PROXIMATE ASSESSMENT OF SMOKE-DRIED AND SPICED AFRICAN CATFISH USING SALT, GARLIC, GINGER AND TURMERIC AS PRESERVATIVES IN LAFIA, NASARAWA STATE

[1]*Yusuf, J.K., [2]Okunsebor S.A., [1]Umar K.A. and [1]Kwala, G. J.
[1]Department of Fisheries and Aquaculture, Federal University of Lafia
[2]Department of Aquaculture and Fisheries Management, Nasarawa State University, Keffi, Shabu-Lafia Campu
Corresponding author: khadijat2050@gmail.com; 08148538323

ABSTRACT
Effectiveness of salt, ginger, garlic and turmeric as preservatives on the proximate quality of smoked C. gariepinus was investigated after treatments and storage for two months, with a view to extend its shelf life as well as consumer acceptance. A 42-kg fresh C. gariepinus was distributed at 2 kg per treatment, and cured with T1 (Salt), T2 (Ginger), T3 (Garlic), T4 (Turmeric), T5 (mixed ginger and garlic) T6 (mixed ginger and turmeric) and T7 (mixed garlic and turmeric) at different concentrations (10g, 20g, and 30g) in a 7x3x2 factorial arrangement. The various treatment samples were smoked for 9 hours. The results obtained on proximate analysis indicated; moisture was highest T7 (16.33 ± 4.51) at 30 g and lowest in T1 (10.00 ± 3.00) at 30g concentrations. Ether extract was highest T5 (23.33 ± 1.53) at 10g concentration and lowest in T1 (15.00 ± 5.00) at 10g concentration. Protein was highest in T5 (43.67 ± 7.51) at 30g concentration and lowest T2 (41.00 ± 5.00) at 10g concentration. Highest NFE was recorded in T6 (11.00 ± 1.00) at 10g and lowest in T5 (3.67 ± 0.58) at 20g. With high reduction in moisture contents and high protein values obtained before and after storage, it is recommended that C. gariepinus be cured using natural spices. These findings suggest that spices (ginger, garlic, and turmeric as well as combined ginger and turmeric) are suitable for use as sensory enhancer.

Keywords: Fish, Preservation, Proximate composition, Enhancer, Lafia

INTRODUCTION
Processing and preservation of fish is done in the most indigenous traditional ways with little or no attempt to add value or improve on the old practices through branding of the processed fish products which often times are prone to insects infestation, rodents invasion and unattractive with little or no appeal; considering also that its quality is of concern to consumers who most often have to trust fish handlers like the fishermen, processors and traders with the healthy state of the fish they consume (Ghaly *et al.,* 2020). According to report by Maillet *et al.,* (2021), smoking of fish can have protective function against spoilage to increase shelf-life of harvested fishes. It is interesting to note also that seasonings such as cloves, cinnamon, black pepper, turmeric, ginger, garlic and onions in parts or in whole are used as therapeutic agents in a range of processed foods either as anti-inflammatory, anti-cancer and anti-microbial agents nevertheless they are not fully exploited (Nikmaram *et al.,* 2018)

In addition to increasing shelf-life, processing carried out to enhance food value and improve merchandise quality. Fish handling activities such as processing is targeted at increasing value addition to make available a range of fishery product and impact the launch of an assortment of products that appeals to domestic as well as the international consumers (Indrajit *et al.,* 2021). Nigeria and Ghana leads in the fish farming practices, 96% of the 389,302 tons of fish produced in 2016 positioned them as Economic Community of West African States largest fish exporters, which is estimated at 301,950 tons while imports amounted to 1,690,501 tons (ECOWAS, 2020), these must have motivated the production of smoked fish product which are a perceived as excellent and harmless source of omega-3 fatty acids (Grzegorz *et al.,* 2022). Proximate assessment of processed dried and spiced African catfish using brine, garlic, ginger, turmeric as value added enhancer seem meaningful in the study for longer shelf life of *Clarias gariepinus*.

