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PROXIMATE COMPOSITION OF SOME COMMON HOT SMOKED FRESHWATER FISH SPECIES USING DIFFERENT PACKAGING MATERIALS

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ABSTRACT: *Three Different packaging materials of (37cm x 25cm) size (Sealed Transparent Polythene Bag (STPB), Sealed Paper Bag (SPB), Open Mouth Polythene Bag (OMPB)) were used for each of Oreochromis niloticus, Clarias gariepinus and Mormyrus rume. Twenty fish samples per species (averaging 250gm) collected from Asejire Dam, Ibadan were hot smoked for 36hours at an average temperature of 100°C. Six fish of each species were packaged hot and stored for 12 weeks. There were significant differences (P<0.05) between the proximate composition of the fish treatments assessed. SPB had the best Crude Protein (CP) of 51.94±0.04% for C. gariepinus (SPBC) and least in M. rume (SPBM) (48.86±0.06%). The fresh fish CP of 29.40±0.04% (C. gariepinus) was condensed to 50.93±0.03% (initial smoked) and ranged between 51.94±0.04% (SPBC) to 52.86±0.02% (OMPBC). SPB packaging was the best for all the three fish samples in the study, C. gariepinus and O. niloticus stored better than M.rume.*

KEY WORDS: Proximate Composition, Hot smoked, cold smoked, Packaging Material

INTRODUCTION

In Nigeria, fish is eaten fresh, preserved or processed. The percentage composition in the artisanal sector according to Tobor (1984) are as follows: - live fish 7%, fresh fish 27%, smoke dried 45%, sundried\salted and sundried 21%. Smoke drying methods used in Nigeria requires low capital investment and it is conducted in fishermen camps and fish processing centres in traditional smoking kilns of clay, cement blocks, drums or iron sheets (Eyo, 1992). Fish smoked by this process have a shelf life of 6-9 months when stored properly. Smoked drying is by far the commonest method, since the distribution process of the smoked fish may take a long time and producers often want to store it for months while waiting for a more favourable market.

Smoke drying of fresh fish is of utmost importance since fish is highly susceptible to deterioration immediately after harvest and to prevent economic losses (Okonta and Ekelemu, 2005). Efficient preparation of fish is important when top quality, maximum yield and highest possible profits are to be achieved. Fish processing is to give the product a form which is attractive to the consumers and storage life of fish is extended. The characteristics of processed fish to be stored should ensure full health safety of the product, proper sanitary conditions as well as rendering it impossible for the development of harmful micro-organisms and toxins. High quality products which are safe that will satisfy the consumers can be reached by compliance with processing parameters from the start of the operation of the storage and distribution of the final products.

Post-harvest losses in fish are represented by a net reduction in the amounts of nutrients potentially available to the consumer either by direct physical loss or nutritional loss. Those factors have effect on consumer acceptability, commercial value and income of fish farmers\traders. Also the health implication of consuming spoilt fish cannot be quantified. Smoking enhances flavor and increases utilization of the fish. Nonetheless, deterioration and spoilage still occur in smoked fish during storage. The extent and value of quantitative losses caused by insect pest (Dermestes species) have been assessed by various authors such as Azeza (1979), FAO (1981), Osuji (1995), and Oluborode *et al*. (2013) and estimated range from negligible up to 50% weight losses depending on length of storage, salt content, moisture content, climatic conditions and general hygienic conditions during processing and storage. According of Sachitharanthan (2000), says storage of a processed fish is done with the aim of extending the lifespan of the fish and also to retain the taste texture and odour of the product. For longer storage, the fish may be frozen immediately after smoking. According to Doe *et al.* (1998), smoked fish stored in the freezer should not exceed 2-3months.

An effective fish packaging material should be able to reduce oxidation and dehydration, provide less bacterial and chemical spoilage, prevent odour permeation and protect the product from physical damage (Byett, 2006). The purpose of food packaging is to preserve the quality and safety of the food it contains from the time of manufacture to the time it is used by the consumer (Dallyn and Shorten, 1989). An equally important function of packaging is to protect the product from physical, chemical and biological damages; and it also acts as an insulating barrier between the environment and product.

