Full Length Research

Production and Proximate Composition of Ogiri-Ahuekere (Arachis hypogaea Linn) Seed condiment

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The production and evaluation of ogiri-ahuekere- fermented groundnut (Arachis hypogaea Linn) seed condiment were studied. The groundnut seeds were sun-dried for 8 hours, dehulled and boiled for 8 hours. The cooked cotyledons were milled manually into a paste and wrapped in small portions (30g) with blanched plantain leaves. The wrapped samples were fermented in a container for 1–10 days while the unfermented cooked groundnut paste was used as a control. The effects of fermentation time on the proximate composition of ogiri-ahuekere samples were evaluated. Statistical analyses of the data were carried out using ANOVA method with the application of SPSS Version 20. The significant difference between the mean values was determined by Tukey’s test at 95% level of confidence. Comparison of proximate composition of unfermented ahuekere with ten days fermented ogiri-ahuekere samples had the following: carbohydrate (47.40% and 20.79%), protein (18.20% and 32.63%), fat (18.78% and 33.06%), ash (2.88% and 1.47%), fibre (2.60% and 1.40%), and moisture (10.14% and 10.65%) respectively. Fermentation time significantly decreased carbohydrate, ash and fibre but increased fat and protein. This showed that increase in the fermentation time improved the quality of the ogiri-ahuekere samples.

Key Words: Condiment, Ogiri, Groundnut, Fermentation, Proximate Composition.

Introduction

A condiment is an edible substance which is added to some foods to impart/enhance its flavour or texture. They are healthy diets which boost brain power, protect the heart and prevent cancer. Generally, they are referred to as oily pastes made from oil seeds in West Africa. The fact that these pastes are called by the same name by different ethnic groups is an indication of a common origin (Chukwu et al., 2017, 2018).

The Yorubas of the Southwest Nigeria locally call fermented condiment made from African locust beans (Parkia biglobosa) “iru” while the Hausas who inhabit most of the Northern part of Nigeria call condiment produced from soya bean “daddawa” (Popoola and Akueshi, 1984; Ogbadu and Okagbue, 1988) and condiment from bambara groundnut is called “dawadawa” (Barimalaa et al., 1989). “Ogiri” as the name used by the Ibos of the Southeast of Nigeria is made from melon seeds while ogiri-igbo made from castor seeds (Odunfa, 1985b) and ogiri-ugu is produced from fluted pumpkin seeds (Barber et. al., 1989; Odibo and Umeh, 1989). “Owoh”, on the other hand, is the popular name among Urhobos and Itskiri in Niger Delta region of Nigeria for food condiments which is produced from African Yam beans (Ogbonna et al., 2001) and cotton seeds (Sanni and Ogbonna, 1991). Similarly, “okpiye” is popular among Igala people of the Middle Belt region and is produced from Prosopis africana (Achi, 1992). Odibo et al. (1992) called condiment from Prosopis africana, “okpehe” while Sanni, (1993) called it “ogiri-okpefi”.

“Ogiri” is prepared from fermented Sesame seeds (Sesame indicum L), is also called bean seeds. Sesame is an important source of protein in the developing countries especially in Sierra Leone. The art of making condiments was introduced in Sierra Leone probably by
the free slaves, mostly Nigerians who settled there. Ogiri is widely used as condiments, sometimes in the daily preparation of soups, sauces and stews (Achi, 2005; Chukwu et al., 2018).

Obizoba and Atu (1993) reported that four (4)-day fermentation period caused the highest increases in protein and decreases in ash, lipids and non-protein nitrogen (NPN). Fermentation times have various effects on mineral levels. Fermentation for 4 days increased zinc, sodium and phosphorus. In contrast, Oladunmoye (2007) found that the mean composition of carbohydrates decreases from 19.30% of the raw sample to 17.09% of the fermented locust beans; while the moisture content decreases from 12% to 42.65%, the fat content decreases from 21.02% of raw sample to 10.10% in fermented locust bean; ash content decreases from 4.47% of unfermented locust bean to 4.31% of fermented locust beans. The crude fibre also decreases from 13.06% to 8.53% in the fermented locust beans, while protein contents decreases from 30.17% to 17.32%. Sanni et al. (2000) reported that the moisture contents of iru, ugba and ogiri are 57.18%, 46.32% and 42.34% respectively, while the protein contents are 18.26%, 17.17% and 17.96% respectively. The percentage fat is 29.88%, 40.25% and 44.14% for iru, ugba and ogiri respectively. The ash content ranges from 5.8-6.1%.

