# EFFECTS OF SOME NATURAL PRESERVATIVES ON THE NUTRIENT COMPOSITION AND SHELF LIFE OF SMOKED TILAPIA SPECIES *(Oreocromis niloticus)*

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**ABSTRACT**
*The effects of some natural preservatives on the nutrient composition and shelf life of smoked tilapia species (Oreocromis niloticus) was evaluated. Three natural preservatives Syzygium aromaticum, Myristica fragrans and Piper guineense were used in their powdery form at (10%) inclusion rate to coat tilapia species before smoking. The smoked treated tilapia fish samples were stored for 8 weeks and analyzed for nutrient and shelf life parameters using standard methods. Results of the nutrient composition showed significant differences (P<0.05) in nutrient retention among treatments throughout the storage period. The clove treated smoked tilapia species lost 2.41% crude protein, nutmeg treated smoked tilapia lost 1.70%, black pepper treated smoked tilapia was reduced by 9.03% while control had a significant (P<0.05) loss of 22.8% of its crude protein value. Clove treated smoked tilapia recorded highest lipid value (57.72%) while the control has lowest lipid percentage (31.70%). The ash content was significantly higher (P<0.05) for nutmeg treated smoked tilapia (93.5%) while the control gave an increment of (27.62%). The clove and nutmeg treated smoked tilapia species had moisture increment by (87.75%) and (89.07%) respectively while the control has the lowest moisture increment (53.88%). The nitrogen free extract (NFE) was significantly low for nutmeg treated smoked tilapia (49.16%) while the control had the highest value (61.72%). The result indicated that nutmeg treated smoked tilapia gave a high nutrients retention followed by clove treated smoked tilapia. All treatments including the control did not develop insect attack during the study period which is a function of good shelf life. Therefore, it is recommended that, for better nutrient retention of preserved smoked tilapia species and extended shelf life, Myristica fragrans can be used.*

**Key words:** fish, preservation, natural, tilapia, smoked

## INTRODUCTION

Preservation techniques are needed to prevent fish spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes that result in the loss of fish quality. Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish. Fish normally host many bacteria that are not spoilage bacteria, and most of the bacteria present on spoiled fish played no role in the spoilage. To flourish, bacteria need the right temperature, sufficient water and oxygen, and surroundings that are not too acidic. Preservation techniques work by interrupting one or more of these needs (Ananou *et al*., 2007). Fish is a major source of protein and its harvesting, handling, processing and distribution provide livelihood for millions of people. Freshwater fish processing should assure best market quality, assure health safety of products, apply the most appropriate processing method and reduce wastes to the barest possible extent (Al-jufaili and Opara, 2006). Al-jufaili and Opara (2006) also reported high incidence of fish losses as a major impediment to the realization of government approach towards increasing the contribution of the sector to the overall national economy.

*Oreochromis niloticus* is the second largest fish species cultured worldwide (FAO, 2000). The cultivation of tilapia is becoming more and more popular due to its higher growth rate, higher fecundity, ease of manipulation, good consumer acceptance, and ability to grow under suboptimal nutritional problems and response to adverse environmental conditions such as low oxygen and high ammonia levels in the water (Nazrul *et al*., 2011).

Natural preservatives are vegetable products used for flavoring, seasoning and imparting aroma in food (FAO, 2005). Cloves are the aromatic flower buds of a tree of family Myrtaceae. They are native to the Maluku Islands (or Moluccas) in Indonesia and are commonly used as a spice. It is locally called kanunfari. Cloves are available throughout the year due to different harvest seasons in different countries (Merr and Perry, 2011). Nutmeg is the seed or ground spice of several species of the genus Myristica. *Myristica fragrans* is native to Indonesia. It is also a commercial source of an essential oil and nutmeg butter. Locally, called gyadankanshi. The California nutmeg, *Torreya californica*, has a seed of similar appearance, but is not closely related to *Myristica fragans*, and is not used as a spice (Remany, 2004). West African black pepper, *Piper guineense*. They are known as Guinea cubeb, Benin pepper and Ashanti pepper. Locally, they are called uziza, iyere, sasema, kale, masoro, etc. in different parts of West and Central Africa which they are native to. West African black pepper seeds and leaves are widely used in West Africa for culinary and medicinal purposes because of its aromatic

flavour and medicinal properties. The root is also used for medicinal preparations (Katzer, 2015).

The inclusion of artificial preservatives in fish processing is a major concern to healthy fish food. This research evaluated the nutrient composition and shelf life of smoked tilapia fish preserved with selected natural preservatives.

