Sensory evaluation of spiced catfish using brine, garlic, ginger, turmeric as preservatives and value-added enhancers in Lafia, Nasarawa State, Nigeria

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ABSTRACT: The sensory quality of smoked catfish (*Clarias gariepinus*) treated with different natural preservatives was studied. Catfish chunks were cured with; Salt (T1), Ginger (T2), Garlic (T3), Turmeric (T4), Ginger and garlic (T5), Ginger and turmeric (T6) and Garlic and turmeric (T7) at different levels (10, 20, and 20 g) and evaluated. The study comprises seven (7) treatments including T1 (Salt cured), T2 (Ginger cured), T3 (Garlic cured), T4 (Turmeric), T5 (Ginger and garlic cured), T6 (Ginger and turmeric cured) and T7 (Garlic and turmeric cured). Salt cured *C.gariepinus* scored the highest mean for appearance at 20 g concentration (4.08) followed by Ginger cured at 20 g (3.88); for texture ginger cured recorded the mean sensory value (4.16) at 20 g concentration followed by garlic and turmeric cured *C. gariepinus* at 20 g concentration(4.08) respectively. The result showed that ginger cured treatment recorded the highest mean sensory value for taste (4.22) at 20 g concentration followed by ginger and garlic cured treatment (4.1) at 30 g concentration while the highest sensory mean value for flavour was the garlic and turmeric cured treatment (3.96) at 10 g concentration followed by ginger turmeric (3.92) at 20 g concentration. Conclusively, to improve sensory properties of smoked *C. gariepinus*, it is recommended that mixed spices of ginger and garlic, ginger and turmeric and or garlic and turmeric be used before smoking.

Keywords: Sensory evaluation, spiced catfish, brine, garlic, ginger, turmeric and smoking.

INTRODUCTION

Improving food preservation can significantly contribute to reducing food waste and unlock the potential utilisation of underutilised fish catch (Bhaviksinh *et al.*, 2024). Smoked fish product is considered a delicacy and used in local dishes in Nigeria. Its quality is of concern to consumers who most often trust fish handlers like the fishermen, processors and traders with the healthy condition of the fish, either freshly caught or processed, that they consume. Smoking, drying, marinating, and salting are the most traditional methods of preservation (Taherzadeh-Shalmaei *et al.,* 2021). Like all food products, fish is composed of biological raw materials which inherently spoil and deteriorate over time (Ahmad *et al.*, 2021).

Therefore, particular care is required during harvesting and throughout the supply chain to preserve its nutritional attributes, avoid contamination, reduce loss and waste, and deliver a high-quality product (Peñarubia, 2021). Fish processing is done to ensure a longer shelf life and convert the raw fish into a form that will still be acceptable to the consumer. In addition to increasing the shelf life of fishery products, processing is carried out to increase added value and product quality. Processing activities are aimed at increasing the added value of a fishery product and impact the launch of various types of processed products that are more valuable and appeal to domestic as well as the international market (Wicaksana *et al.,* 2022). Reports

have it that spices are commonly used as curing agents in a variety of food products as anti-inflammatory, anti-cancer and anti-microbial agents. Plants like guar gum, cloves, cloves, ginger, garlic, and mustard seeds produce many antimicrobial substances. When added to food items, these tend to inhibit the growth of pathogenic bacteria and increase food's shelf life, flavour, nutritional quality and healthiness in a variety of foods (Nilius and Appendino, 2013). Therefore, the objective of the present study is to assess the effect of salt and different spices (ginger, garlic and turmeric) on the sensory quality of smoked African catfish.

METHODOLOGY

Experimental setup/sample preparation

Fish sample

Three hundred pieces of table size *C. gariepinus,* totalling one hundred and five kilograms (105 kg) were divided into seven treatments in three levels (10, 20 and 30 g), including a control. Each treatment group consisted of 15 kg of *C. gariepinus,* while each level of fish was 5 kg. Fish were gutted and cut into chunks of near equal sizes, washed thoroughly under clean tap water to remove slime, sand and visceral.

Spices

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 10, 20, and 30 g 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 chunk of fish was immersed in the solution for 2 hours, respectively and tagged.

Smoking

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 fish were smoked in a gas kiln for 9 hours under low heat at 30°C so as to reduce the water activity after which the smoked fish products were left to cool inside the smoking kiln for 2 hours; and thereafter the cooled smoked product (10, 20, and 30 g) were packed and labelled respectively. The first sample treated with brine (10, 20, and 30g) solution served as the control.

Sensory evaluation

The smoked fish products were subjected to sensory evaluation using a descriptive test based on a 5-point hedonic scale modified by Sadasivam and Manickam (1996) to evaluate for appearance, texture, taste and flavour.