David and Aderibigbe (2010) observed that the moisture content of unfermented melon seeds and 4 days fermented ogiri egusi samples increased from 7.13% to 35.43%, ash content increased from 2.85% to 3.56%, carbohydrate increased from 11.03% to 24.43%, protein decreased from 32.27% to 29.37%, fat decreased from 50.13% to 33.95% and fibre decreased from 3.53% to 2.57%. Akinleye and Oloruntoba (2013) reported that average proximate composition of unfermented ogiri-egusi was crude fibre 7.14%, crude protein 37.41%, crude fat 29.55%, ash 3.17% and moisture 4.77%; while after five days fermentation, the proximate composition was crude fibre 11.43%, crude protein 33.3%, crude fat 33.54%, ash 3.17% and moisture 8.25%.

Chukwu et al. (2010) found that moisture content raw locust bean and dawadawa are 7.01% and 37.10% respectively. This increase may be as a result of metabolic activities of microorganisms during fermentation period which give out moisture as one of their end-products (Omafuvbe et al., 2003). The crude fibre decreases from 4.70% to 2.00% while lipid content increases from 9.57% to 21.17% and crude protein values are 28.0% and 38.5% for raw bean and dawadawa. This is because there are reduction in carbohydrates, ash and crude fibre content. They further reported that Bacillus subtilis involves in the fermentation shows proteolytic activity and may contribute to high protein content. Bacillus subtilis has been known to cause hydrolysis of protein to amino acids and peptides. In the process, ammonia is released, which increases the protein content of the fermented products (Chukwu et al., 2010). The slight reduction in the ash content (2.0%-1.8%) may be due to leaching of soluble minerals in the processed sample during boiling. The carbohydrate content decreases from 55.73% to 36.53% may be due to leaching into the cooking water while some are lost during fermentation due to the utilization of some sugars by fermenting organisms for growth and metabolic activities (Asibuo et al., 2008).

The effect of fermentation on the nutrient content of locust beans: that protein and fat increase when fermented whereas the quality of carbohydrates decreases. Increased levels of the amino acids are also reported except for arginine, leucine, and phenylalanine. Similar results are reported for other seed legumes (Achinewhu, 1986b; Odunfa, 1985b). Soluble products increase during fermentation of melon seeds resulting in high digestibility of the fermented product. Alanine, lysine and glutamic acid are the predominant amino acids, with arginine and proline occurring in small amounts. The improved nutritive values are attributed to the increase in amino acid profiles due to fermentation (Aidoo, 1986; Achi, 2005).

Food condiments made from vegetable protein may be a good source of certain B-vitamins, but are deficient in ascorbate and some fat-soluble vitamins, which are lost during fermentation. Achinewhu and Ryley (1987) have shown that fermentation significantly increases the content of thiamin, riboflavin and niacin in the African oil bean. Similarly changes have been observed during the fermentation of melon seed and fluted pumpkin seed (Achinewhu, 1986a, b). Ogbonna et al., (2001) observed increases in calcium, phosphorus and potassium when African yam bean is fermented for condiment production. This is in contrast to previous results of Achinewhu (1986b), which report that decrease in calcium, copper and phosphorus but increased iron and zinc in fluted pumpkin. It is evident that fermented food condiment is a good source of nutrients and could be used to produce complementary food supplements. Macronutrients in fermented legumes contribute to enhanced food quality (Fagbemi et al., 2005).