MATERIALS AND METHODS

COLLECTION OF SAMPLES\PACKAGING

Twenty pieces (sample) of each fish species of average weight 250grams were collected for *Oreochromis niloticus* (O), *Clarias gariepinus* (C) and *Mormyrus rume* (M). Also fresh samples were collected for the initial proximate analysis while the remaining fresh fishes were transported to the processing unit for smoking. After which the initial proximate analysis of the hot smoked fish was also taken before packaging in the 37cm x 25cm packaging materials for each of the smoked fish species (using each of the three different packaging material for each fish species) at the rate of six (6) fish species per package and labeled e.g for *Oreochromis niloticus* (STPBO –Sealed Transparent Polythene Bag *Oreochromis niloticus*, SPBO – Sealed paper Bag *Oreochromis niloticus*, OMPBO – Open Month Polythene Bag *Oreochromis niloticus*.

HOT SMOKING OF THE FISH SPECIES

The smoking kiln was locally improvised. Three broken blocks each of 0.3m height was used to raise the wire gauze (on which the fish were laid) to avoid direct contact with fire. Big wire gauze of mesh size 2cm was set on the fire when the fire was fully lit. The three species of the fish to be smoked were placed on the gauze. Big aluminum basin with opening at the centre was used to cover the fish species in order to conserve the fire. It was through the opening that the temperature of the smoking kiln (chimney) was taken daily, until the three fish species were hot smoked dried. Hot smoking was done for 36 hours (this was achieved in three days at an average of 12hours smoking per day) at an average temperature of 100^{o}C.

Hot smoking was done with an exotic hard wood (Eucalyptus species), collected from the Forestry Department of the University of Ibadan. Turning of the fish species were done at the same time to maintain uniform drying\smoking at an interval of one hour (1½ hr) thirty minutes for 3days.

PACKAGING AND SHELFING

After three days of intensive smoking, each species of the three freshwater fish species were packaged under three different packaging materials (Sealed Transparent Polythene Bag (STPB), Sealed Paper Bag (SPB) (Brown envelope), Open Mouth Polythene Bag (OMPB) (Black in colour)) under room ambient temperature range of 25^{o}C – 32^{o}C for 12 weeks. Mould growth: insect infestation was checked daily during this period for each of the fish species.
The three different materials used were:
A. Sealed Transparent Polythene Bag (STPB)
1. Tilapia (*Oreochromis niloticus*) (STPBO)
2. *Clarias gariepinus* (STPBC)
3. *Mormyrus rume* (STPBM)
B. Sealed Paper Bag (SPB)
1. Tilapia (*Oreochromis niloticus*) (SPBO)
2. *Clarias gariepinus* (STBC)
3. *Mormyrus rume* (STBM)
C. Open Mouth Polythene Bag (OMPB)
1. Tilapia (*Oreochromis niloticus*) (OMPBO)
2. *Clarias gariepinus* (OMPBC)
3. *Mormyrus rume* (OMPBM)
The fishes were packaged hot in the packaging bags and stored in the laboratory for 12 weeks.

PROXIMATE ANALYSIS

Proximate analysis of the fish samples was carried out according to the methods of AOAC (2002). The crude protein was determined according to kjeldahl method (AOAC, 2002). The crude protein content value was determined by multiplying percentage Nitrogen by a constant factor of 6.25 i.e. CP= %N x 6.25. Crude Fibre, Ash, Crude Fat and Dry Matter were also obtained according to AOAC (2002).