MATERIALS AND METHODS
Forty-two kilogram (42 kg) samples were divided into seven (7) treatments in three (3) concentrations including a control in a 7x3x2 factorial arrangement. Each treatment consisted of 2kg making a total of 42 kg table size *Clarias gariepinus.* Each concentration group of fish (2 kg) was gutted and cut into chunks of near equal sizes and washed thoroughly under clean tap water to remove fish slime, sand and fish visceral.

The test spices (ginger, garlic, and turmeric) were crispy dried, ground into powder, and placed in containers separately in preparation for the study and thereafter 10g, 20g, and 30g of each of the ground spices were

weighed using a sensitive scale (Atom A 122 Electronic kitchen digital weighing scale, model SF: 400A). Each of the weighed spices was mixed in a litre of water) separately and thereafter each fish treatment sample were immersed in the solution for two hours (2h) respectively and tagged. Smoking was carried out at the processing unit of the Department of Aquaculture and Fisheries Management Nasarawa State University, Faculty of Agriculture Shabu Campus Lafia. The tagged cured fish were smoked in a gas kiln for nine hours (9 hours) under low heat to reduce the water activity after which the smoked fish products were left to cool inside the smoking kiln for two hours (2h); and thereafter the cooled smoked product was packed and labelled respectively. The first sample treated with brine solution served as the control.

RESULTS AND DISCUSSION

Proximate Composition of Variously Cured Smoked *C. gariepinus* Before Storage in Shabu-Lafia Campus, Nasarawa State University Keffi

Table 1 shows the results of a two-way ANOVA for various nutritional parameters of *C. gariepinus* across treatment groups (T1 to T7) at different concentrations (10g, 20g, and 30g) which are T1 (salt), T2 (ginger), T3 (garlic), T4 (turmeric), T5 (mixed ginger and salt), T6 (mixed ginger and turmeric), and T7 (mixed garlic and turmeric). The moisture content did not show significant differences across treatment groups or concentrations, as indicated by the F and P values ($P > 0.05$ for all). Crude protein content did not significantly vary across treatment groups or concentrations ($P > 0.05$ for all). No significant differences in ether extract content were observed across different treatments or concentrations ($P > 0.05$ for all). Significant differences in crude fibre content were noted at the 10g concentration ($F = 15.18$, $P < 0.001$), but not at higher concentrations ($P > 0.05$ for 20g and 30g). No significant differences were found in NFE content across treatments or concentrations, except at 30g where a significant interaction observed ($F=2.91$, $P>0.005$).

Proximate Composition of Variously Cured and Smoked *C. gariepinus* after storage.

Proximate composition of the variously cured smoked catfish samples After Storage is as presented in Table 2. The cured samples of *C. gariepinus* smoked at different concentration across treatments presented in this study, showed Proximate analysis carried out presented some variation. *C. gariepinus* cured using mixed garlic and turmeric (T7) gave the highest moisture (16.33 ± 4.51) and lowest in ginger (T2) and ginger and turmeric T6 (9.20 ± 1.00) respectively. Samples cured with ginger and garlic (T5) presented highest Crude protein values (43.67±7.51) and lowest in ginger cured sample at 30g (41.00±5.00). Again highest ash content was recorded in sample cured with combined ginger and turmeric at 30g (13.00±3.000 and lowest in ginger treated sample at 10g (7.00±1.00) respectively. However, Sample cured with combined ginger and turmeric at 10g recorded the highest ether extract (23.33±1.53) which was lowest in salt cured sample again at 10g (15.00 ± 5.00). Nitrogen free extract (NFE) recorded its highest value in T6 GTcsdf at 20g (11.00±1.00) and lowest in T5 GGacsdf at 10g (3.67±0.58).

The proximate composition of the various treated samples in the present study revealed that increased concentration of salt was responsible in reducing moisture to 10%, this reduction conform to codex alimentarious standard (2013) for smoked fish, this finding agrees with those of Ajai *et al. (*2019) that salt together with smoking could significantly reduce moisture as well as spoilage and the result also agrees with the finding of Ali *et al.* (2011) who reported low moisture content in smoked-dried fish.

