101

Effect of spices on the chemical properties of hot-smoked catfish (*Clarias gariepinus*)

Ayeloja, A. A. / George, F. O. A. / Akinyemi, A. A. / Atanda, O. O.

Abstract

Effect of spices on the chemical properties of hot-smoked catfish (C. gariepinus) was examined. The experimental design was complete randomized design (CRD) with the treatments been the variously spiced hot-smoked catfish (garlic, ginger, garlic-ginger homogenate spiced and the control without spices). Proximate and mineral content analyses were carried out using standard experimental procedures. There exist significant differences ($p < 0.05$) in the percentage moisture and crude protein content with smoked catfish without spices having the highest moisture content with mean value 6.18 ± 0.13 and 79.44 ± 0.13 respectively which could be as a result of the increase in the fibre content of the spiced fish products which is a function of fibre content of the spices applied to the fish products. Similar trend was also observed for the lipid and ash contents the fish products. There exist significant differences ($p < 0.05$) in the mineral content present in the various fish products with the exception of magnesium. The products are 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, C. gariepinus

Introduction

Fish constitutes a very important component of diet for many people, and often provides much needed nutrients for a healthy living, its characteristics 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 that of milk, egg and meat in its amino acid composition. (Iheagwara, 2013). Fish serves as a principal source of dietary protein, which is very inexpensive in relation to other protein foods (Fawole et al., 2007). Fish protein is indispensable to many people in developing countries, such as Nigeria, for diet supplementation, where the staple diet or food consist primarily of starchy foods (Idris, 2010). As important as fish is, high degree of fish spoilage still occur in Nigerian due to the absence of storage facilities and serves a major constraint to the development of fishing industry in Nigeria (Akinpelu et al., 2013). Akinola et al. (2006) reported that some of the different types of preservation methods employed to arrest fish spoilage include: drying, smoking, freezing, chilling and brining. While 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 in that it prolongs the shelf-life of the fish, enhances flavour and increases utilization of the fish in addition to reducing wastes when catches are good as well as increasing protein availability to rural people (Jallow, 1995). The reasons for fish smoking are varied, but in Nigeria, the process has proven relevant to prolonging shelf-life, enhancing flavour and increasing protein availability to people throughout the year (Kumolu–Johnson et al., 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). *C. gariepinus*, one of the species of catfish is a highly nutritious fish that contain high amount of vitamins, proteins, minerals and a little or no saturated fat, and is low in carbohydrates (Idris, 2010). It is an economically important freshwater fish, and enjoys wide acceptability; it is extensively cultivated in ponds but is sometimes underpriced (Kumolu–Johnson, 2010). *C. gariepinus* is a very important fresh water 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). Nigeria is rich in indigenous spices, their food and other uses as well as anti-microbial and preservative properties have not been widely exploited. The spices (aromatic in nature), depending

on the part of the plant being used can be classified into fruits, seed leaves or floral parts and bulbs (Kiin–Kabari et al., 2011). Spices (ginger, onion, garlic, etc.) are edible plant materials that possess anti-oxidant, 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 (Onycagba et al., 2004). Garlic (*Allium sativum*), is one of the most used natural ingredient to enhance flavour in food. It has a wide spectrum of actions, which include: antibacterial, antifungal and anti-oxidative. It also has a beneficial effect on cardio-vascular and immune system of human (Sallam et al, 2004). 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). Achinewhu (1995) investigated the chemical composition of thirty wild spices indigenous to Nigeria and observed that they contained high amounts of fats as well as essential oils. This study was, therefore, carried out to investigate the effect of some spices on the chemical properties of hot-smoked catfish.

Materials and Methods

Twelve live catfish from an earthen pond of Korede fish farm Omi-Adio Second Gate, Ibadan, Oyo State, Nigeria. The average weight of the fish was 226±23g, they were transported by road within 43 minutes early in the morning to reduce stress and were taken to the fish processing unit of Federal College of Animal Health and Production Technology (FCAH&PT) Moor Plantation Ibadan where they were slaughtered immediately and smoked. 6kg of dried garlic bulb and 10kg of dried ginger rhizome (*Zingiber officinale*) was bought from Bodija market in Ibadan, it was ground using electric grinder where 6kg of garlic bulb produced 5kg of powdered garlic and 10kg of ginger rhizome produced 5kg of powdered ginger (*Zingiber officinale*), they were then transported to the fish processing unit of Federal College of Animal Health and Production Technology (FCAH&PT) Moor Plantation, Ibadan where they were later applied as spices to the fish at ratio 5:100g in accordance with the recommendation of Kumolu–Johnson and Ndimele (2011). Seventy grams each of powdered garlic and ginger were homogenized in ratio 1:1 manually using hand and were applied as spices on the catfish (treatment four) prior to fish smoking. The experiment was a completely randomized design where the treatments were the variously spiced catfish (garlic, ginger and garlic + ginger) with a control (without spices). The 12 catfish samples were slaughtered and prepared in the following sequence: the fish were slaughtered with sharp knife —> washed with clean water —> immersed in 15% brine —> spiced with garlic powder in ratio 5:100g of garlic to fish, ginger powder in ratio 5:100g of ginger to fish and ratio 1:1 homogenate mixture of garlic and ginger powder respectively while the control were not spiced —> spread on wire gauze —> placed in the smoking kiln after which smoking was carried out.