STATISTICAL ANALYSIS

2-way Analysis of Variance (ANOVA) was carried out on all the parameters measured to test for variability at 5% level of significance. Duncan Multiple Range Test was used to separate means

RESULTS

The initial proximate composition of the fresh fish sample for the three different fish species under study as shown in Table 1. *C. gariepinus* had the highest initial fresh crude protein (29.40±0.40%), followed by *O. niloticus* (27.80±0.75%) and lastly *M. rume* (26.75±26.75%). However, the highest moisture content of 61.60±0.60% was recovered in *M. rume*, although with the least crude fibre of 0.41±0.08. In addition, *Clarias gariepinus* had the highest fat

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content (6.96±0.05%), crude fibre (0.54±0.04%), Ash (2.40±0.32%) and moisture content (57.40±0.15%) (Second to *M. rume* - 61.60±0.60%) coupled with highest crude protein of 29.40±0.40%. Fat content generally followed a narrow range of 6.80±0.21% (*O. niloticus*) and 6.88±0.04% (*M. rume*), and 6.96±0.05% (*C. gariepinus*). Also ash content also followed a narrow range of 2.27±0.04% - 2.40±0.15% in all cases. The result generally showed that there was a significant (P<0.05) different in the initial proximate composition of the fresh three fish species except for fat and ash content.

TABLE 1: PROXIMATE COMPOSITION OF FRESH FISH

Fish Sample	%Crude Protein	% Fat	% Crude Fibre	% Ash	% Moisture Content	NFE
C. gariepinus	29.40±0.40^{c}	6.96±0.05	0.54±0.04^{b}	2.40±0.32	57.40±0.15^{a}	3.30±0.19^{b}
O. niloticus	27.80±0.75^{b}	6.80±0.21	0.50±0.08^{ab}	2.27±0.04	56.90±0.05^{a}	5.72±0.07^{c}
M. rume	26.75±0.50^{a}	6.88±0.04	0.41±0.08^{a}	2.35±0.05	61.60±0.60^{b}	2.01±0.05^{a}

Table 2 shows the initial proximate composition of the processed hot smoked three different fish species. Crude protein was highest in *O. niloticus* (52.13±0.03%), highest moisture content (32.60±0.20%) was also recorded in *C. gariepinus*. *M. rume* had the least crude protein (48.53±0.04%), Moisture content (31.84±0.04%) and crude fibre (0.32±0.06%). The results of the initial proximate composition of the three different processed hot smoked fish were significantly (P<0.05) different from each other.

TABLE 2 INITIAL PROXIMATE COMPOSITIONS OF PROCESSED HOT SMOKED FISH

Fish Sample	%Crude Protein	% Fat	% Crude Fibre	% Ash	% Moisture Content	NFE
C. gariepinus	50.93±0.03^{b}	7.60±0.60^{c}	0.64±0.04^{c}	3.40±0.25^{c}	32.60±0.20^{b}	4.83±0.30^{a}
O. niloticus	52.13±0.03^{c}	6.96±0.06^{a}	0.44±0.02^{b}	2.74±0.04^{b}	31.90±0.40^{a}	5.83±0.30^{b}
M. rume	48.53±0.04^{a}	7.20±0.10^{b}	0.32±0.06^{a}	2.27±0.06^{a}	31.84±0.04^{a}	9.84±0.04^{c}

Table 3 shows the result of the proximate composition of three fish species stored for 12 weeks using three different packaging materials. There were no significant (P>0.05) different in the packages used for *O. niloticus* since values obtained in the final proximate analysis follow a narrow range e.g crude protein 50.74±0.02% (OMPBO) – 50.94±0.12% (STPBO) – 50.96±0.02% (SPBO). This is also true for the fat 5.74±0.04% (SPBO) – 5.77±0.01% (OMPBO and STPBO) , Crude fibre 0.40±0.02% (OMPBO) – 0.41±0.01% (SPBO) – 0.42±0.20% (STPBO), Ash 2.66±0.01% (OMPBO) – 2.68±0.02% (SPBO) – 2.71±0.01% (STPBO), and moisture content 33.86±2.89% (STPBO) – 33.96±0.01% (OMPBO) – 34.60±0.10% (SPBO).