However, Enujiugha (2003) has shown that fermentation for 72 hours slightly increases the crude protein and ash content of ugba. The amino nitrogen increases steadily from 1.23mgN/g dried matter prior to fermentation to 13.68mgN/g dried matter after 72 hours of fermentation. He also found that the principal fatty acids-linoleic acid increases from 60.68% to 67.57% of the total fatty acids while oleic acid decreases from 26.95 to 22.59%. Palmitic acid and other saturated fatty acids in the seed oil are also slightly affected by the fermentation. However, Onwuliri et al. (2004) found that fatty acid concentrations do not change appreciably with processing and fermentation. There is also accumulation of formic acid, acetic, lactic and butyric acids and goes to 0.20, 0.18, 0.35 and 0.41mg/g respectively after 72 hours of fermentation (Ogueke et al., 2010).
Many families in West Africa often use fermented condiments as low cost meat substitute. Condiments are primarily used as flavour intensifiers for soups and to enhance sweetness. The liberal use of condiments is expected to increase the intake of high levels of protein, minerals and vitamins. It could be used to produce complementary food supplements which add advantage over seasoning salts that now tend to replace the local condiments in our kitchen (Giami and Barber, 2004).

Fermented condiments help to reduce high cholesterol levels in the blood. It strengthens and supports our digestive and immune system thereby helping our bodies to fight and prevent diseases like cancer, tuberculosis, and cardiovascular complication. Fermented condiments improve nutritive values of foods as well as sensory properties as taste enhancers. Fermentation increases the phenolic content and antioxidant capacity of fermented bambara groundnut, and condiment produced from bambara groundnut seeds could serve as a cheap functional food. Traditionally, legumes and oil seeds are usually fermented into local condiments which serve as soup thickeners and flavour enhancers in food preparation. Fermentation is being shown not only to improve the nutritional quality of legume seeds but also to increase the antioxidant properties by increasing their potentials as functional foods (improvement of conventional foods with added health benefits) and nutraceutical sources (Ademiluyi and Oboh, 2011).

Although saponins have been reported to be toxic, they may be beneficial since they have been found to lower plasma cholesterol. Monago et al. (2004) have shown that condiments fermented for up to four days decreased the level of plasma cholesterol in rats, the rate of decrease increasing with the time (days) of fermentation. Thus, consumption of the well fermented products promotes health. Chidzie (2006) has shown that administration of the fermented seeds as a food supplement have greatly reduced the risk of cancer and other oil seeds. The fungus can only grow when the environmental conditions are favourable to fungal growth (Nevius, Oni, 2008).

Aspergillus flavus is present in groundnut and some other oil seeds. The fungus can only grow when the moisture content of the seeds exceed 9%. This mostly happened due to poor storage conditions which allow pods or kernels to become damaged and contaminated (Kabagambo et al., 2005). Aflatoxins are a group of secondary metabolites produced by certain toxigenic strains of Aspergillus flavus and Aspergillus parasiticus of various foods and feed commodities. They are highly toxic and have been implicated epidemiologically as environmental carcinogens in men and animal toxins. Aflatoxins are intensely fluorescent under uv light. There are four major types of aflatoxin namely B1, B2, G1 and G2. A wide range of agricultural products as well as industrial commodities get contaminated with aflatoxin. Aflatoxins produce liver lesions and can result to death when the dose is sufficiently high, but lower dose can produce chronic effects like lethargy, hepatitis, etc. Aflatoxin B1 is the most potent hepatocarcinogen (liver cancer promoting compound). Hepatocarcinogens are compounds that cause cancer of the liver (Iwu et al., 2011).

Ingale and Shrivastava (2011) reported that the values of cyanide content, tannin content and oxalate content are 4.818, 0.412 and 0.180/100g respectively in groundnut seeds. No inhibition of trypsin was found in groundnut. Groundnut has haemagglutinin activity for chicken and human blood group was found. Inuwa et al. (2011) reported that the lethal dose of some anti-nutritional factors is as follows: oxalate (2-5g/kg), phytate (50-60mg/kg), tannin (30mg/kg), cyanogenic glycoside (50-60g/kg), hemagglutinin (50mg/kg), and trypsin.
inhibitor (2.50g/kg). Ingale and Shrivastava (2011) indicated low levels of anti-nutritive factors in ground nut seeds (Gupta and Shrivastava, 2004). The continuous exposure of HCN through diet may lead to pancreatic diabetes, Vitamin B12 deficiency and decreased uptake of iodine by thyroid glands which may further lead to goiter. Tannins are the oligomeric higher molecular weight polyphenolic compounds occurring naturally in plants. Due to their binding ability with proteins and carbohydrates, tannins can inhibit digestive enzymes and reduce the bioavailability of different proteins (Muhammad et al., 2009). The low levels of anti-nutrients could enhance absorption of nutrients in groundnut seeds. The anti-nutritional contents of groundnut husks are below the lethal level and are safe for consumption. It is envisaged that the usability of groundnut husks as agricultural feed would solve a waste disposal problem and help in turning the waste around us for wealth (Abdurazak et al., 2014).

