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Preliminary Study on the Antioxidative and Anti-Fungal Effects of Ginger Oil on the Shelf Life of Hot Smoked Fish

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ABSTRACT

The antioxidative and anti-fungal effects of ginger oil on smoked *Chrysichthys nigrodigitatus*, *Clarias gariepinus* and *Oreochromis niloticus* were examined during five week storage at room temperature 25-30°C. The ginger oil was extracted from fresh ginger through hydro-distillation. The fish samples were gutted washed thoroughly and each fish species were divided into three groups. Two groups were spiced with 1.0 and 1.5 mL of ginger oil/kg of fish, respectively before they were smoke dried for 2 h. The third group acts as the control which was not spiced with ginger oil. Chemical and microbiological analyses were performed to investigate quality changes and to determine the shelf stability of the products. The lowest TBA (14.64 mg MDA kg⁻¹) and peroxide (3.91 mEq kg⁻¹) values were recorded in *Oreochromis niloticus* samples treated with 1.5 mL ginger oil/kg of fish at week 1, while the highest TBA (30.48 mg MDA kg⁻¹) and PV (18.76 mEq kg⁻¹) occurred in the *Clarias gariepinus* control at week 5. The result also revealed that samples treated with ginger oil had lower mould count than the control but there was no significant different ($p \geq 0.05$), when compared to the control after 5 weeks of storage.

Key words: Catfish, ginger, peroxide, quality, smoked, storage, thiobarbituric acid

INTRODUCTION

Fish constitutes a very important component of diet for many people and often provides much needed nutrients for a healthy living. Fish serves as a principal source of dietary protein which is very inexpensive in relation to other protein foods (Fawole *et al.*, 2007). The fish muscle contains four basic nutrients in varying proportions; water 70-80%, protein 16-25%, lipids 1-5% and vitamins (Clucas, 1982) which makes it less tough and more digestible compared to beef, chicken and mutton. Fish has higher levels of essential sulphur-containing amino-acids such as cysteine, methionine and lysine which are limiting in some legumes and most cereal diets (Paul and Southgate, 1978). It is the characteristics of fish as a cheap source of animal protein which is now evident throughout the world that makes it an excellent component of human diet. Fish protein now takes precedence over other protein of animal origin and compares favorably with that of milk, egg and meat in its amino acid composition. It is this quality that makes fish protein to be practically indispensable to developing countries, such as Nigeria, for diet supplementation, where the staple diet or food consist primarily of starchy foods (Idris *et al.*, 2010). Besides, fish is known to contain a very high quality of fats and oil and fish fat is very high in polyunsaturated fatty acids

which are very important in lowering blood cholesterol level. The fish oil, on the other hand, contains the fat soluble vitamins. Fish is also a very good source of thiamine and riboflavin and contains minerals, phosphatids sterols, enzymes, hormones, hydrocarbons and pigments (Larsen *et al.*, 2007; Usyduş *et al.*, 2009). However, fish is an extremely perishable food commodity than cattle, sheep and poultry, as it gets spoil very quickly after capture unless it is disposed off quickly after capture (Kumolu-Johnson and Ndimele, 2011), hence, it is subject to post harvest losses ranging from bacterial and autolytic spoilage to other factors. These causes cause fish to lose its organoleptic qualities and generally unacceptable for human consumption as the quality will be diminished. It is this perish-ability of fish that makes it to be processed into fish based products, such as smoked and canned fish, fish cake, fish meal, fish burger, etc. (Bechtel, 2003).

Fish smoking is one of the traditional methods of preservation of fish in Africa. It is mostly done at the artisanal level by women in riverside communities whose main economic activity is fish processing and marketing. Smoke curing, as applied to fish, is a method of preservation effected by combination of drying and the deposition of naturally produced chemicals, resulting from the thermal breakdown of wood (Ahmed *et al.*, 2010). Dried fish spoilage has been characterized by reddening, browning, or other discoloration mould attack and development of rancidity. The reasons for fish smoking are varied but in Nigeria, the process has proven relevant to prolonging shelf-life, enhancing flavor, storing for lean season and increasing protein availability o people throughout the year (Kumolu-Johnson and Ndimele, 2011).