One hundred panellists were drawn in clusters from Staff and Student of Faculty of Agriculture Nasarawa State University of Keffi, Shabu campus; as well as College of Agriculture Science and Technology Lafia, Nasarawa State Nigeria for sensory evaluation exercise. The Fish samples were given out with questionnaires for the panellists to evaluate and fill the products score based on how it appealed to their senses as indicated above, using the five (5) scale rating: in the following order 5 (like extremely), 4 (like very much), 3 (like moderately), 2 (like slightly), and 1 (neither like nor dislike). The mean obtained from the evaluation was calculated by weighing the various hedonic modes, accordingly, in the following order: 5+4+3+2+1 = 15/5 = 3. Using the interval of 0.05, the upper limit was 3.00 + 0.05 = **3.05**, while the lower limit was 3.00 – 0.05 = **2.95**. **Decision rule**: The following decision rule was used to determine the acceptability of the product or not; any mean of sensory parameter score equal to or less than 2.95 was considered not important, while means equal to or greater than 3.00 were considered very important.

RESULTS

The result of the effects of brine on the sensory evaluation of table size *C. gariepinus* is presented in Table 1. The fish immersed in 20 g brine recorded the highest (4.08) appearance mean value, while the least (3.81) was recorded from the fish immersed in 30 g. The fish immersed in 30 g brine recorded the highest (3.76) texture mean value, while the least (3.68) texture mean value was recorded in 10 g brine. The fish immersed in 20 g brine recorded the highest (4.0) taste mean value, while the least (3.82) taste mean value was recorded from the fish immersed in 10 g. While the fish immersed in 30 g brine recorded the highest (3.78) flavour mean value for flavour while the least (3.7) was recorded from fish immersed in 20 g brine.

The result of the effects of ginger on the sensory evaluation of *C. gariepinus* is presented in Table 2. The result revealed that fish immersed in 20 g of ginger recorded the highest (3.86) appearance mean value while the least (3.77) mean value was recorded in fish immersed in 30 g. Similarly, fish immersed in 20 g of ginger recorded the highest (4.16) texture mean value and the lowest (3.64) mean value was recorded on the 30 g. Again, fish immersed in 20 g of ginger recorded the highest (4.22) taste mean value, and it was lowest (3.8) for fish immersed in the 10 g and 20 g. The fish immersed in 10 g ginger recorded highest (3.78) flavour mean sensory value and fish immersed in 30 g ginger was lowest (3.58) flavour mean value.

The result of the effects of garlic on the sensory

Table 1. Mean sensory evaluation scores of branded, processed dried and salt cured (Scsdf) table size *Clarias gariepinus* in Nasarawa State University Shabu Campus Lafia.

Treatment	Conc.	5	4	3	2	1	Decision total	Decision mean	Ranking
	10g	34	36	12	16	2	384	3.84	2nd
Appearance	20g	30	42	12	8	6	408	4.08	1st
	30g	36	28	24	4	8	381	3.81	3rd
	10g	26	40	20	4	10	368	3.68	3rd
Texture	20g	22	40	28	6	4	370	3.7	2nd
	30g	36	28	20	8	8	376	3.76	1st
	10g	36	32	16	10	6	382	3.82	3rd
Taste	20g	34	40	20	4	2	400	4	1st
	30g	28	50	12	6	4	392	3.92	2nd
	10g	36	32	12	14	4	376	3.76	2nd
Flavour	20g	26	36	24	10	4	370	3.7	3rd
	30g	32	36	20	4	6	378	3.78	1st

Key to rating: 5 = Like extremely; 4 = Like very much; 3 Like moderately; 2 = Like slightly; 1 = Neither like nor dislike; Decision = 3.00; Range = 2.95 - 3.95.

Table 2. Mean sensory evaluation scores of branded, processed dried and ginger cured (Gcsdf) table size *Clarias gariepinus* in Nasarawa State University Shabu Campus Lafia.

Treatment 2	Conc.	5	4	3	2	1	Decision total	Decision mean	Ranking
	10g	30	42	14	6	6	378	3.78	2nd
Appearance	20g	30	40	20	6	4	386	3.86	1st
	30g	26	34	30	10	0	377	3.77	3rd
	10g	30	32	20	14	4	371	3.71	2nd
Texture	20g	46	30	20	2	2	416	4.16	1st
	30g	32	26	22	14	6	364	3.64	3rd
	10g	30	42	14	6	8	380	3.8	2nd
Taste	20g	46	30	18	8	2	422	4.22	1st
	30g	34	26	28	10	2	380	3.8	2nd
	10g	22	50	14	12	2	378	3.78	1st
Flavour	20g	30	22	32	12	4	360	3.6	2nd
	30g	24	32	28	10	6	358	3.58	3rd

Key to rating: 5 = Like extremely; 4 = Like very much; 3 Like moderately; 2 = Like slightly; 1 = Neither like nor dislike; Decision = 3.00; Range = 2.95 - 3.95.