Thompson et al. (2010) reported that groundnuts seeds can be eaten raw, cooked, use in recipes, made into solvents and oil, used in make-up, medicine, textile materials, groundnut butter as well as many other uses. It used to help fight protein malnutrition because it has high protein, high energy, and high nutrient groundnut based pastes that were developed to aid in famine relief. Low grade or culled groundnuts, not suitable for the edible market, are used in the production of groundnut oil. The protein cake (oil cake meal) residue from oil pressing is used as an animal feed and as soil fertilizers. The low grade groundnuts are also widely sold as garden bird feed. Groundnut can be used like other legumes and grains to make lactase-free milk like beverages and peanut milk (Chukwu et al., 2018).

The main objective of this work is to produce ogiri-ahuekere from boiled fermented groundnut seeds using traditional method and determine the proximate composition of the fermented condiment samples;

MATERIALS AND METHODS

Source of Materials: The groundnuts seeds were bought from a local market at Aba, Abia State, Nigeria. The reagents used were of analytical grade. Reagents were produced by BDH Chemicals Ltd, Poole England.

Production of Ogiri Samples: Five hundred grams (500g) groundnut seeds were weighed and spread under the sun for 8 hours easy removal of the seed coats (hulls). The hulls were removed by rubbing the seeds in between the palms (Wakshama et al., 2009, 2010; Chukwu et al., 2017, 2018).

Preparation of Ogiri from Dehulled Groundnut Seeds: The cotyledons were boiled for eight (8) hours. After which the water was drained-off and allowed to cool. The cooked cotyledons were milled into a paste manually using pestle and mortar. The paste was wrapped in small portions of approximately 30g with blanched plantain leaves and left to ferment in a container for 1–10 days (Omafuvbe et al., 2003a, b). The unfermented sample served as control and the other ten samples were known as ogiri-ahuekere (fermented groundnut condiment). Both the fermented condiment and unfermented condiment were used for analyses. Figure 1 shows the flow diagram for the production of ogiri-ahuekere (Chukwu et al., 2017, 2018).

Proximate Analysis of Ogiri-Ahuekere

Dried fermented ogiri-ahuekere samples were used for the proximate analysis.

Protein Determination

The protein content was determined using the methods described by AOAC (2005). Approximately 0.5g of each sample was weighed into digestion flask, digested with 10ml of concentrated H2SO4 and a tablet of selenium catalyst was added into the flask. The process was accelerated by heating in a fume cupboard until a clear light green solution was obtained. The digest was carefully diluted to 100ml with distilled water followed by distillation using 10ml of 40% boric acid and 45% sodium hydroxide solution containing three drops of mixed indicator (bromocresol green and methyl red), and a total of 50ml distillate was obtained and titrated against 0.02N EDTA/ H2SO4. Titration was carried out until the titre turned from the initial green colour to a deep red end point. The nitrogen (N2) content was calculated as shown in Equation 1:

\[
\%N_2 = \frac{[100XN \times 4XV_f] - B}{W \times 100 \times V_A}
\]

Where

- W = weight of sample analyzed = 0.5g
- N = normality of titrant = 0.02N
- V_t = total volume of digest = 100ml
- V_a = volume of digest distilled = 50ml
- Y = litre value of the sample
- B = Blank litre value

The percentage protein content was calculated using % N2 x 6.25. The protein content of each sample was repeated three times and the average was calculated (Onwuka, 2018).