The use of synthetic antioxidant has been very effective in controlling rancidity. However, synthetic antioxidants Butylated Hydroxytoluene (BHT) and Butylated Hydroxyanisole (BHA) have been prohibited in many countries of the world because of the undesirable effect on the enzymes of the liver and lungs (Sallam *et al.*, 2004). This has necessitated the use of natural antioxidants, such as spices, in the prevention of rancidity in smoked fish (Kahkonen *et al.*, 1999; Patrick-Iwuanyanwu *et al.*, 2007). Spices (ginger, onion, garlic, etc.) are edible plant materials that possess antioxidant, antiseptic and bacteriostatic properties. They are added to foods to delay onset of deterioration, such as rancidity and also function as seasonings to foods as well as impart flavor to the foods (Abdel-Hamied *et al.*, 2009). Ginger as a spice has a geographical spread that covers every part of the globe and it is consumed whole as a delicacy, used in traditional oriental medicine, or as spice in foods, such as fish (Onyeagba *et al.*, 2004; Abdul *et al.*, 2008; Akram *et al.*, 2011). Ginger contains spectra of biologically active compounds, such as curcumin, 6-gingerol, 6-shagaols, zingiberene, bisabolene and several other types of lipids that confer on it, the properties of being pungent and a stimulant. These compounds are responsible for the unique aroma and flavour of ginger and account for about 1-3% of the weight of fresh ginger (Akram *et al.*, 2011). This present study was designed to investigate the effect of ginger extract (oil) in improving the stability and organoleptic quality of smoked *Chrysichthys nigrodigitatus*, *Clarias gariepinus* and *Oreochromis niloticus*.

MATERIALS AND METHODS

The experiment was conducted in the Laboratory of the Department of Fisheries, Faculty of Sciences, Lagos State University from February, 2013 to August, 2013.

Fish handling: Sixty pieces each of fresh catfish *Clarias gariepinus*, Tilapia *Oreochromis niloticus* and *Chrysichthys nigrodigitatus* with a mean weight of 100±10 g used for the experiment were obtained from Lagos State University hatchery complex. They were stunned, eviscerated and

washed in clean water to remove blood. Each species of fish was divided into 3 batches (for the 2 treatments and control). Each batch was made up of 20 fish specimens. Fresh ginger (*Zingiber officinale*), was bought from Alaba market, Ojo and the outer coat was scrapped off and cleaned properly. The ginger was grinded and oil was extracted from it through hydro-distillation. The fish samples were spiced with the ginger oil and were applied at a concentration of 1 mL kg⁻¹ of fish and 1.5 mL kg⁻¹ of fish. A batch was not spiced to be used as the control. The fish were smoked with tropical hardwood at 80-85°C for 2 h. After smoking each treatment was arranged in different basket, stored at ambient temperature of 25-30°C for 5 weeks. The fish samples were subjected to chemical analysis, microbiological analysis and organoleptic assessments.

Peroxide value analysis: The oxidative stability of the samples were measured using titrimetric determination of the amount of peroxide and hydro-peroxide group (the initial products of lipid oxidation) according to AOAC (1995).

Thio barbituric acid analysis: Thio-Barbituric acid reactive substance (Tba-Rs) determination; the oxidative stability of the samples was measured according to Association of Official Analytic Chemist (AOAC, 1995). The TBA value was expressed as mg malonaldehyde per kg sample.

Microbial limit test for smoked samples: The total coliform count was determined according to the method of Fawole and Oso (1995).

Statistical analysis: Analysis of variance (ANOVA) was applied to the treatment value obtained using SPSS V. 16.0 for Windows. Statistical significance was set at p<0.05. Fisher's least significant difference was used to separate differences in treatment means.

RESULTS

The study assessed the effects of ginger oil on the oxidative stability and organoleptic quality of some economically important fish species (*Chrysichthys nigrodigitatus*, *Clarias gariepinus* and *Oreochromis niloticus*) during 5 week ambient storage. The TBA values of the fish samples are presented in Fig. 1. There was no significant difference (p>0.05) in the TBA values of the fish samples treated with different concentrations of ginger and the control. However, the TBA values increased in all the samples over time, particularly in the control. Tilapia treated with 1.5 mL of ginger oil/kg of fish at the first week had the lowest value (14.64 MDA kg⁻¹), while the highest value of 30.65 MDA kg⁻¹ was recorded in *Chrysichthys nigrodigitatus* (control) at week 5.

Figure 2 shows the changes in the peroxide values as primary products of lipid oxidation. Although, there was a general increase in the peroxide values of all the treatments during the 5 week storage period, this difference was not statistically significant. The highest value (18.76 mEq kg⁻¹) of peroxide was recorded in the control of the *Clarias gariepinus* samples in the fifth week, while the lowest value (3.91 mEq kg⁻¹) occurred in the Tilapia samples treated with 1.5 mL of ginger oil/kg of fish at week 1.

