38e</td>
</tr>
</tbody>
</table>

% variation 39.5  64  14.0  228.9  10.7  21.9  18.0  39.7

Means of three replicates, Means with the same letters for a particular measurement are not significantly different (p≤0.05).

Table 3.3. ANOVA of the properties significantly affected by Hessian Bag.

<table>
<thead>
<tr>
<th>Sum of squares</th>
<th>Df</th>
<th>Mean squares</th>
<th>F</th>
<th>Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Group</td>
<td>0.247</td>
<td>1</td>
<td>0.247</td>
<td>16.295</td>
</tr>
<tr>
<td>Within Group</td>
<td>0.606</td>
<td>40</td>
<td>0.015</td>
<td>0.008</td>
</tr>
<tr>
<td>Total Group</td>
<td>0.853</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water absorption capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Group</td>
<td>11.671</td>
<td>1</td>
<td>11.671</td>
<td>35.267</td>
</tr>
<tr>
<td>Within Group</td>
<td>13.237</td>
<td>40</td>
<td>0.33</td>
<td>0.000</td>
</tr>
<tr>
<td>Total Group</td>
<td>24.908</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TVFC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Group</td>
<td>37381.167</td>
<td>1</td>
<td>37381.167</td>
<td>12.375</td>
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<tr>
<td>Within Group</td>
<td>120825.490</td>
<td>40</td>
<td>3020.637</td>
<td>12.375</td>
</tr>
<tr>
<td>Total Group</td>
<td>158206.656</td>
<td>41</td>
<td></td>
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<tr>
<td>TVBC</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Between Group</td>
<td>1337.357</td>
<td>1</td>
<td>1337.357</td>
<td>6.570</td>
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<tr>
<td>Within Group</td>
<td>8142.823</td>
<td>40</td>
<td>203.571</td>
<td>6.570</td>
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<tr>
<td>Total Group</td>
<td>9480.180</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p at 95%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between group</td>
<td>0.089</td>
<td>1</td>
<td>0.089</td>
<td>0.677</td>
</tr>
<tr>
<td>Within group</td>
<td>5.240</td>
<td>40</td>
<td>0.131</td>
<td>0.415</td>
</tr>
<tr>
<td>Total</td>
<td>5.328</td>
<td>41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


The colour, water absorption capacity, total viable fungal and bacterial counts of the yam packaged in Hessian bags were significantly lower (p<0.05) than the one packaged in polythene bags.
3.2. Discussion

The moisture content increased in both the Hessian and polythene bag of the yam flour by over 200% its initial value after two months of storage this showed that Hessian bag is not moisture resistant. The increase in the moisture content of yam flour packaged in Hessian bag was a result of the increase in the relative humidity of the storage environment and since the Hessian bag is not totally impermeable to moisture and gases. The increase in moisture leads to the increase in the water absorption of yam flour and microbial load due to the fact that most micro-organisms require moisture to grow.

The microbial organisms (mound and fungi) are grayish in colour as observed by Holding and colelee, 1971, this account for the increase in colour of yam flour. The decrease in the crude fiber, ash, carbohydrate, density, and bulk density was as a result of concentration effect resulting from increase/decrease in moisture content.

The higher values of crude protein, carbohydrate, swelling capacity water absorption capacity, density and bulk density of Hessian bag compared to polythene bag was due to concentration effect due to slightly lower moisture absorbed by the packaged sample Hessian bag in conformity with canovas and Mercado, 1996; Oluwole et al., 2004. The lower the moisture absorbed the lower the water absorption capacity, density and bulk density of the product. The decrease in bulk density was a result of the increased moisture content which will cause an increase in the volume of the yam flour thereby reducing the bulk density. The increase in colour was due to the increase in moisture content which will influence and encourage microbial activities in the Hessian bag. The high moisture absorbed by the polythene bag of yam flour resulted in the higher microbial load, fat and colour content and the lower swelling capacity of the product this agrees with the reports of Ogeihor et al. (2005) and Steinkraus (1993).

The steady and gradual increase recorded in the total viable bacterial and fungal counts in the Hessian and polythene sample suggest a favorable micro environmental condition and nutrient availability. The variation in the count observed may be attributed to the permeability to atmospheric gases such as oxygen, carbon dioxide and water vapour by the Hessian bag. Similar reports for other food items have been documented. In addition the high fungal count compared to the bacterial count was due to the ability of fungi to tolerate and survive in slightly harsh environment condition such as low pH and low moisture content. However, the microbial load of the yam flour packaged in Hessian bag at the end of the three month storage period is still within the limits and in agreement with the reports of Ihabadeniyi (2007) while the polythene are still more acceptable.

References

[9] FAO Agricultural Service Bulltin 89.Rome FAO.