Moisture content in other treatment (T2,T4,T5, and T6) were within the standard the present study agrees with the findings of Ndife *et al.* (2022) who recorded 10-13% moisture content of cured smoked fish under similar study, which is an indication that the use of natural spices in the present study impacted on the moisture content of the products, however there was low moisture reduction in T3 (garlic) and T7 (combined garlic and turmeric) to the recommended standard, the high moisture recorded in these treatments could lead to proliferation of microorganisms, this can be further supported by Ndife *et al.* (2022) who stated that moisture had been as an important attribute in food processing and preservation because many biochemical and physiological changes depends on it.

Lipid levels reported in this study were lower in salt cured samples (15.00 ±5.00) than those reported by Chukwu, (2009) who reported 21.2% lipid for *C. gariepinus*. However, Treatment 5 and 6 presented (values 21.00 ± 1.00) and above a5 20 and 30g concentration which is considered high according to (Ndife *et al.,* 2019).

Moisture content of cured smoked *C. gariepinus* after storage was lowered than those of the sample before storage. The use of spices at 20g concentration combined with smoking significantly reduce moisture to 9% in T1, T2, T3, T4, T5 (10% to 11%) and below as prescribed by WHO, an indication that storage did not affect the nutrient composition with the use of spices.

Table 1: Proximate Composition of Variously Cured and Smoked *C. gariepinus* before Storage

Concentrations		T_1	T_2	T_3	T_4	T_5	T_6	T_7		
Parameters	N	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	F	P
Moisture										
10 g	3	11.67 ± 4.51	13.00 ± 3.00	13.00 ± 4.00	11.00 ± 3.00	11.00 ± 3.00	13.00 ± 4.00	14.33 ± 4.51	0.91§	0.497
20 g	3	12.00 ± 4.00	11.00 ± 2.00	13.00 ± 3.00	11.33 ± 3.51	12.33 ± 3.51	11.33 ± 2.52	15.00 ± 5.00	1.21•	0.309