Fat Determination

The fat contents of the samples were determined by the
solvent extraction method using Soxhlet apparatus described by AOAC (2005) and Onwuka (2018). About 5g of each sample was wrapped in a porous paper (Whatman No.1 filter paper). The wrapped sample was placed in an extraction thimble. The thimble was placed in a Soxhlet reflux flask containing 200ml of petroleum ether. The upper end of the reflux was connected to a water condenser. The solvent (petroleum ether) was heated, boiled, vaporized and condensed into the reflux flask. The sample remained in contact with the solvent until the reflux flask filled up and siphoned over, carrying its oil extract down to the boiling flask. This process was allowed to run repeatedly for at least four (4) hours before the defatted samples were removed, the solvent recovered, and the oil extract was left in the flask. The flask, containing the oil extract was dried in the oven at 60°C for 30minutes to remove any residual solvent. Oil extracts were cooled in desiccators and weighed. By difference, the weight of fat extract was determined and expressed as a percentage of the weight of sample analysed and given the expression in Equation 2.

\[
\% \text{ Fat} = \frac{W_2 - W_3}{W_3} \times 100 \tag{Equation 2}
\]
Where
- \( W_1 \) = weight of flask
- \( W_2 \) = weight of flask and extracted fat
- \( W_3 \) = weight of sample

This analysis was done in triplicates of each sample. The means were calculated and recorded accordingly.

Moisture Content Determination

This was done by the gravimetric method as described by AOAC (2005) and Onwuka (2018). About 5g of each sample was weighed and put into a weighed moisture can. The can and its sample content were dried in the oven at 105°C for 3 hours in the first instances. It was cooled in desiccators and reweighed. The weight was recorded while the sample was returned to the oven for further drying. The drying, cooling and weighing were repeated until a constant weight was obtained. The weight of moisture lost was determined by difference and expressed in percentage. It was calculated as in Equation 3:

\[
\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \tag{Equation 3}
\]
Where
- \( W_1 \) = weight of empty moisture can
- \( W_2 \) = weight of can + sample before washing and drying in the oven
- \( W_3 \) = weight of can + sample after drying to a constant weight

This was done in triplicate and mean value was calculated.

Ash Content Determination

This was done using the furnace incineration gravimetric method (AOAC, 2005) and Onwuka (2018). About 5g of each sample was put in a previously weighed porcelain crucible. The sample in the crucible was put in a muffle furnace set at 550°C and allowed to burn for 2-3 hours. The sample was carefully removed from furnace and cooled in desiccators. Each sample was reweighed and the weight of the ash was obtained by difference and expressed as percentage using the formula given in Equation 4:

\[
\% \text{ Ash} = \frac{w_2 - w_3}{w_2 - w_1} \times 100 \tag{Equation 4}
\]
Where
- \( W_1 \) = weight of empty crucible
- \( W_2 \) = weight of crucible + weight of sample
- \( W_3 \) = weight of crucible + weight of ash

This was done three times and the mean value was calculated.

Crude Fibre Determination

This was determined by the method as described by AOAC (2005) and Onwuka (2018). About 5g of each sample was defatted (during fat analysis). The defatted samples were boiled in 200ml 1.25% \( H_2SO_4 \) solution under reflux for 30 minutes. After which, each sample was washed with several portions of hot (boiling) water using two–fold Mushin cloth to trap the particles. The washed sample was carefully put backed to the flask. 200ml of 1.25% sodium hydroxide (NaOH) solution was added to flask. Again, the sample was boiled for 30 minutes and washed as before with hot water. Each sample was carefully transferred to a weighed porcelain crucible and dried in the oven at 105°C for 3 hours. After cooling in desiccators, they were reweighed, put in a muffle furnace and incinerated at 550°C for two hours. Again, they were cooled in desiccators and reweighed. The crude fibre content was calculated using Equation 5:

\[
\% \text{ Crude fibre} = \frac{w_2 - w_3}{w_2 - w_1} \times 100 \tag{Equation 5}
\]
Where
- \( W_1 \) = weight of empty crucible
- \( W_2 \) = weight of crucible + sample before washing and drying in the oven
- \( W_3 \) = weight of crucible + sample after drying

Carbohydrate Content Determination

The carbohydrate content was calculated by difference as described by AOAC (2005) and Onwuka (2018).
%Carbohydrate = 100 – (%(a + b + c + d + e)  
Equation 6

Where a = protein
b = fat
c = fibre
d = ash
e = moisture

The results obtained were recorded according to the days of fermentation.