Fish smoking was done at the temperature of 90 ± 10°C for 48 hours using NIOMR (Nigeria Institute for Oceanography and Marine Research) smoking kiln installed in the fish processing unit of the Fisheries Technology Department, Federal College of Animal Health and Production Technology (FCAH&PT) Moor Plantation, Ibadan, Oyo State. Charcoal was used to generate heat and smoke. After smoking, the charcoal was removed and the fish were left for 20 hours to cool in the smoking kiln.

- **Chemical Analyses:** The 12 samples of the smoked fish products (comprising of 3 samples of each of the differently spiced smoked fish product) were collected for laboratory analysis at the chemistry laboratory of the Institute of Agric Research and Training (IAR&T) Moor Plantation in Ibadan. The samples used for the analysis were assayed in triplicate. The proximate composition of the fish samples was determined using the standard methods of AOAC (1994). The minerals were determined using Atomic Absorption Spectrophotometer (AAS).
- **Statistical Analysis:** Analysis of variance (ANOVA) was carried out using F-test to determine the treatments level of significance. Treatments were separated using Duncan Multiple Range Test (DMRT) at 95% confidence value ($P<0.05$).

Results and Discussion

Table 1: mean proximate composition of differently spiced hot-smoked catfish.

Treatments	% Moisture content	% Protein	% Lipid	Ash	% Crude fiber
Control	6.18 ± 0.15^{a}	79.44 ± 0.13^{a}	6.31 ± 0.19^{a}	7.04 ± 0.17^{a}	0.16 ± 0.16^{d}
Garlic-spiced	6.10 ± 0.14^{b}	71.00 ± 0.07^{d}	6.04 ± 0.22^{b}	6.06 ± 0.23^{c}	10.54 ± 0.23^{a}
Ginger-spiced	5.90 ± 0.16^{c}	76.06 ± 0.15^{b}	3.85 ± 0.11^{d}	5.14 ± 0.22^{c}	8.54 ± 0.13^{b}
Garlic/ginger spiced	5.73 ± 0.14^{d}	75.69 ± 0.12^{c}	4.83 ± 0.14^{c}	5.14 ± 0.23^{c}	8.49 ± 0.13^{c}

Column with different superscript are significantly different ($P<0.05$) from each other.

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

Treatments	% Ca	% Mg	% K	% Na	% P	% Mn	% Fe	% Zn	% Cu
Control	0.539±0.04^{d}	0.328±0.02	0.209±0.04^{c}	0.267±0.02^{b}	0.471±0.02^{b}	0.362±0.01b^{c}	0.246±0.04^{b}	0.350±0.02^{b}	0.128±0.01^{d}
Garlic-spiced	0.619±0.06^{c}	0.334±5.03	0.399±0.05^{b}	0.319±0.01^{a}	0.431±0.30^{c}	0.367±0.03^{c}	0.130±0.11^{c}	0.370±0.04^{b}	0.986±0.04^{a}
Ginger-spiced	0.826±0.04^{b}	0.453±0.02	0.305±0.07^{bc}	0.326±0.04^{a}	0.548±0.04^{a}	0.442±0.05^{a}	0.328±0.02^{a}	0.360±0.02^{b}	0.739±0.05^{b}
Garlic/ginger spiced	0.980±0.02^{a}	0.525±0.05	0.416±0.05^{ab}	0.335±0.02^{a}	0.519±0.02^{a}	0.434±0.02^{ab}	0.322±0.03^{a}	0.406±0.01^{a}	0.627±0.01^{c}

Column with different superscript are significantly different (P<0.05) from each other.