30 g	3	10.00 ± 3.00	13.00 ± 3.00	14.00 ± 4.00	14.00 ± 5.00	15.00 ± 6.00	15.67 ± 5.51	16.33 ± 4.51	0.29‡	0.998
Ash										
10 g	3	9.33 ± 4.51	8.00 ± 2.00	8.00 ± 2.00	9.00 ± 2.00	10.67 ± 2.52	10.67 ± 3.06	9.33 ± 2.52	3.51§	**0.007**
20 g	3	8.00 ± 2.00	7.00 ± 1.00	7.67 ± 2.08	10.00 ± 3.00	12.00 ± 4.00	11.67 ± 3.51	10.00 ± 2.00	0.74•	0.483
30 g	3	6.00 ± 1.00	9.00 ± 3.00	8.33 ± 1.53	12.00 ± 5.00	12.67 ± 3.51	13.00 ± 3.00	11.00 ± 2.00	0.46‡	0.925
Crude protein										
10 g	3	41.33 ± 8.51	41.00 ± 5.00	42.67 ± 7.02	42.00 ± 4.00	41.00 ± 7.00	42.00 ± 5.00	42.33 ± 3.06	1.01§	0.432
20 g	3	41.00 ± 7.00	42.00 ± 4.00	42.00 ± 5.57	41.00 ± 5.00	43.00 ± 8.00	42.67 ± 2.52	43.33 ± 4.04	0.20•	0.816
30 g	3	41.33 ± 6.51	42.00 ± 6.00	41.00 ± 7.00	42.67 ± 6.51	43.67 ± 7.51	42.00 ± 6.00	42.00 ± 3.00	0.21‡	0.997
Ether extract										
10 g	3	15.00 ± 5.00	18.00 ± 4.00	18.00 ± 5.00	19.00 ± 4.00	23.33 ± 1.53	18.67 ± 5.51	19.00 ± 3.00	2.22§	0.060
20 g	3	16.00 ± 3.00	19.00 ± 4.00	18.00 ± 3.00	16.00 ± 7.00	21.00 ± 1.00	20.33 ± 3.51	18.33 ± 3.51	0.07•	0.935
30 g	3	18.00 ± 3.00	17.00 ± 5.00	17.67 ± 2.08	15.67 ± 6.03	22.00 ± 1.00	21.00 ± 2.00	16.67 ± 4.51	0.34‡	0.977
Crude fibre										
10 g	3	17.67 ± 4.51	10.00 ± 5.00#	10.00 ± 5.00#	8.00 ± 3.00#	7.00 ± 3.00#	4.67 ± 2.52#	4.00 ± 1.00#	15.18§	**<0.001**
20 g	3	17.67 ± 4.51	10.00 ± 5.00#	9.33 ± 2.08#	12.00 ± 5.57#	8.00 ± 1.00#	4.00 ± 1.00#	5.00 ± 1.00#	0.97•	0.387
30 g	3	17.00 ± 5.57	11.00 ± 6.00#	9.33 ± 3.06#	7.00 ± 2.00#	2.00 ± 1.73#	1.33 ± 0.58#	7.67 ± 1.53#	0.81‡	0.634
NFE										
10 g	3	5.00 ± 0.00	10.00 ± 1.00	8.33 ± 1.16	11.00 ± 0.00	7.00 ± 0.00	11.00 ± 1.00	11.00 ± 0.00	1.16§	0.347
20 g	3	5.33 ± 0.58	11.00 ± 0.00	10.00 ± 1.73	9.67 ± 0.58	3.67 ± 0.58	10.00 ± 1.00	8.33 ± 0.58	2.32•	0.110
30 g	3	7.67 ± 0.58	8.00 ± 1.00	9.67 ± 0.58	8.67 ± 0.58	4.67 ± 0.58	7.00 ± 0.00	6.33 ± 0.58	2.91‡	**<0.005**