The microbial count of the smoked fish samples during the 5 week storage as shown in Fig. 3 showed a steady increment. The lowest microbial count (3.16 Log₁₀ CFU g⁻¹) was recorded also in the tilapia samples treated with 1.5 mL ginger oil/kg of fish. This occurred in the first week of storage. The highest value (5.95 Log₁₀ CFU g⁻¹) was recorded in the *Clarias gariepinus* samples

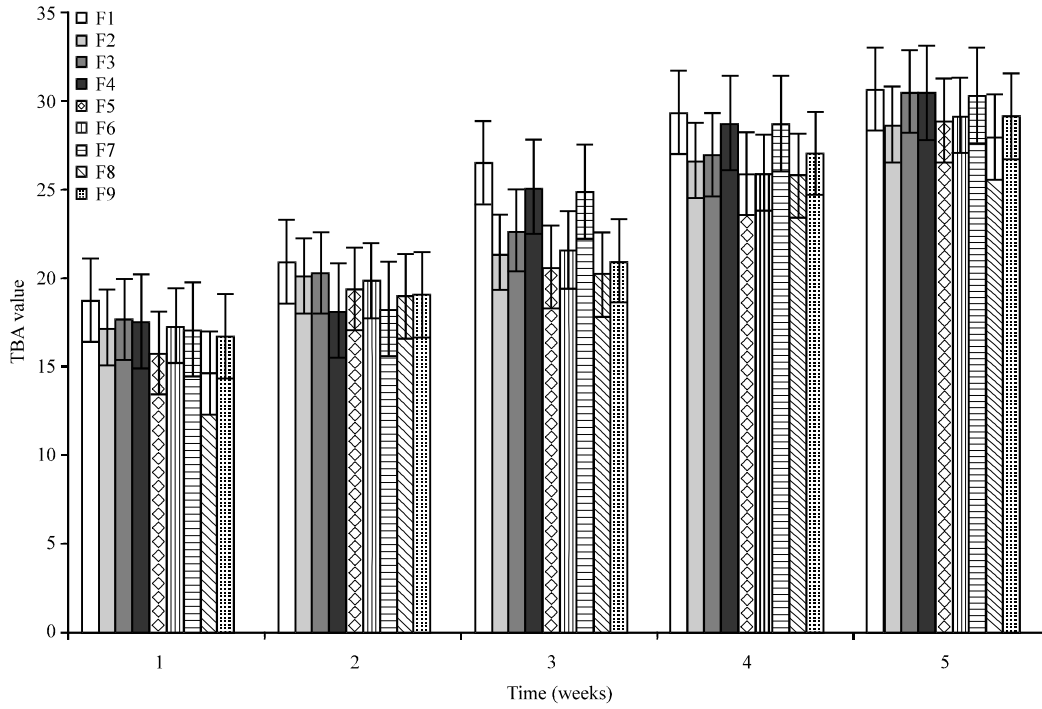


Fig. 1: Effect of ginger extract concentrations and storage duration on TBA values of smoked fish samples