The result on tables 1 and 2 evoked significant differences ($p < 0.05$) of the proximate and mineral compositions of differently spiced hot-smoked catfish. The smoked catfish with no spice has the highest moisture content with mean value 6.18 ± 0.13 which reduces significantly ($p < 0.05$) with the application of different spices where smoked catfish spiced with garlic–ginger homogenate have the lowest moisture content 5.73 ± 0.14. The observed differences in the loss of moisture could be due to variation in the moisture absorbing properties of the various spices applied prior to smoking, this resultant reduction in the moisture content of the smoked fish product will reduce rate of spoilage and in turn elongate the shelf life of the smoked fish products, this is line with the opinion of Fapohunda and Ogunkoya (2006) that the removal of moisture content increases the shelf life of fish products, similar opinion was also expressed by Daramola et al. (2007) that water activity determines the storage life of fish. The result of this study indicate that the crude protein in the mean proximate composition formed the largest quantity of the dry matter in all the fish products, this is in line with the report of Ajani et al. (2013) that crude protein formed the largest quantity of the dry matter in all fish. Also, there is significant difference ($p < 0.05$) in the percentage crude protein content of the differently spiced hot-smoked catfish with the crude protein of the control (smoked catfish without spices) being the largest with mean value of 79.44±0.13 which reduce significantly ($p < 0.05$) when compared with other spiced hot-smoked catfish where garlic-ginger spiced hot-smoked catfish had the lowest percentage crude protein content (75.69±0.13). The reduction in the percentage crude protein of spiced fish product could be as a result of the increase in the fibre content of the product which is a function of fibre content of the spices applied to the fish products. Similar trend was also observed for the lipid and ash contents the fish products. However, the result of the percentage crude fibre indicate that the control have the lowest crude fibre with mean value 0.16 ± 0.13 which is significantly different ($p < 0.05$) from other spiced fish products while garlic spiced hot-smoked catfish have the highest percentage crude fibre with mean value 10.54±0.13. The result of the mineral composition presented on table 2 indicates that there is no significant difference ($p > 0.05$) in the magnesium present the various fish products. However, there exists significant difference ($p < 0.05$) in other minerals present in the various fish products. The products are rich in calcium with garlic-ginger homogenate spiced product having the highest level of calcium (0.980±0.02) while the control has the lowest calcium level (0.539±0.04). Calcium is required in maintaining and building bone and tooth, it also performs the functions of adjusting the acid-base balance, blood coagulation and transporting the nerve impulse (Meta et al., 2010). Similar report of heavy and trace metals was reported by Fawole et al. (2007) where they reported the 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 the same fish species. Generally, the minerals occurred at low levels within international limits, thereby making this fish product safe for consumption, this is in agreement with the opinion of FAO/APHCA (1998).

Conclusion

The result of the proximate composition of the spiced fish product indicate that there exist significant differences ($p < 0.05$) in the percentage moisture content with smoked catfish without spices having the highest moisture content with mean value 6.18 ± 0.13 which reduce significantly ($p < 0.05$) with the application of different spices where smoked catfish spiced with garlic-ginger homogenate have the lowest moisture content 5.73±0.14. The observed differences in the loss of moisture could be due to variation in the moisture absorbing properties of the various spices applied prior to smoking, this resultant reduction in the moisture content of the smoked fish product will reduce rate of spoilage and in turn elongate the shelf life of the smoked fish products. The result of this study also indicate that there exist significant difference ($p < 0.05$) in the percentage crude protein content of the differently spiced hot-smoked catfish with the crude protein of the control (smoked catfish without spices) being the largest with mean value of 79.44±0.13, the reduction in the percentage crude protein of spiced fish product could be as a result of the increase in the fibre content of the spiced fish products which is a function of fibre content of the spices applied to the fish products. Similar trend was also observed for the lipid and ash contents the fish products. There exist significant differences ($p < 0.05$) in the mineral content present in the various fish products with the exception of magnesium. The products are rich in calcium and other minerals with garlic-ginger homogenate spiced product having the highest level of calcium (0.980±0.02) while the control has the lowest calcium level (0.539±0.04). The study also indicate that the products are also rich in iron with ginger and garlic-ginger homogenate spiced product having the highest level of iron, this supply of iron is needed for the bounding of hemoglobin therefore iron took an important role by the oxygen transportation (Meta et al., 2010). Generally, the minerals occurred at low levels within international limits, thereby making this fish product safe for consumption.

REFERENCES

Abdel-Hamied, A. A., Nassar, A. G. and El-Badry, N. (2009). Investigations of antioxidant and antibacterial activities of some natural extracts. *World Journal of Dairy and Food Sciences*. 4: 1–7.

Achinewhu, S. C., Ogbonna, C. C. and Hart, A. D. (1995). Chemical composition of indigenous wild herbs, spices, fruits, nuts, and leafy vegetables used as food. *Plant Food for Human Nutrition*. 48: 344–348.

Ajani, F., Adetunji, V. O. and Oyedokun, J. O. (2013). Biophysicochemical changes that occur in fish during different stages of traditional processing. AJFAND. 13/3: 7840–7852.

Akinola, O. A., Akinyemi, A. A. and Bolaji, B. O. (2006). Evaluation of traditional and solar drying systems towards enhancing fish storage and preservation in Nigeria (Abeokuta Local Government as a case study). *J. Fish Int.* 1: 44–49.