Statistical significance was expressed as P <0.005 for pairwise comparison of treatment groups (T_n) with T1 as the comparator (reference group)

Table 2: Proximate Composition of Variously Cured Smoked *C. gariepinus* After Storage

Concentrations		T_1 (Scsdf)	T_2 (Gcsdf)	T_3(Gacsdf)	T_4 (Tcsdf)	T_5(GGacsdf)	T_6(GTcsdf)	T_7(GaTcsdf)		
Parameters	N	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	F	P
Moisture										
10 g	3	9.67 ± 2.51	9.20 ± 1.00	9.20 ± 2.00	9.4.00 ± 1.00	9.40 ± 1.00	9.20 ± 1.00	9.33 ± 1.51	0.91§	0.427
20 g	3	10.00 ± 4.00	9.80 ± 2.00	9.80 ± 3.00	9.31 ± 3.51	10.13 ± 3.51	10.33 ± 2.52	12.00 ± 5.00	1.21•	0.319
30 g	3	10.00 ± 3.00	13.00 ± 3.00	14.00 ± 4.00	14.00 ± 5.00	15.00 ± 6.00	15.67 ± 5.51	16.33 ± 4.51	0.29‡	0.938
Ash										
10 g	3	8.00 ± 2.00	7.00 ± 1.00	7.67 ± 2.08	10.00 ± 3.00	12.00 ± 4.00	11.67 ± 3.51	10.00 ± 2.00	0.74•	0.423
20 g	3	9.33 ± 4.51	8.00 ± 2.00	8.00 ± 2.00	9.00 ± 2.00	10.67 ± 2.52	10.67 ± 3.06	9.33 ± 2.52	3.51§	**0.007**
30 g	3	6.00 ± 1.00	9.00 ± 3.00	8.33 ± 1.53	12.00 ± 5.00	12.67 ± 3.51	13.00 ± 3.00	11.00 ± 2.00	0.46‡	0.915
Crude protein										
10 g	3	41.33 ± 6.51	42.00 ± 6.00	41.00 ± 7.00	42.67 ± 6.51	43.67 ± 7.51	42.00 ± 6.00	42.00 ± 3.00	0.21‡	0.917
20 g	3	41.00 ± 7.00	42.00 ± 4.00	42.00 ± 5.57	41.00 ± 5.00	43.00 ± 8.00	42.67 ± 2.52	43.33 ± 4.04	0.20•	0.826
30 g	3	41.33 ± 8.51	41.00 ± 5.00	42.67 ± 7.02	42.00 ± 4.00	41.00 ± 7.00	42.00 ± 5.00	42.33 ± 3.06	1.01§	0.412
Ether extract										
10 g	3	15.00 ± 5.00	18.00 ± 4.00	18.00 ± 5.00	19.00 ± 4.00	23.33 ± 1.53	18.67 ± 5.51	19.00 ± 3.00	2.22§	0.070
20 g	3	16.00 ± 3.00	19.00 ± 4.00	18.00 ± 3.00	16.00 ± 7.00	21.00 ± 1.00	20.33 ± 3.51	18.33 ± 3.51	0.07•	0.915
30 g	3	18.00 ± 3.00	17.00 ± 5.00	17.67 ± 2.08	15.67 ± 6.03	22.00 ± 1.00	21.00 ± 2.00	16.67 ± 4.51	0.34‡	0.977
Crude fibre										
10 g	3	17.67 ± 4.51	10.00 ± 5.00#	10.00 ± 5.00#	8.00 ± 3.00#	7.00 ± 3.00#	4.67 ± 2.52#	4.00 ± 1.00#	15.18§	**<0.001**
20 g	3	17.00 ± 5.57	11.00 ± 6.00#	9.33 ± 3.06#	7.00 ± 2.00#	2.00 ± 1.73#	1.33 ± 0.58#	7.67 ± 1.53#	0.81‡	0.624
30 g	3	17.67 ± 4.51	10.00 ± 5.00#	9.33 ± 2.08#	12.00 ± 5.57#	8.00 ± 1.00#	4.00 ± 1.00#	5.00 ± 1.00#	0.97•	0.327
NFE										
10 g	3	5.33 ± 0.58	11.00 ± 0.00	10.00 ± 1.73	9.67 ± 0.58	3.67 ± 0.58	10.00 ± 1.00	8.33 ± 0.58	2.32•	0.120
20 g	3	5.00 ± 0.00	10.00 ± 1.00	8.33 ± 1.16	11.00 ± 0.00	7.00 ± 0.00	11.00 ± 1.00	11.00 ± 0.00	1.16§	0.317
30 g	3	7.67 ± 0.58	8.00 ± 1.00	9.67 ± 0.58	8.67 ± 0.58	4.67 ± 0.58	7.00 ± 0.00	6.33 ± 0.58	2.91‡	**<0.005**

Statistical significance was expressed

#P <0.005 for pairwise comparison of treatment groups (T_n) with T1 as the reference group

The high ash value of smoked *C. gariepinus* in the current study may be due to low moisture recorded which may be connected to the heating effect of the smoking process, this account agrees with those of Ndife *et al.* (2022) who reported that smoking significantly increased ash in sun dried *C. gariepinus.* Fish species with more than 20% lipid content is considered lipidty (Ndife *et al.,* 2019). Reports have it that lipid increases with heat processing resulting from reduction in moisture content (Akintola *et al.,* 2013). Lipid levels reported in the current study (18 to 19%) were lower than those reported for *C. gariepinus*, for instance Chukwu, (2009) reported 21.2% lipid content for *C. gariepinus.* The significant ash content at lower concentrations could be due to mineral-rich components in treatments like turmeric and ginger.