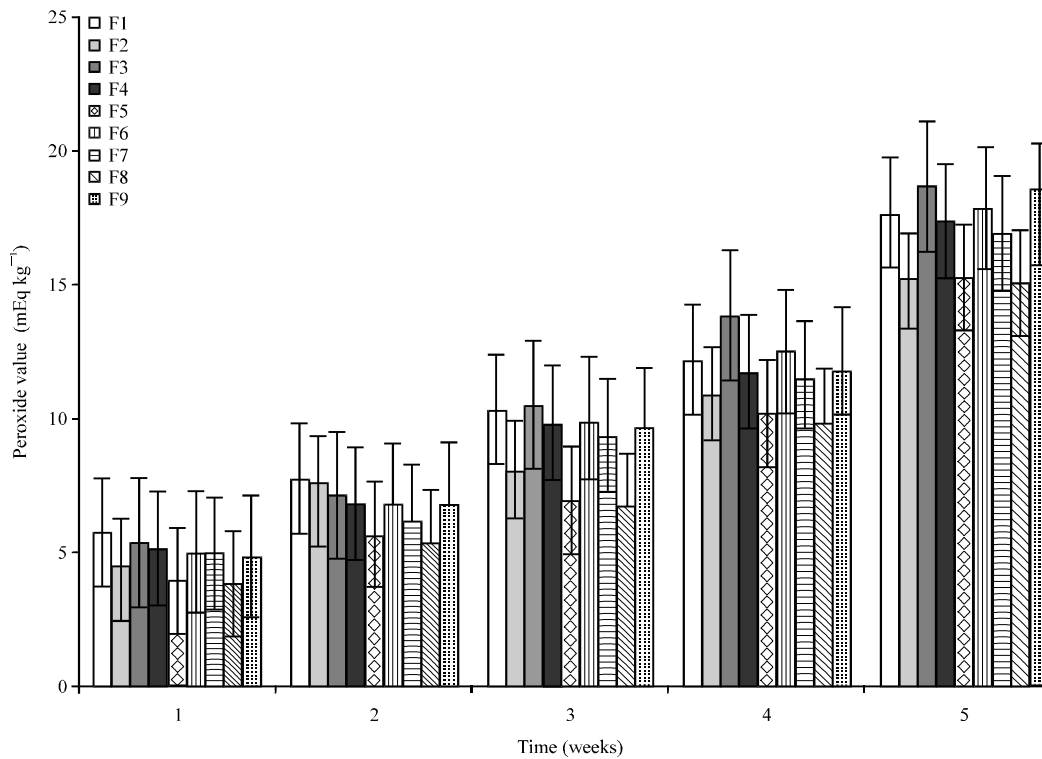


Fig. 2: Effect of ginger oil concentrations and storage duration on peroxide value of the fish samples

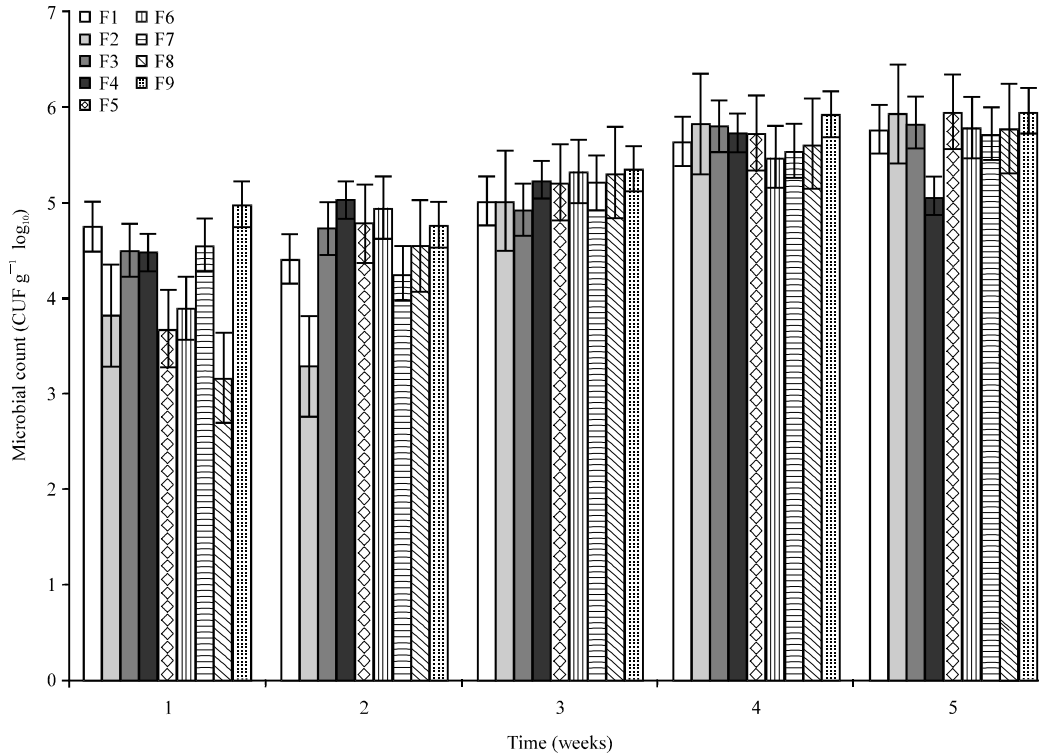


Fig. 3: Effect of ginger on the microbial count of the fish samples

Table 1: Mean thiobarbituric acid TBA, peroxide and microbial growth (Log_{10} CFU g^{-1} of fish sample) for 5 weeks