Statistical Analysis

The data obtained from the analyses were analysed statistically using the Analysis of Variance (ANOVA) method with the application of SPSS Version 20. The difference between the mean values was determined by Tukey’s test. Significance was accepted at 5% probability level (Pallant, 2004). Figure 1

DISCUSSION

Proximate Composition of Ogiri-Ahuekere Fermented from 0-10 Days

Table 1 shows the proximate composition of ogiri-ahuekere produced from groundnut seeds fermented from zero to 10 days. There were significance differences in the proximate compositions among the ogiri-ahuekere samples at 95% level of confidence.

Carbohydrate Contents of the Ogiri-Ahuekere Samples

Table 1 showed that the carbohydrate contents of the samples significantly (p ≤ 0.05) reduced as the fermentation time (0-10 days) increased. The carbohydrate content of the unfermented groundnut sample (47.40%) was significantly different from that of ogiri-ahuekere fermented for 1day (44.90%). There were significant differences among the ogiri-ahuekere samples fermented for 0-5 day(s). It was observed that there was progressive reduction of carbohydrate contents (47.40-29.81%) of the ogiri-ahuekere samples fermented from 0-5 day(s). The ogiri-ahuekere samples fermented for 5, 6 and 7 days had carbohydrate contents of 29.81±0.78%, 29.04±0.32% and 28.63±1.00% respectively which were statistically the same. Table 1 showed that there was no significant reduction in the carbohydrate contents of the samples fermented for 5, 6 and 7 days respectively. In addition, there was a significant difference between that of 7 and 8 days fermentation of ogiri-ahuekere samples. Furthermore, there was no significant difference in carbohydrate contents of ogiri-ahuekere samples from 8 and 9 days fermentations while there was a significant difference between the carbohydrate contents of ogiri-ahuekere of samples from 8 and 10 days fermentation which were 24.48% and 20.79% respectively. Similarly, there was no significant difference in carbohydrate contents of samples from 9 and 10 days fermentations. The significant reduction of the carbohydrate contents of the ogiri-ahuekere samples indicates that increased fermentation time helps the microorganisms to breakdown the polysaccharides thereby reducing the carbohydrate content of the ogiri-ahuekere samples. The fermenting organisms might have utilized carbohydrates as carbon source for growth and metabolic activities (Asibuo et al., 2008; Wakashama et al., 2010).

Protein Contents of the Ogiri-Ahuekere Samples

Table 1 illustrated the significant increase in the protein contents of ogiri-ahuekere samples as the fermentation time increased. However, there was no significant increase until after 3 days of fermentation. The protein contents of unfermented samples (18.20%) and samples fermented for 1 and 2 day(s) (18.29% and 18.67% respectively) were significantly the same at 95% level of confidence. The protein content of ogiri-ahuekere samples fermented for 4 days (22.47%) increased significantly whereas the protein contents of samples fermented for 5days (25.01%) and 6 days (25.19%) were significantly the same but different from the protein content of sample fermented for 4 days. Similarly, the protein contents of 7days (27.86%) and 8 days (28.71%) fermented ogiri-ahuekere samples were significantly (p≤0.05) the same but were significantly different from the 6 days fermented ogiri-ahuekere samples. There was no significant difference in the protein contents of 9 and 10 days fermented ogiri-ahuekere samples but their protein contents were significantly different from that of 8 days fermented ogiri-ahuekere sample. The similar increase in the protein content of ogiri was also observed by Chukwu et al. (2010).