CONCLUSION AND RECOMMENDATIONS

To prevent post-harvest losses, effectiveness of salt, ginger, garlic and turmeric as preservatives on the proximate, quality of smoked *C. gariepinus* were investigated which indicated that moisture was highest T7 at 30g and lowest in T1 at 30g concentrations, lipid was highest T5 at 10g concentration. Protein was highest in T5 at 30g concentration while highest NFE was recorded in T6 at 10g.In conclusion therefore the treatments as used in the present study did improve on the proximate composition of smoked *C. gariepinus*. With high reduction in moisture contents and high protein values observed in this study, it is therefore recommended that *C. gariepinus* be cured using natural spices. These findings suggest that spices (ginger, garlic, and turmeric as well as combined ginger and turmeric) are suitable for use as value added enhancer in the processing and preservation of *C. gariepinus* post-harvest.

REFERENCES

Ajai, A. I., Inobeme, A., Nwakife, N. and Abubakar, N. A. (2019). Proximate and Essential Mineral Composition of Fresh and Smoked Catfish and Beef Sold in Minna, Niger State. *FUW Trends in Science and Technology Journal*, e-ISSN: 24085162; p-ISSN: 20485170; August, 2019: Vol. 4 No. 2 pp. 569 – 571

Akinola, O. A., Akinyemi, A. A. and Bolaji B. O. (2006). Evaluation of traditional and solar fish drying systems towards enhancing fish storage and preservation in *Nigeria. Journal Fish Int., Pakistan* 3.4: 44-49.

Akintola S.L and Bakare S.B. (2011). Microbiological Changes in Freshwater Fishes in Nig. *International Journal of Food Safety a: 52-55*

Aliyu, G., Humaid, K., Nasser, A., Sami, G. and Aziz, K. (2011). Effect of the freshness of starting material on the final product quality of dried salted shark. *Advanced Journal Food Sci Technology 4: 60 – 63.*

Ghaly AE, Dave D, Budge S, Brooks MS (2010) A review fish spoilage mechanisms and preservation techniques. *Am J Appl Sci* 7: 859-877.

Grzegorz B., Grzegorz T., and Patrycja B. (2022). Influence of Storage Time and Method of Smoking on the Content of EPA and DHA Acids and Lipid Quality of Atlantic Salmon (*Salmo salar*) Meat. *Int J Food Sci.* 2022; 2022: 1218347. Published online 2022 Feb 23. doi: 10.1155/2022/1218347

Indrajit W; Rita N. and Suprehatin (2021). Value Chain Upgrading: Evidence from Smoked Fish Agribusiness In *Central Java. AGRISEP* Vol. 21 No. 1 March 2021 Page: 243 – 256. ISSN: 1412-8837, e-ISSN: 2579-9959.

Maillet A., Denojean P., Bouju-Albert (2021). Characterization of bacterial communities of cold-smoked salmon during storage. Foods. 2021; 10(2):p. 362. doi: 10.3390/foods10020362. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

Ndife J., Onyeiwu S.C., Ubbor S.C. and Ukor I.C. (2022) Effects of Curing Methods on Quality of Hot Smoked Fish (*Sardina pilchardus*). *Science World Journal* Vol. 17(No 2) 2022. ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print) Published by Faculty of Science, Kaduna State University.

Nikmaram, N., Budaraju, S., Barba, F.J., Lorenzo, J.M., Cox, R.B., Mallikarjunan, K. and Roohinejad, S., (2018). Application of plant extracts to improve the shelf-life, nutritional and health-related properties of ready-to-eat meat products. *Meat Science*, vol. 145, pp. 245-255. http://dx.doi.org/10.1016/j. meatsci.2018.06.031. PMid: 29982079.

NIMET (2022). Nigerian Metrological Agency. Synoptic office, Nasarawa State, Nigeria.

Oparaku, N. F. and Mgbenka, B. O. (2012). Effects of Electric Oven and Solar Dryer On A Proximate and Water activity of *Clarias gariepinus* Fish. *European J. Sci. Res.*81(1):139-144.