evaluation of table size *C. gariepinus* is presented in Table 3. The result indicated that fish immersed in 30 g of garlic recorded the highest (3.68) appearance mean value, while fish immersed in 10 g of garlic recorded the lowest (3.54) appearance mean value. Contrarily, fish immersed in 10 g of garlic recorded the highest (3.8) texture mean value, and the least (3.54) texture mean value was recorded in fish immersed in 20 g of garlic. The fish immersed in 10 g of garlic recorded the highest (3.6) taste mean value, and the lowest (3.58) at 20 g and 30 g, respectively. Fish immersed in 20 g of garlic recorded the highest (3.7)

flavour mean value, and the lowest (3.54) in fish immersed in 30 g of garlic.

The result of the effects of turmeric on the sensory evaluation of table size *C. gariepinus* is presented in Table 4. The result indicated that fish immersed in 20 g of turmeric recorded the highest (3.74) appearance mean value, while the least (3.34) appearance mean value was recorded at 10 g. However, fish immersed in 10 g of turmeric recorded the highest (3.8) texture mean value, while fish immersed in 30 g of turmeric recorded the lowest (3.28) texture mean value. Fish immersed in 20 g turmeric

Table 3. Mean sensory evaluation scores of branded, processed dried and garlic cured (Gcsdf) table size *Clarias gariepinus* in Nasarawa State University Shabu Campus Lafia.

Treatment 3	Conc	5	4	3	2	1	Decision total	Mean decision	Ranking
	10g	22	30	30	16	2	354	3.54	3rd
Appearance	20g	30	22	36	8	4	366	3.66	2nd
	30g	26	32	26	16	0	368	3.68	1st
	10g	36	30	18	10	6	380	3.8	1st
Texture	20g	18	40	22	16	6	354	3.54	3rd
	30g	20	40	22	14	4	358	3.58	2nd
	10g	24	34	22	18	2	360	3.6	1st
Taste	20g	18	44	20	14	4	358	3.58	2nd
	30g	22	34	28	12	4	358	3.58	3rd
	10g	24	40	18	16	2	368	3.68	2nd
Flavour	20g	24	40	20	14	2	370	3.7	1st
	30g	20	38	24	12	6	354	3.54	3rd

Key to rating: 5 = Like extremely; 4 = Like very much; 3 Like moderately; 2 = Like slightly; 1 = Neither like nor dislike; Decision = 3.00; Range = 2.95 - 3.95.

Table 4. Mean sensory evaluation scores of branded, processed dried and turmeric cured (Tcsdf) table size *Clarias gariepinus* in Nasarawa State University Shabu Campus Lafia.

Treatment	Conc.	5	4	3	2	1	Decision total	Mean decision	Ranking
	10g	22	30	20	20	4	334	3.34	3rd
Appearance	20g	24	46	16	8	6	374	3.74	1st
	30g	18	40	20	12	10	344	3.44	2nd
	10g	20	46	28	6	0	380	3.8	1st
Texture	20g	26	38	20	12	4	370	3.7	2nd
	30g	16	34	24	14	12	328	3.28	3rd
	10g	28	36	20	14	2	374	3.74	2nd
Taste	20g	24	42	18	16	4	378	3.78	1st
	30g	22	44	12	16	10	364	3.64	3rd
	10g	20	30	38	8	4	354	3.54	1st
Flavour	20g	18	44	22	6	8	352	3.52	2nd
	30g	20	38	20	12	10	346	3.46	3rd

Key to rating: 5 = Like extremely; 4 = Like very much; 3 Like moderately; 2 = Like slightly; 1 = Neither like nor dislike; Decision = 3.00; Range = 2.95 - 3.95.

recorded the highest (3.78) taste mean value, while fish immersed in 30 g turmeric recorded the lowest (3.64) taste mean value. *C. gariepinus* immersed in 10 g turmeric recorded the highest (3.54) flavour mean value, while the lowest (3.46) flavour mean value was recorded in fish immersed in 30 g turmeric.

The result of the effects of mixed ginger and garlic on the sensory evaluation of the table size *C. gariepinus* is presented in Table 5. Fish samples immersed in 30 g

mixed ginger and garlic recorded the highest (3.58) appearance mean value, while samples immersed in 10 g mixed ginger and garlic recorded the lowest (3.44) appearance mean value. However, samples immersed in 10 g mixed ginger and garlic recorded the highest (3.66) texture mean value, while it was lowest (3.28) in samples immersed in 30 g. Samples of fish immersed in 30 g mixed ginger and garlic recorded the highest (4.1) taste mean value, while fish immersed in 10 g mixed ginger and garlic

Table 5. Mean sensory evaluation scores of branded, processed dried and ginger and garlic cured (GGacsdf) table size *Clarias gariepinus* in Nasarawa State University Shabu Campus Lafia.