Open Mouth Polythene Bag – *C. gariepinus* packaging (OMPBC) (which allowed some amount of fresh air) with the highest conserved value of crude protein (52.86±0.02%) (Out of the nine package). This also had the lowest moisture content (34.18±0.18%), crude fibre (0.54±0.01%) and also lowest fat (6.79±0.02%) among the three *C. gariepinus* packages. Generally, the significant differences (P<0.05) in the packaging materials influenced the proximate composition of the three species of fish stored under the three different packaging. However, the final OMPBC crude protein of 52.86±0.02% was higher than the initially smoked *C. gariepinus* of 50.93±0.03%, and it also had a higher moisture content of 34.18±0.02% (final) compared to 32.60±0.20% (in the initial hot smoked proximate composition).
The percentage fat of the initial smoked fish was generally higher than the final hot smoked fish after 12 weeks packaged storage as shown in Tables 2 and 3 (i.e 7.60±0.60% initial for *C. gariepinus* to a final range of 6.82±0.02% - 6.86±0.02%, *O. niloticus* 6.96±0.06% to a final range of 5.74±0.04% - 5.77±0.01% and *M. rume* initial smoked fat 7.20±0.10% compared to 6.79±0.02.% - 6.99±0.01% in the final stored.

TABLE 3: - FINAL PROXIMATE COMPOSITION OF PROCESSED HOT SMOKED PACKAGED STORED FISH

Fresh Sample	%Crude Protein	% Fat	% Crude Fibre	% Ash	% Moisture Content	NFE
SPBC	51.94±0.04^{f}	6.86±0.02^{e}	0.55±0.05^{e}	3.17±0.03^{d}	35.24±0.04^{g}	2.24±0.06^{a}
OMPBC	52.86±0.02^{h}	6.79±0.02^{c}	0.54±0.01^{e}	3.20±0.01^{d}	34.18±0.02^{c}	2.43±0.02^{b}
STPBC	52.74±0.01^{g}	6.82±0.02^{d}	0.57±0.01^{e}	3.21±0.01^{d}	34.27±0.03^{d}	2.39±0.03^{b}
SPBO	50.96±0.02^{e}	5.74±0.04^{a}	0.41±0.01^{cd}	2.68±0.02^{c}	34.60±0.10^{e}	5.61±0.20^{c}
OMPBO	50.74±0.02^{d}	5.77±0.01^{b}	0.40±0.02^{bcd}	2.66±0.01^{c}	33.96±0.01^{b}	6.47±0.02^{e}
STPBO	50.94±0.12^{e}	5.77±0.01^{b}	0.42±0.20^{d}	2.71±0.01^{c}	33.86±2.89^{a}	6.30±0.04^{d}
SPBM	48.86±0.06^{c}	6.99±0.01^{f}	0.30±0.02^{a}	2.28±0.02^{b}	34.77±0.03^{f}	6.80±0.78^{f}
OMPBM	46.74±0.04^{b}	6.88±0.03^{e}	0.32±0.02^{abc}	2.21±0.00^{ab}	33.92±0.02^{ab}	9.93±0.40^{g}
STPBM	45.83±0.03^{a}	6.79±0.01^{c}	0.31±0.00^{ab}	2.20±0.03^{a}	33.96±0.02^{b}	10.91±0.00^{h}

LEGEND: SPBC- Sealed Paper Bag - *Clarias gariepinus*, OMPBC - Open Mouth Polythene Bag - *Clarias gariepinus*, STPBC - Sealed Transparent Polythene Bag - *Clarias gariepinus*, SPBO - Sealed Paper Bag -Tilapia (*Oreochromis niloticus*), OMPBO - Open Mouth Polythene Bag - Tilapia (*Oreochromis niloticus*), STPBO - Sealed Transparent Polythene Bag - Tilapia (*Oreochromis niloticus*), SPBM - Sealed Paper Bag - *Mormyrus rume*, OMPBM - Open Mouth Polythene Bag - *Mormyrus rume*, STPBM - Sealed Transparent Polythene Bag - *Mormyrus rume*