Crude Fat Contents of the Ogiri-Ahuekere Samples

Table 1 shows that the crude fat content of the ogiri-ahuekere samples increased significantly with fermentation time. The unfermented ahuekere sample had 18.78% fat content. The fat content of 1day fermented ogiri-ahuekere sample (21.02%) was significantly different from the fat content of the unfermented ogiri-ahuekere and 2 days fermented ogiri-ahuekere sample. Fat contents of 2 days (25.02%) and 3days (26.74%) fermented ogiri-ahuekere samples were significantly the same but different from other samples. As fermentation time increased, the fat content of the ogiri-ahuekere samples increased significantly. The fat content of 4 days (28.33%) fermented ogiri-ahuekere
Shelled Groundnut Seeds

- Sun drying
- Removal of Seed Coats (Hulls)
- Washing
- Boiling (8 Hours)
- Draining
- Cooling
- Grinding
- Wrapping in Blanched Plantain leaves
- Fermentation in a container at ambient temperature

**Figure 1**: Flow Chart for the Production of Fermented Ogiri–Ahuekere Samples.

Sample was statistically the same with that of 5 days (29.99%) fermented ogiri-ahuekere sample whereas the fat content of ogiri-ahuekere sample fermented for 5 days was significantly similar from those of 6 days (31.37%) and 7 days (31.12%) fermented ogiri-ahuekere samples. Also, fat contents of ogiri-ahuekere samples from 6, 7 and 9 days fermentation were significantly higher than the fat content of 4 days fermented ogiri-ahuekere sample but they were not significantly different from that of 8 days (32.75%) and 10 days (33.06%) fermented ogiri-ahuekere samples. This proves that increased fermentation time increases the fat content of the ogiri-ahuekere samples. Sanni et al. (2000) observed similar increase in fat content of ogiri condiment produced from fermented iru, ugba and ogiri. Odebumni et al. (2010) also reported that increase in fermentation time increases fat content of fermented condiment.
### Table 1: Mean Scores of Proximate Composition of Ogiri-Ahuekere Fermented from Zero to Ten Day(s)

<table>
<thead>
<tr>
<th>Fermentation Time (day)</th>
<th>Carbohydrate (%</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Fibre</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>47.40 ± 0.46a</td>
<td>18.20 ±0.10f</td>
<td>18.78 ± 0.65f</td>
<td>2.88 ±0.03a</td>
<td>2.60±0.08a</td>
<td>10.14±0.17a</td>
</tr>
<tr>
<td>1</td>
<td>44.90 ± 0.20b</td>
<td>18.29±0.03ef</td>
<td>21.02±0.47e</td>
<td>2.77±0.04a</td>
<td>2.40±0.03b</td>
<td>10.62±0.28a</td>
</tr>
<tr>
<td>2</td>
<td>40.34 ± 0.67c</td>
<td>18.67±0.15a</td>
<td>25.02±0.73a</td>
<td>2.56±0.07b</td>
<td>2.28±0.03bc</td>
<td>11.13±0.38a</td>
</tr>
<tr>
<td>3</td>
<td>37.40 ± 0.76d</td>
<td>20.20±0.36e</td>
<td>26.74±0.84ed</td>
<td>2.41±0.02bc</td>
<td>2.20±0.01cd</td>
<td>11.05±0.20a</td>
</tr>
<tr>
<td>4</td>
<td>33.55 ± 0.76e</td>
<td>22.47±0.66d</td>
<td>28.33±0.75cd</td>
<td>2.31±0.10cd</td>
<td>2.12±0.02d</td>
<td>11.22±0.35a</td>
</tr>
<tr>
<td>5</td>
<td>29.81 ± 0.76f</td>
<td>25.01±0.10c</td>
<td>29.99±0.87bc</td>
<td>2.20±0.01de</td>
<td>1.92±0.06e</td>
<td>11.07±0.09a</td>
</tr>
<tr>
<td>6</td>
<td>29.04 ± 0.32f</td>
<td>25.19±0.49c</td>
<td>31.37±0.23ab</td>
<td>2.13±0.06a</td>
<td>1.71±0.04f</td>
<td>10.51±0.23a</td>
</tr>
<tr>
<td>7</td>
<td>28.63±1.00f</td>
<td>27.86±0.77b</td>
<td>31.12±0.49b</td>
<td>2.09±0.01a</td>
<td>1.60±0.02f</td>
<td>10.70±0.23a</td>
</tr>
<tr>
<td>8</td>
<td>24.48 ± 1.30g</td>
<td>28.71±0.29b</td>
<td>32.75±0.38a</td>
<td>2.04±0.03a</td>
<td>1.63±0.11f</td>
<td>10.3±0.58a</td>
</tr>
<tr>
<td>9</td>
<td>22.13±0.54h</td>
<td>31.86±1.09a</td>
<td>31.90±1.10ab</td>
<td>1.85±0.08f</td>
<td>1.26±0.05f</td>
<td>11.00±0.58a</td>
</tr>
<tr>
<td>10</td>
<td>20.79±1.24h</td>
<td>32.63±0.92a</td>
<td>33.06±1.06a</td>
<td>1.47±0.06g</td>
<td>1.40±0.04g</td>
<td>10.65±0.56a</td>
</tr>
</tbody>
</table>