## METHODOLOGY

### Study Area

The study was conducted in the fish processing unit of the Department of Fisheries and Aquaculture, Faculty of Agriculture, Federal University Dutse, Jigawa State, Nigeria located on latitude 11° 70' North and longitude 9° 33' East and Altitude of 431m above sea level (Elevation-map, 2019).

### Experimental design

A complete randomized design (CRD) was adopted where four (4) treatments were used; tilapia species (*Oreochromis niloticus*) was seasoned with the three selected natural spices (*Syzygium aromaticum* (Treatment A), *Myristica fragrans* (Treatment B), *Piper guineense* (Treatment C) at 10% body weight while Treatment D was the control with no preservative except brimming. The spices were ground into powdery form and was used in coating the fish inside-out before smoking. The treatments were in replicates, and each replicate has three fish, making it twelve (12) tilapia species per treatment, the processe0.d tilapia was preserved for eight weeks for insect infestation study, nutrients analysis at both initial and final carcass analysis.

### Collection and preparation of *Syzygium aromaticum* (nut meg), *Myristica fragrans* (clove), *Piper guineense spices* (black pepper)

The *Syzygium aromaticum, Myristica fragrans, Piper guineense* were purchased from Shuwari market, Kiyawa, Jigawa State, Nigeria. They were ground to fine powder with a grinding machine, packaged in air tight bag and stored at room temperature for later use.

### Experimental fish

Forty-eight (48) *Oreocromis niloticus* juvenile of total weight of 2.4kg and mean weight of 49.71g were purchased from Warwade dam, Dutse, Jigawa State, Nigeria. The samples were transported to the Teaching and Research Fish Farm of the Department of Fisheries and Aquaculture, Federal University Dutse, Jigawa State in plastic robber with ice. Identification of *Oreochromis niloticus* was done using fish identification guide by Olaosebikan and Raji (1998).

### Preparation of the fresh fish sample

The fish was descaled using a sharp knife to scrape the scales toward the head until all are removed. After descaling, the fish was cut along its mid ventral side, and the visceral organs were removed and washed. The weight of the fish was then obtained. The fishes were then washed with clean freshwater with two litres of freshwater in plastic bowl. The cleaned fish was then brined in10% salt concentration in a one litre of freshwater for twenty minutes. This was done for all treatments. This was followed by application of selected preservatives at 10% inclusion rate per the weight of the fish. The treated fishes were then spread in the sun for 20 minutes for pre-drying process.

### Fish smoking

The modified drum kiln was used for the smoking process. It was made from a 400 L drum with 90 cm length and 58 cm diameter. The drum was cut open midway. The base was used as the combustion chamber with a firebox of 22 × 22 $cm^2$. The fish samples were then placed on the mesh in the for about 5 hours. The burning wood was adjusted continuously to maintain the required temperature (33°C) in the chamber during the smoking period. After smoking, the total weight of 469.6g was recorded for the all treatments, with average weight of 9.78g per fish. TA weight was 154.4g, TB (97.1g), TC (127.2g) while the control TD was 90.9g respectively.

### Cooling and Packaging

After this process, the fire was lowered, the fish uncovered and left to cool for 1 hour. Then, the products were unloaded and were hygienically packaged in sealed labelled polythene material and thereafter stored in a deep freezer at -18°C for further laboratory analyses.

### Determination of proximate composition of smoke tilapia species

Proximate compositions (crude protein, crude lipid, ash, moisture, and nitrogen free extracts) of smoke tilapia treated with selected natural preservatives was conducted using the methods described by AOAC, (2006).

### Insects infestation examination

The fish samples were sampled fortnightly and examined for insect attack for the period of 8 weeks of the experiment.

### Statistical Analysis

The data obtained from the parameters evaluated were subjected to one-way analysis of variance (ANOVA). The differences between the means were determined using Turkey at 95% confidence level with Minitab release version 14 statistical tool.

## Results

The dried weight of fish indicated significant water loss including scale and visceral loss (80.32%) which indicates a good dry matter (Table 1).