Treatment	TBA	Peroxide value	Microbial count
F 1	25.20±2.34	10.80±2.06	5.11±0.26
F 2	22.76±2.12	9.29±1.80	4.78±0.53
F 3	23.59±2.30	11.17±2.39	5.15±0.28
F 4	23.98±2.66	10.23±2.14	5.10±0.20
F 5	21.96±2.28	8.45±2.00	5.06±0.40
F 6	22.73±2.13	10.47±2.27	5.08±0.33
F 7	23.82±2.67	9.83±2.12	5.05±0.28
F 8	21.49±2.40	8.21±1.98	4.87±0.48
F 9	22.55±2.37	10.26±2.28	5.39±0.24

F 1: *Chrysichthys nigrodigitatus* control, F 2: *Oreochromis niloticus* control, F 3: *Clarias gariepinus* control, F 4: *Chrysichthys nigrodigitatus* treated with 1 mL of ginger/kg of fish, F 5: *Oreochromis niloticus* treated with 1 mL of ginger/kg of fish, F 6: *Clarias gariepinus* treated with 1 mL of ginger/kg of fish, F 7: *Chrysichthys nigrodigitatus* treated with 1.5 mL of ginger/kg of fish, F 8: *Oreochromis niloticus* treated with 1.5 mL of ginger/kg of fish and F 9: *Clarias gariepinus* treated with 1.5 mL of ginger/kg of fish

treated with 1.5 mL of ginger oil/kg of fish at week 5. All the values are below 7 Log_{10} CFU g^{-1} which is the maximum permissible limit for aerobic plate count, recommended by ICMSF (1986). There was no significant difference ($p>0.05$) in the values recorded.

The results of the organoleptic analyses of the smoked fish samples during the 5 week storage period showed that the samples treated with 1.5 mL ginger oil/kg of fish received the highest panel scores while the control received the lowest panel scores. However, there was no significant difference ($p>0.05$) among the treatments in all the measured organoleptic parameters (Table 1).

DISCUSSION

The medicinal and anti-microbial properties of ginger have been studied extensively but the use of ginger oil as a preservative and its ability to retard lipid oxidation in fish has not been subject of much studies. In the present study, the mean peroxide values in all the samples were below 25 mEq kg⁻¹ of active O₂ kg⁻¹ which is considered as the limit of acceptability in fatty foods. Figure 1 and 2 shows, there were a steady increase in the TBA and peroxide values for all the samples during the storage period, though at different rates. However there was no significant difference (p>0.05) in the recorded values. It was observed that the Tilapia fish samples had the lowest TBA and peroxide values. This may be due to its relatively lower fat content compared to *Clarias gariepinus* and *Chrysichthys nigrodigitatus*.

The ginger extract was also effective in reducing microbial load in the stored fish samples though the difference in the microbial loads among the concentrations of ginger extract (oil) studied was not significant (p>0.05). This could be attributed to high initial microbial load of all the treatments, which must have been due to storage temperature (room temperature). This temperature range was chosen in order to simulate what happens in the local communities where there is no refrigerator to preserve perishable products. A lower storage temperature of 3-4°C may produce much lower microbial load as was reported by Sallam *et al.* (2004). These results observed are in agreement with the studies of Kumolu-Johnson and Ndimele (2011) in which it was observed that there was a reduction in microbial proliferation and lipid oxidation in the samples treated with ginger paste (Ikeme and Bhandary, 2001; Sallam *et al.*, 2004) in which ginger and garlic paste were effective in retarding the development of oxidative rancidity in mackerel, *Scomber scombrus* and in chicken sausage respectively in which the effectiveness of the spice was directly related to their concentration. These results also indicate that the ginger which is natural spice clearly has anti fungal properties that can compare with synthetic antimicrobial agents like Potassium sorbate, Citric acid and Sodium metabisulphite (Omojowo *et al.*, 2008).

CONCLUSION

This study has shown that ginger oil has some antioxidative and antimicrobial properties, which can retard the growth of micro organisms and thus extend the shelf life of fish. Treatment of fish in a concentration of ginger oil before smoking has beneficial effects on the overall quality of the final products. However, the insignificance in the values recorded suggests further studies should be carried out. This in a way will not only reduce the substantial losses associated with this type of product estimated at billions of naira but would also increase the rate of turn over as consumers would now find increased satisfaction with the processed fish as indicated by the sensory quality of the product. This would substantially improve fish protein intake in Nigeria and reduce protein malnutrition and its associated problems in the country.

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