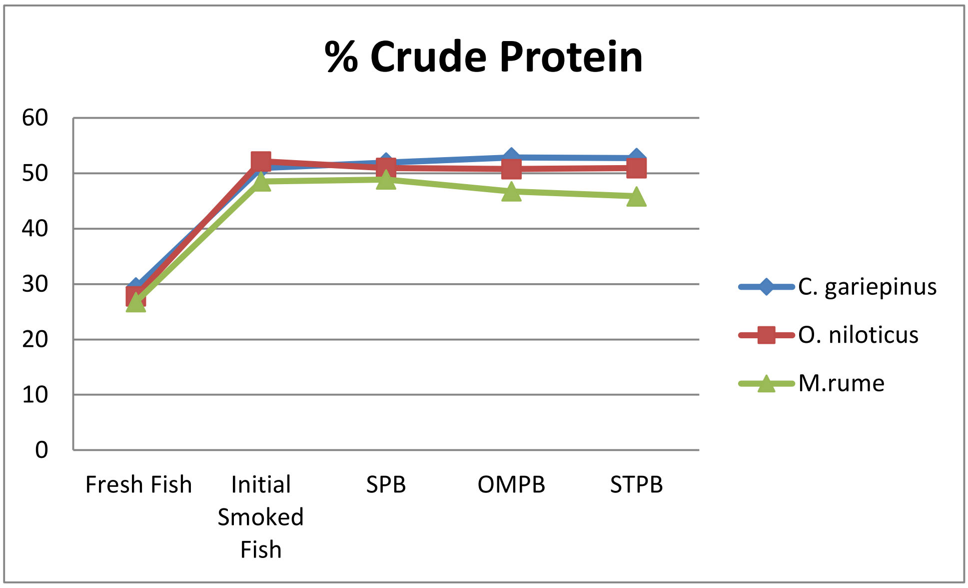

Fig. 1: Proximate composition of Protein content for the three fish species for the fresh fish, initial hot smoked and final/smoked packaged

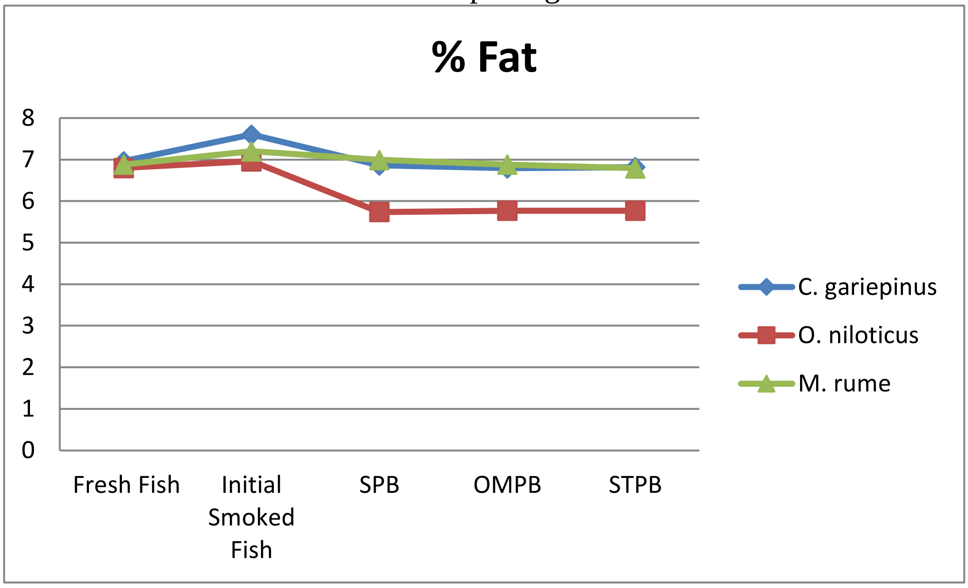

Fig. 2: Proximate composition of Fat for the three fish species for the fresh fish, initial hot smoked and final/smoked packaged

