ABSTRACT
Effect of spices on the chemical properties of hot-smoked catfish Clarias gariepinus (Burchell, 1822) was examined. A Completely Randomized Design (CRD) was used for the study. Freshly harvested catfish were spiced with garlic, ginger, garlic-ginger homogenate-spiced and the control without spices before smoking. Proximate and mineral content analysis were carried out using standard experimental procedures. There were significant differences (p < 0.05) in the proximate composition of the spiced smoked fish. Smoked catfish without spices had the highest mean values of moisture and protein contents with mean values of 6.18 % ± 0.13 and 79.44 % ± 0.13 respectively. Similar trend was also observed for the lipid and ash contents of the fish products. There existed significant differences (p < 0.05) in the mineral content in the various fish products with the exception of magnesium. The products were rich in calcium and other minerals with garlic-ginger homogenate-spiced product having the highest level of calcium (0.980 % ± 0.02).

Keywords: Spices, organoleptic properties, chemical properties, hot-smoked, Clarias gariepinus

INTRODUCTION
Fish constitutes a very important component of diet for many people, and often provides much needed nutrients for a healthy living. Its characteristic as a cheap source of animal protein, which is now evident throughout the world makes it an excellent component of human diet (Iheagwara, 2013). Fish protein now takes precedence over other protein of animal origin, and compares favorably with those of milk, egg and meat in its amino acid composition (Iheagwara, 2013). Fish serves as a principal source of dietary animal protein, which is very inexpensive in relation to other protein foods (Fawole et al., 2007). Fish protein is indispensable to many people for diet supplementation in developing countries such as Nigeria, where the staple diet consists primarily of starchy foods (Idris, 2010). As important as fish is, high degree of fish spoilage still occurs in Nigerian due to the absence of storage facilities, this serves as a major constraint to the development of the
fishing industry in Nigeria (Akinpelu et al., 2013). Akinola et al. (2006) reported that some of the different types of preservation methods employed to reduce fish spoilage include: drying, smoking, freezing, chilling and brining. Bellagha et al. (2007) reported that due to the perishable nature of fish, traditional methods of preservation have been developed over the years which include salting, drying and smoking. Fish smoking is particularly relevant in the artisanal fisheries sector, as a method of processing and preservation. It enhances the flavour and increases utilization of the fish in addition to reducing wastes when catches are good and influences protein availability to rural people (Jallow, 1995; Kumolu-Johnson and Ndimele, 2011). Igene (1983) as reported by Kiin-Kabari et al. (2011) opined that smoke-dried fish is an important ingredient in the Nigerian traditional diet; and is relished for its appetizing taste and flavour. The traditional smoked fish, though popular, suffer from some inherent problems, including uneven cooking of the product, scorching and burning due to direct heating, bitterness, unattractive appearance, rancidity development, limited shelf-life and insect infestation (Bellagha et al., 2007). *Clarias gariepinus*, one of the species of catfish is highly nutritious. It contains high amount of vitamins, proteins, minerals, no saturated fat, and is low in carbohydrates (Idris et al., 2010). It is an economically important freshwater fish, and enjoys wide acceptability. It is extensively cultivated in ponds but is sometimes under-priced (Kumolu-Johnson et al., 2010). *Clarias gariepinus* is a very important freshwater fish in Nigeria as it enjoys wide acceptability in most parts of the country because of its unique taste, flavour and texture (Ayeloja et al., 2011).

**MATERIALS AND METHODS**

Twelve live catfish (*Clarias gariepinus*) were selected from an earthen pond of Korede fish farm Omi-Adio second gate, Ibadan Oyo state. The average weight of the fish was 226±23g. They were transported by road within 43 min. to the fish processing unit of the Federal College of Animal Health.
and Production Technology (FCAH&PT), Moor Plantation Ibadan where they were prepared in the sequence presented on Fig 1. Six kilogram of dried garlic bulb (Allium sativum) and 10kg of dried ginger rhizome (Zingiber officinale) were bought from Bodija market in Ibadan, Oyo State, Nigeria and ground using sterile explosion proof blender (Waring Products, New Hartford, CT) and later applied as spices to the fish at ratio 5:100g in accordance with the recommenda-
tion of Kumolu-Johnson and Ndimele (2011). Seventy gram each of powdered garlic (A. sativum) and ginger (Z. officinale) were manually homogenized in ratio 1:1. This was applied as spices on the catfish (treatment four) prior to smoking. The experiment was Completely Randomized Design where the treatments were the variously spiced catfish (garlic, ginger and mixture of garlic and ginger) with a control (without spices).

![Fig. 1: Flow chart for the preparation of smoked spiced-catfish (Clarias gariepinus)](image)

**Chemical Analyses**
The samples of smoked fish products (comprising 3 samples each of the differently spiced smoked fish product) were collected for chemical analysis at the Chemistry Laboratory of the Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan, Nigeria. The samples used for the analysis were assayed in triplicates. The fish samples was homogenized after which proximate composition (moisture, protein, lipid ash and crude fibre) of fish samples was determined using the standard methods of AOAC (1995); and mineral content (calcium, magnesium, potassium, sodium, phosphorus, manganese, iron, zinc and copper) were also determined using Atomic Absorption Spectrophotometer (AAS Buch Scientific Accusys 211).

**Statistical analysis**
Analysis of variance (ANOVA) was used to determine differences between means; and
Duncan Multiple Range Test (DMRT) was used to compare differences among means. Significant level was chosen at p<0.05.