LSD: 2.484 2.183 2.212 0.193 0.181 1.191

Means with the same superscripts are not statistically the same but means with the different superscripts are significantly different from each other in the same column.

### Ash Contents of the Ogiri-Ahuekere Samples

Table 1 shows significant reduction of ash content of ogiri-ahuekere samples with increase in the fermentation time. The ash content of the unfermented ahuekere sample (2.88± 0.03%) was similar to that of 1 day ogiri-ahuekere sample (2.77±0.04%). The ash contents of 2 and 3 days fermented ogiri-ahuekere samples had ash content similar to the ash contents of fermented ogiri-ahuekere samples from 6, 7 and 8 days fermentation but was significantly different from that of 9 days fermented ogiri-ahuekere sample. It also observed that 10 days fermented ogiri-ahuekere sample had ash content of 1.47±0.04% which was significantly different from the ash content of 9 days fermented ogiri-ahuekere sample (1.85%). This significant reduction in the ash contents of ogiri-ahuekere could be because the fermenting organisms utilized soluble inorganic minerals during the fermentation processing (Chukwu et al., 2010).

### Crude Fibre Contents of the Ogiri-Ahuekere Samples

Table 1 indicated that there was significant decrease (p≤0.05) in fibre contents (2.60-1.40%) of ogiri-ahuekere samples with increase in fermentation time (0-10 days). The crude fibre content of the unfermented ahuekere sample was
2.60% which was significantly different from that of 1 and 2 days fermented ogiri-ahuekere samples (2.40% and 2.28%) respectively which were significantly similar. Three days fermented ogiri-ahuekere sample had a fibre content of 2.20% which was significantly similar to the 2 and 4 days fermented ogiri-ahuekere samples. There was no significant reduction in fibre contents of samples from 6, 7 and 8 days fermentation which were 1.76%, 1.60% and 1.63% respectively. Crude fibre contents of ogiri-ahuekere samples from 9 and 10 days were significantly (p ≤ 0.05) the same (1.26% and 1.40% respectively) but were significantly different from fibre contents of rest of ogiri-ahuekere samples. This shows that increase in fermentation time decreased the fibre contents of ogiri-ahuekere significantly. This could be attributed to the breakdown of plant tissues during fermentation.

Conclusion and Recommendation

The data obtained from proximate composition shows that there were significant (p≤0.05) differences in the ogiri-ahuekere samples at various fermentation time. There was significant reduction in the ash (2.88-1.47%), fibre (2.60-1.40%) and carbohydrate (47.40-20.79%) contents as well as significant increase in protein (18.20-32.63%) and fat (18.78-33.06%) contents at various days of fermentation. Ogiri-ahuekere samples fermented for 1-4 days had high carbohydrate contents (47.40-33.55%) with low fat (18.78-28.33%) and protein (18.20-22.47%) contents while 8-10 days fermented ogiri-ahuekere samples had improved fat (32.75-33.06%) and protein (28.71-32.63%) contents with low carbohydrate (24.48-20.79%) contents. There was about 50% reduction of carbohydrate after eight days fermentation because the unfermented ogiri-ahuekere had 47.40% carbohydrate while ten days fermented ogiri-ahuekere sample had 20.79%. The ash and fibre contents reduced significantly by 49% and 46% respectively within the ten days fermentation. The protein and fat contents increased significantly by 44% and 43% respectively. The use of starter culture could be applied to reduce fermentation time and probably improve the quality of the product.

References


Omafuvbe, B.O., Shonukan, O.O. and Abiose, S.H.