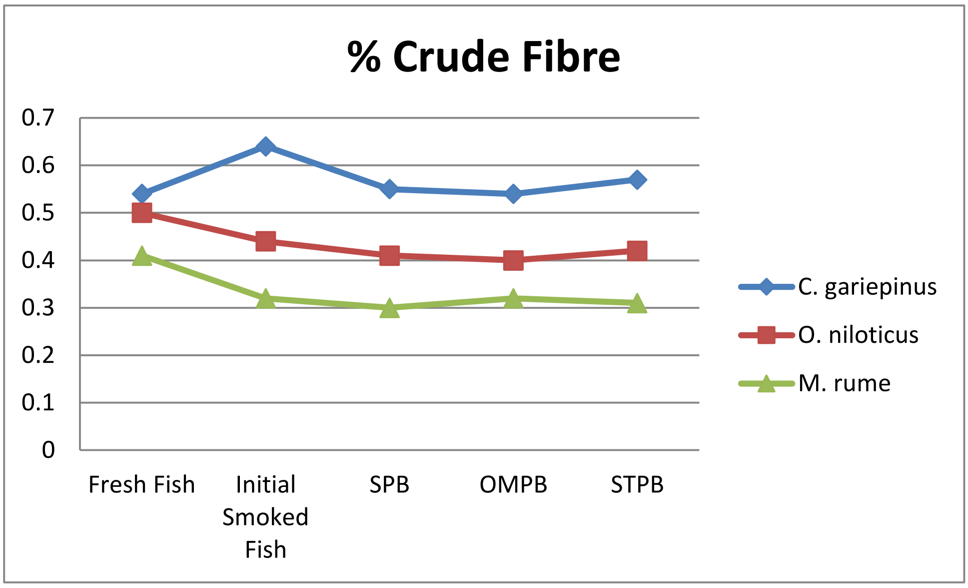

Fig. 3: Proximate composition of Crude fibre for the three fish species for the fresh fish, initial hot smoked and final/smoked packaged

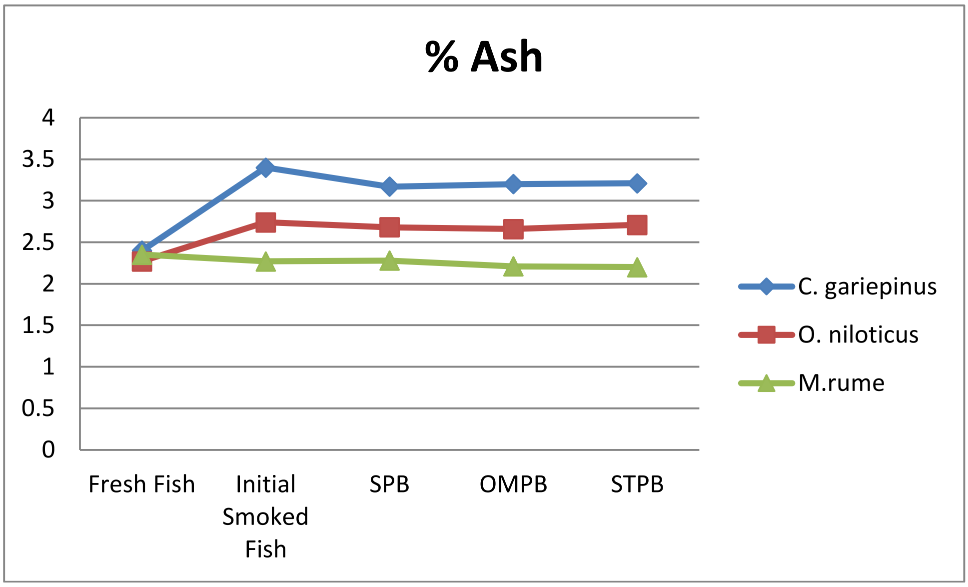

Fig. 4: Proximate composition of Ash for the three fish species for the fresh fish, initial hot smoked and final/smoked packaged