**RESULTS AND DISCUSSION**

The result shown on Tables 1 and 2 indicated significant differences (p < 0.05) in proximate and mineral compositions of differently spiced hot-smoked catfish. The smoked catfish with no spice had the highest moisture content with a mean value of 6.18 ± 0.13% which reduced significantly (p < 0.05) with the application of different garlic and ginger. Smoked catfish spiced with garlic-ginger homogenate had the lowest moisture content of 5.73 ± 0.14%. The differences in moisture content could be due to variation in the moisture absorbing properties of the spices applied prior to smoking. The resultant reduction in the moisture content of the smoked fish products will prolong the shelf life of the products. This is in line with the findings of Fapohunda and Ogunkoya (2006) that the removal of moisture content increased the shelf life of fish products. However, there were significant differences (p < 0.05) in other mineral contents. The spiced smoked fish were rich in calcium with garlic-ginger homogenate-spiced product having the highest value of calcium (0.980±0.02%), while the control had the lowest calcium value (0.539±0.04%). Calcium is required in maintaining and building bone and tooth, and also performs the functions of adjusting the acid-base balance, blood coagulation and transportation of nerve impulses (Meta et al., 2010). Similar report of trace metals was reported by Fawole et al. (2007) giving mean mineral compositions (%) of 0.34 (P), 0.33 (Ca), 0.36 (K), 0.30 (Mg), 0.12 (Fe), 0.80 (Na) and 0.02 (Cu) in C. gariepinus. Generally, the minerals occurred at levels within international limits, thereby making this fish product safe for consumption, most especially with FAO/APHCA (1998) standards.
### Table 1: Proximate composition of differently spiced hot-smoked catfish

<table>
<thead>
<tr>
<th>Treatments</th>
<th>%Moisture</th>
<th>%Protein</th>
<th>%Lipid</th>
<th>%Ash</th>
<th>%Crude Fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.18 ± 0.15a</td>
<td>74.99 ± 0.13a</td>
<td>6.31 ± 0.19a</td>
<td>7.04 ± 0.17a</td>
<td>0.16 ± 0.16d</td>
</tr>
<tr>
<td>Garlic</td>
<td>6.10 ± 0.14b</td>
<td>71.00 ± 0.07d</td>
<td>6.04 ± 0.22b</td>
<td>6.06 ± 0.23b</td>
<td>10.54 ± 0.23a</td>
</tr>
<tr>
<td>Ginger</td>
<td>5.90 ± 0.16c</td>
<td>76.06 ± 0.15b</td>
<td>3.85 ± 0.11d</td>
<td>5.14 ± 0.22c</td>
<td>8.54 ± 0.13b</td>
</tr>
<tr>
<td>Garlic/Ginger homogenate</td>
<td>5.73 ± 0.14d</td>
<td>75.69 ± 0.12c</td>
<td>4.83 ± 0.14c</td>
<td>5.14 ± 0.23c</td>
<td>8.49 ± 0.13b</td>
</tr>
</tbody>
</table>

Values in the same column with different superscripts are significantly different (p<0.05).

### Table 2: Mineral composition of differently spiced hot-smoked catfish

<table>
<thead>
<tr>
<th>Treatments</th>
<th>% Calcium</th>
<th>% Magnesium</th>
<th>% Potassium</th>
<th>% Sodium</th>
<th>% Phosphorous</th>
<th>% Manganese</th>
<th>% Iron</th>
<th>% Zinc</th>
<th>% Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.539±0.004d</td>
<td>0.328±0.02</td>
<td>0.209±0.04c</td>
<td>0.367±0.02b</td>
<td>0.362±0.01bc</td>
<td>0.246±0.04b</td>
<td>0.300±0.02b</td>
<td>0.128±0.01d</td>
<td>0.128±0.01d</td>
</tr>
<tr>
<td>Garlic-spiced</td>
<td>0.639±0.006c</td>
<td>0.394±0.03</td>
<td>0.399±0.05b</td>
<td>0.319±0.01a</td>
<td>0.431±0.30c</td>
<td>0.367±0.03c</td>
<td>0.130±0.11c</td>
<td>0.370±0.01b</td>
<td>0.066±0.04a</td>
</tr>
<tr>
<td>Ginger-spiced</td>
<td>0.535±0.01b</td>
<td>0.453±0.02</td>
<td>0.305±0.07bc</td>
<td>0.326±0.04a</td>
<td>0.441±0.04a</td>
<td>0.442±0.05a</td>
<td>0.323±0.02a</td>
<td>0.300±0.02b</td>
<td>0.739±0.05b</td>
</tr>
<tr>
<td>Garlic/Ginger homogenate</td>
<td>0.980±0.02a</td>
<td>0.525±0.06</td>
<td>0.416±0.05ab</td>
<td>0.355±0.02a</td>
<td>0.519±0.02a</td>
<td>0.434±0.02ab</td>
<td>0.322±0.03a</td>
<td>0.406±0.01a</td>
<td>0.627±0.01c</td>
</tr>
</tbody>
</table>

Values in the same column with different superscripts are significantly different (p<0.05).
CONCLUSION
The result of this study indicated significant differences (p < 0.05) in the proximate composition and mineral contents of variously spiced smoked fish products. The moisture content on account of the addition of spices suggested the possibility of prolonging the shelf-life of fish by reducing water activity. The addition of spices also enriched the mineral contents of the products. Generally, the use of spices (garlic and ginger) in the present study added quality value to smoked fish products.

REFERENCES