**Table 1: Weight loss of processed fish**

| Fresh weight of fish(g) | Dressed weight(g) | Weight after smoking(g) | Total weight loss(g) | %weight loss |
|---|---|---|---|---|
| 2385.7 | 1591.13 | 469.6 | 1916.1 | 80.32 |

**Table 2: Nutrient composition (dry weight basis) of Tilapia species preserved with natural spices for 8 weeks**

| Proximate compositions (%) | Treatments | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | A | | B | | C | | D | |
| | Initial | Final | Initial | Final | Initial | Final | Initial | Final |
| Crude protein | 61.39±0.01$^{b}$ | 59.91±0.01$^{ab}$ | 58.69±0.01$^{ab}$ | 57.69±0.01$^{b}$ | 60.49±0.01$^{ab}$ | 55.03±0.01$^{c}$ | 69.79±0.01$^{a}$ | 53.96±0.01$^{c}$ |
| Crude lipid | 6.19± 0.01$^{c}$ | 10.72±0.01$^{b}$ | 5.69± 0.01$^{c}$ | 13.52±0.01$^{a}$ | 4.39± 0.01$^{d}$ | 11.21±0.01$^{b}$ | 3.89± 0.01$^{d}$ | 12.27±0.01$^{a}$ |
| Ash | 7.29± 0.01$^{c}$ | 10.11± 0.01$^{b}$ | 9.39± 0.01$^{ab}$ | 10.04±0.01$^{b}$ | 8.49± 0.01$^{ab}$ | 14.32±0.01$^{d}$ | 3.59± 0.01$^{d}$ | 13.00±0.01$^{a}$ |
| Moisture | 5.59± 0.01$^{c}$ | 7.76± 0.01$^{b}$ | 7.59± 0.01$^{b}$ | 8.65± 0.01$^{a}$ | 6.19± 0.01$^{c}$ | 6.95±0.01$^{ab}$ | 4.79± 0.01$^{d}$ | 8.89± 0.01$^{a}$ |
| NFE | 19.49±0.01$^{a}$ | 10.63± 0.01$^{c}$ | 18.59±0.01$^{bc}$ | 9.14±0.01$^{bc}$ | 20.39± 0.01$^{a}$ | 11.69±0.01$^{c}$ | 17.79±0.01$^{b}$ | 10.98±0.01$^{c}$ |

Data along the row/column with different superscripts are significantly different ($p<0.05$)

**Nutrient composition of tilapia species preserved with natural preservatives**

Table 2 shows results on nutrient compositions of smoked tilapia treated with natural preservatives. The crude protein for the initial carcass analysis ranged from 69.79% (treatment D) to 58.69% (treatment B) with significant differences across the treatment while the final carcass analysis also showed a significant difference ($p<0.05$) among final treatments with highest crude protein value of 59.91% (Treatment A) and lowest value for Treatment D (53.96%). Within the treatment, treatment A, had reduction in crude protein content from 61.39% to 59.91% (2.41%), treatment B from 58.69% to 57.69% (1.70%), treatment C from 60.49% to 55.03% (9.03%) while treatment D gave reduction from 69.69% to 53.96% (22.68%) respectively with significant differences ($p<0.05$).The initial crude lipid values for the carcass was significantly high ($p<0.05$) for treatment A (6.19%) and significantly low ($p<0.05$) for treatment C (4.39%) and D (3.89%) with no significant difference ($p>0.05$) between the two. While the treatment B was significantly high in lipid for final carcass analysis (13.52%) and low for treatment A (10.11%). Within treatment levels, treatment A had lipid increment from 6.19% to 10.72% (73.18%), treatment B 5.69% to 13.52% (42.09%), treatment C 4.39% to 11.21% (39.16%) while treatment D had increase from 3.89% to 12.27% (31.70%) respectively.

The ash content of the treatments for the initial and final carcass analysis were also significantly different ($p<0.05$). The ash values ranged from 9.39% for treatment B to 3.59% for treatment D for the initial carcass values while it ranged from 14.32% for treatment C to 10.04% for treatment B. The ash content was significantly varied within treatments. Treatment A increased from 7.29% to 10.11% (72.11%), treatment B from 9.39% to 10.04% (93.33%), treatment C from 8.49% to 14.32% (52.29%) while treatment D varied from 3.59% to 13.00% (27.62%) respectively.

Similarly, the moisture content was significantly different ($p<0.05$) among treatments for both initial and final carcass values. Treatment B had highest moisture content (7.59%) while treatment D had a low moisture value (4.79%) for the initial carcass value. However, the moisture values were highest for treatment D (8.89%) and lowest for treatment D (6.95%). The moisture content within treatments also showed variation. Treatment A increased from 5.59% to 7.76% (72.04%), treatment B from 7.59% to 8.65% (87.75%), treatment C from 6.19% to 6.95% (87.07%) while treatment D increased in its moisture content from 4.79% to 8.89% (53.88%) respectively.