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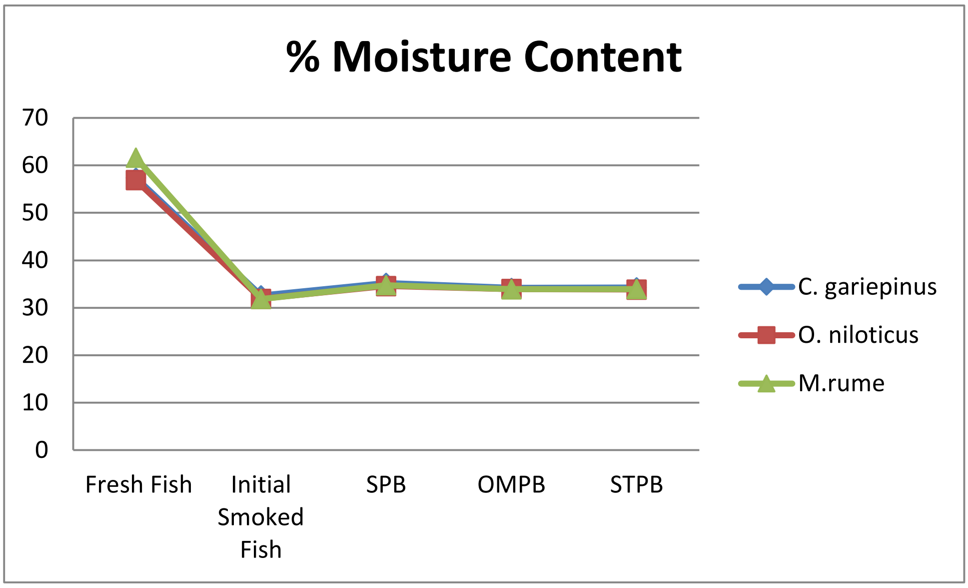

Fig. 5: Proximate composition of Moisture content for the three fish species for the fresh fish, initial hot smoked and final/smoked packaged

DISCUSSION

The initial proximate compositon of the three fresh fish species showed crude protein to be higher in value (*C. gariepinus* (29.40±0.40%), followed by *O. niloticus* (27.80±0.75%) and lastly *M. rume* (26.75±0.50%)) than the initial smoked fish (*C. gariepinus* (50.93±0.03%), *O. niloticus* (52.13±0.03%) and *M. rume* (48.53±0.04%)). This is probably as a result of the condensation of the protein due to the moisture loss during the hot-smoking process. There was not much difference between the initial crude protein and the final crude protein after 12 weeks storage packaging. For instance, for *C. gariepinus* the fresh C.P was 29.40±0.40% condensed to 50.93±0.03% (initial smoked) but in the final it ranges between 51.94±0.04 (SPBC), 52.74±0.01 (STPBC) – 52.86±0.02 (OMPBC).

This is confirmed because the initial moisture content of the fresh fish in the three species (*C. gariepinus* (57.40%), *O. niloticus* (56.90±0.05%) and *M. rume* (61.60±0.60%)) which were much higher than the values (*C. gariepinus* (32.60±0.20%), *O. niloticus* (31.90±0.40%) and *M. rume* (31.84±0.04%)) recorded respectively for the initial hot smoked fishes before storing/ packaging for three months (12weeks). Moisture content in all the nine packaging was generally higher after 12 weeks than their initial hot smoked fish. For *C. gariepinus* 34.27±0.03%-35.24±0.04% which is slightly higher than 32.60±0.20% recorded for the initial smoked fish. *O. niloticus* with moisture content (final range) 33.86±2.89%-34.60±0.10% compared to the initially smoked value of 31.90±0.40% and finally *M. rume* with final 33.96±0.01%-34.77±0.03% compared to the initial smoked value of 31.84±0.04%. This is probably because of the moisture absorbed from the environment.

Fat was also condensed from the fresh fish as a result of the initial hot smoking (due to initial moisture loss), seen as a slight increase in fat from 6.96±0.06% to 7.60±0.60% in *C. gariepinus*, 6.80±0.21%-6.96±0.05% in *O. niloticus*, and 6.88±0.04%-7.20±0.10% in *M. rume*. This fat was further reduced in the final packaging with a range of 6.82±0.02%-6.86±0.02% in *C. gariepinus*, 5.74±0.04%- 5.77±0.01% in *O. niloticus* and 6.79±0.02%-6.99±0.01% in *M. rume*. This observation is probably due to gradual leaching of the fat in all the packages as a result of oxidative rancidity due to the oxidation of poly unsaturated fatty acids in all the packages for the 12 week storage period. This is in line with Oyelese and Adejumo (1998) assertions that oxidative rancidity increases with increase in length of storage even under cold storage. Generally in this study, the three packages for *C. gariepinus* preserved better with the OMPBC, best with crude protein (C.P) of 52.86±0.02% second is STPBC (52.74±0.01%) and SPBC (51.94±0.04%). The second best packaged fish is *O. niloticus* with C.P range of 50.74±0.02%-50.96±0.02%. The worst packaged fish was *M. rume* with a C.P range of 45.83±0.03%-48.86±0.06%.