Akinpelu, O. M., Ayeloja, A. A., George, F. O. A., Adebisi, G. L., Jimoh, W. A. and Idowu, S. D. (2013). Gender analysis of processing activities among commercial catfish processors within Ibadan metropolis, Oyo State, southwestern Nigeria. *J. Aquac Res Development*. 4: 176.

Akram, M., Shah, M. I., Usmanghan, K., Mohiuddin, E. and Sami, A. (2011). *Zingiber officinale*: A medicinal plant. *Pakistan Journal of Nutrition*. 10: 399 400.

AOAC (1994). *Official Methods of Analysis of the Association of Official Analytical Chemist*, Vols. I and II, Arlington. 1298pp.

Ayeloja, A. A., George, F. O. A., Obasa, S. O. and Sanni, L. O. (2011). Effect of post-slaughter time intervals on the quality of the African catfish (*Clarias gariepinus*). *American Journal of Food Tech*. 6/9: 790–797.

Bellagha, S., Sahli, A., Farhat, A., Kechaou, N. and Glenza, A. (2007). Studies on salting and drying of Sardine (*Sardinella aurita*): Experimental kinetics and modeling. *J. of Food Engin*. 78: 947 952.

Bhandary, C. S. (1991). Effects of spice treatment on lipid oxidation in smoked mackerel (*Scomber scombu*). *FAO Fisheries Report*. 108–133.

Daramola, J. A., Fasakin, E. A. and Adeparusi, E. O. (2007). Changes in physicochemical and sensory characteristics of smoke-dried fish species stored at ambient temperature. *AJFAND*. 7.6: 1–16.

Fapohunda, O. O. and Ogunkoya, M. (2006). Effect of smoke-drying on the proximate composition of *Tilapia zilli*, *Parachanna obscura* and *Clarias gariepinus* obtained from Akure, Ondo State. *Animal Research International*. 3/2: 478–480.

Fawole, O., Ogundian, M., Anyandiran, T., Olagunji. O. (2007). Proximate and mineral composition in some selected fresh water fishes in Nigeria. *Internet Journal of Food Safety*. 9: 52–55.

Idris G. L., Omojowo, F. S., Omojasola P. F., Adetunji, C. O., Ngwu, E. O. (2010). The effect of different concentrations of ginger on the quality of smoke-dried catfish (*Clarias gariepinus*). *Nature and Science*. 8: 59–63.

Igene, J. O. (1983). Drying of fish, factors to consider. *Proceedings*, 3rd Annual Conference of FISON, Maiduguri. 123pp.

Iheagwara, M. C. (2013). Effect of Ginger extract on stability and sensorial quality of smoked mackerel (*Scomber scombrus*) *Fish. J. Nutr Food Sci*. 3: 199.

Jallow, A. M. (1995). Contribution of improved Chorkor oven to artisanal fish smoking in The Gambia. *Proceedings of the workshop on seeking improvements in fish technology in West Africa*, Nov. 7 9. 1994, Congo, 22 28.

Kiin-Kabari, D. B., Barimalaa, I. S., Achinewhu, S. C. and Adeniji, T. A. (2011). Effects of extracts from three indigenous spices on the chemical stability of smoke-dried catfish (Clarias lezera) during storage. *AJFAND*. 11(6): 5335–5343.

Kumolu–Johnson, C. A. and Ndimele, P. E. (2011). A review on post-harvest losses in artisanal fisheries of some African countries. *Journal of Fisheries and Aquatic Science*. 6(4): 365–378.

_____, Aladetohun, N. S. and Ndimele, P. E. (2010). The effects of smoking on the nutritional qualities and shelf-life of *Clarias gariepinus*. *African Journal of Biotechnology*. 9/1: 073–076.

Nielsen, S. S. (2003). *Food Analysis*. (3rd edn), New York: Kluwer Academic/Plenum Publishers.

Meta, M., Tuflikha, P. P., Indrastuti, F. B., Abu-Bakar, T., (2010). Development of seasoning powder as flavor enhancer made from fish paste. Presented at the International Conference, Short Course and Exhibition on Nutraceutical and Functional Foods. 1–12.

Onyeagba, R. A., Ugbogu, O. C., Okeke, C. U. and Iroakazi, O. (2004). Studies on the antimicrobial effects of garlic (*Allium sativum*), ginger (*Zingiber officinale*) and lime (*Citrus aurantifolia*). *Afr. Jou. Biotechnology*. 3/552–554.

Salaudeen, M. M., Akande, G. R., Oguntade, O. R., Afolabi, O. O., Olusola, A. O. and Ezekiel M. O. (2010). Effect of preservatives on microbial safety and quality of smoked catfish (Clarias gariepinus) during ambient storage. *Acta SA Tech*. 3(2): 81–86.

Sallam, K. H. I., Ishioroshi M. I. and Samejima, (2004). Antioxidant and anti-microbial effect of garlic on chicken sausage. *Lebenson Wiss Technol*. 37(8): 849 855.