The Nitrogen Free Extract (NFE) also showed significant difference ($p<0.05$) for the treatments. Treatment C gave a significantly high ($p<0.05$) NFE value while treatment D gave a significantly low ($p<0.05$) value (17.79%) for the initial carcass values while treatment D gave a significantly high value (10.98%) while treatment B gave a low value (9.14%). The nitrogen free extract was also varied within treatments, treatment A reduced from 19.49% to 10.63% (54.54%), treatment B from 18.59% to 9.14% (49.16%), treatment C from 20.39% to 11.69% (57.33%) while treatment D was lowered to 10.98% from 17.79% (61.72%) (Table 2).

**Insects infestation**

The result shows that, for the period of two months (from 11th July, 2019 to 22nd of August, 2019), there was not any insects attack recorded for the all treatments, the fish samples were checked fortnightly for insect/weevil infestation and the fishes were in good condition.

**Discussion**

Protein content in the processed fish increased with decreasing moisture agreeing with Kumolu-Johnson (2010) that protein nitrogen may not have been lost during drying resulting in increase in protein concentrations as the moisture reduced. High protein value (69.79%) was obtained from initial fish carcass of control, and lowest protein of (55.03%) was obtained from final black pepper. The crude protein (CP) of the *Oreocromis niloticus* recorded for both initial and final in this study was high (61.39%) than the value (47.69%) recorded by (Olapade *et al*., 2013) and (Idah and Nwankwo, 2013) who reported high value of (39.20).The variation of Crude Protein level in this study could be due to the temperature and time, because as temperature and time for smoking increase the protein content increase (Olapade *et al*., 2013).

Increase in fat content could be due to dehydration caused by processing heat during heat which led to concentration of lipids (Chukwu and Shaba, 2009; Holma and Maalekuu, 2013). Aberoumad and Pourshafi (2010) concluded that the lower the percentage of water, the greater the lipid content. However, the highest lipid was from obtained the final carcass of nutmeg treated fish (13.52%), and the lowest value was obtained (3.89%) from initial carcass analysis of control, the lipid obtained from final (13.52%) was higher than the value reported by (Idah and Nwankwo, 2013) which was (7.95%) and (Olapade *et al*., 2013) (10.21%) , but were higher than initially control.

Increased ash values of smoked fish may be a result of concentration of salts in the flesh due to dehydration caused by heat (Kiini-Kabari *et al.*, 2011; Islam *et al*., 2012; Aberoumad, 2014). High ash content is consistent with bony fish such as tilapia species (Devi and Sarojnalini, 2012). High ash content was observed in nutmeg treated fish with value of (14.32%) on final carcass, and lowest was (3.59%) in control (initial), the final and initial value are higher than those reported (Olapade *et al*., 2013) (1.53%) and (Idah and Nwankwo, 2013) (0.8%) respectively.

The fresh fish sample indicated a high content of moisture as compared to smoked tilapia species fish samples, the results can be attributed to the loss of water during the process of either smoking (Ande *et al.,* 2012). On the other hand, it is a known fact that most of the fresh fish body is made up of water hence the higher content of moisture in fresh fish sample. Indeed, moisture is vital for ensuring good palatability of fish. However, it must be watched carefully to ensure that it does not increase too much as it can create a conducive environment for microbial growth (Mphande and Chama, 2015). However, findings from this study are in line with that of Ande*et al. (*2012) who concluded that there is a great loss of water during the smoking process. According to Shehu *et al.* (2013), during smoking, approximately one-quarters and one thirds of moisture is lost, which means that both processes are responsible for the lower moisture values indicated in this study. High moisture from (8.89%) in control carcass on final and lower value observe from (4.79%) in control on initial carcass analysis, the value obtained lower than that reported (Idah and Nwankwo, 2013) (35.5%) and (Olapade *et al*., 2013) (1.53%) (38.36%).High Nitrogen free extract of (20.39%) was obtained in black pepper carcass of initial and lower value observed from (9.14%) in nutmeg on final carcass analysis. Finding from the study was higher than the values (0.32%) obtained by (Idah and Nwankwo, 2013).

**CONCLUSION AND RECOMMENDATION**

The study revealed that natural preservatives have effects on the preservation of tilapia for the eight (8) weeks of study for all the treatments. Nutmeg treated smoked tilapia lost the least crude protein value (1.7%) compared to other natural preservatives used in the study and thus recommended for fish preservation.

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