As shown in Tables 1, 2 and 3 the overall proximate composition (fresh, initial and final smoked packaged fishes) of the three (3) fish species used in the study falls within the range reported by Stanby (1962), Love (1970). It also conforms to the findings of Huss (1988) who observed that the body chemical composition of fish varies from species to species, depending on sex, age, environment and season. Tables 1 and 2 reveals that the fat content of the initial hot-smoked fish was higher than that of the values of the fresh fish samples. This agrees with Doe *et al.* (1998) that fish processing often results in the concentration of nutrients like crude protein and fat and that the quality of fish products is influenced by fish species difference, processing (including smoking), storage practices and duration of storage. Reduction of fat from the initial hot smoked till the end of the final packaging of 12 weeks could be attributed to oxidation of poly-unsaturated fatty acids (PUFA) contained in the fish tissue to products such as peroxides, aldehydes and ketones and the free fatty acids as asserted by Horner(1997), according to him, although there might be high risks of rancidity during prolonged storage conditions due to the fatty nature of fish and the greater the degree of unsaturation, the higher the tendency for fat oxidation (rancidity). High fat content was recorded in the paper packaging for the three species of fish used in this study. This is confirmed by okereke *et al.*, 2014 that increase in crude fat during storage could be attributed to the hydrolysis of some lipid fraction. Paper packaging (SPBC, SPBO, SPBM) had the least mean value of crude fibre for the three fish species while OMPB packaging also had the highest crude fibre values. Percentage crude fibre shows that there was a decrease in the value of the crude fibre after storage but the decrease differences was not ($P>0.05$) significant when compared with the initial smoked samples. Significant ($P<0.05$) increase was observed in ash content of all the fish species after smoking. Suvanich *et al*. (2000), said this increase could be attributed to an increase in the dry matter content per unit of weight following sample dehydration.

Finally, the result of the proximate composition shows that the higher the moisture content, the lower the value of other nutritional composition while the lower the moisture content, the higher the values of other nutritional composition as confirmed by Oyelese and Magawata (2000), Daramola *et al.* (2007).

Also the result of the proximate composition reveals that Sealed Paper Bag (SPB) packaging has the best nutritional composition for all the three fish species with: *Clarias gariepinus* (SPBC) - C.P 51.94±0.04%, Fat – 6.86±0.02%, Crude fibre 0.55±0.05%, Ash 3.17±0.13%, and Moisture Content 35.24±0.04%. *Oreochromis niloticus* (SPBO) – C.P 50.96±0.02%, Fat

5.74±0.04%, Crude fibre 0.41±0.01%, Ash 2.68±0.02%, Moisture content 34.60±0.10% and *Mormyrus rume* (SPBM) – C.P 48.86±0.06%, Fat 6.99±0.01%, Crude Fibre 0.30±0.02%, Ash 2.28±0.02% and Moisture content 34.77±0.03%. However, *Clarias gariepinus* and *Oreochromis niloticus* stored better than *Mormyrus rume*.

CONCLUSION

Sealed Paper Bag (SPB) packaging was the best for all the three fish samples in the study since this gave the best nutrient values in terms of crude protein, fat and other proximate composition parameters including higher moisture content. However *Clarias gariepinus* and *Oreochromis niloticus* stored better than *Mormyrus rume*. The fact that there was no significant differences (P>0.05) in the three packages for *Oreochromis niloticus* (SPBO, OMPBO, STPBO) is probably because they are lean fishes, renders the three packaging materials suitable for *Oreochromis niloticus*.

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