Treatment	Conc.	5	4	3	2	1	Decision total	Decision mean	Ranking
	10g	20	34	26	12	6	344	3.44	3rd
Appearance	20g	14	38	32	14	2	348	3.48	2nd
	30g	26	32	24	10	8	358	3.58	1st
	10g	20	42	28	4	6	366	3.66	1st
Texture	20g	20	40	20	16	2	354	3.54	2nd
	30g	18	22	40	12	6	328	3.28	3rd
	10g	26	34	20	10	10	356	3.56	3rd
Taste	20g	20	46	26	4	4	374	3.74	2nd
	30g	24	28	50	10	8	410	4.1	1st
	10g	22	26	34	10	8	344	3.44	2nd
Flavour	20g	18	32	28	12	10	336	3.36	3rd
	30g	22	26	34	12	8	348	3.48	1st

Key to rating: 5 = Like extremely; 4 = Like very much; 3 Like moderately; 2 = Like slightly; 1 = Neither like nor dislike; Decision = 3.00; Range = 2.95 - 3.95.

Table 6. Mean sensory evaluation scores of branded, processed dried and ginger and turmeric cured (GTcsdf) table size *Clarias gariepinus* in Nasarawa State University Shabu Campus Lafia.

Treatment	Conc.	5	4	3	2	1	Decision total	Decision mean	Ranking
	10g	24	52	12	4	8	380	3.8	2nd
Appearance	20g	24	32	40	10	0	388	3.88	1st
	30g	18	28	38	14	2	346	3.46	3rd
	10g	16	48	20	14	2	362	3.62	1st
Texture	20g	14	44	32	8	2	360	3.6	2nd
	30g	30	22	26	18	4	356	3.56	3rd
	10g	20	40	26	6	8	359	3.59	2nd
Taste	20g	36	22	28	12	2	378	3.78	1st
	30g	12	42	32	14	0	352	3.52	3rd
	10g	14	40	24	20	0	342	3.42	3rd
Flavour	20g	40	22	30	6	2	392	3.92	1st
	30g	38	30	14	12	6	382	3.82	2nd

Key to rating: 5 = Like extremely; 4 = Like very much; 3 Like moderately; 2 = Like slightly; 1 = Neither like nor dislike; Decision = 3.00; Range = 2.95 - 3.95.

recorded the lowest (3.56) taste mean value. Again, fish immersed in 30 g mixed ginger and garlic recorded the highest (3.48) flavour mean value and was lowest (3.36) flavour mean value was in fish immersed in 10 g mixed ginger and garlic.

The result of the effects of ginger and turmeric on the sensory evaluation of table size *C. gariepinus* is presented in Table 6, suggesting that fish immersed in 20 g of ginger and turmeric recorded the highest (3.88) appearance mean value, whereas fish immersed in 30 g recorded the lowest (3.46) appearance mean value. However, fish immersed in 10 g mixed ginger and turmeric recorded the highest (3.62) texture mean value, while the lowest (3.56) was recorded in samples immersed in 30 g mixed ginger and turmeric. Fish immersed in 20 g mixed ginger and turmeric recorded the highest (3.78) taste mean value, which was, however, lowest (3.52) in fish immersed in 30 g. Again, fish immersed in 20 g mixed ginger and turmeric recorded the highest (3.92) flavour mean value, but was lowest (3.42) in fish immersed in 10 g.

The results of the effects of garlic and turmeric on the sensory quality of the table size *C. gariepinus* are presented in Table 7. It indicated that fish immersed in 10 g of garlic and turmeric recorded the highest (3.68)

Table 7. Mean sensory evaluation Scores of branded, processed dried and garlic and turmeric cured table size *Clarias gariepinus* at Nasarawa State University Shabu Campus Lafia.

Treatment	Conc.	5	4	3	2	1	Total respondent	Decision mean	Ranking
	10g	30	34	18	10	8	368	3.68	1st
Appearance	20g	20	24	42	14	0	350	3.5	3rd
	30g	18	30	44	4	4	354	3.54	2nd
	10g	18	48	12	16	6	356	3.56	2nd
Texture	20g	34	44	18	4	0	408	4.08	1st
	30g	32	25	27	8	8	365	3.65	3rd
	10g	26	36	10	14	14	346	3.46	2nd
Taste	20g	14	38	30	16	2	346	3.46	2nd
	30g	26	40	20	6	6	368	3.68	1st
	10g	34	38	18	10	0	396	3.96	1st
Flavour	20g	22	28	38	8	4	356	3.56	2nd
	30g	36	24	4	0	0	288	2.88	3rd

Key to rating: 5 = Like extremely; 4 = Like very much; 3 Like moderately; 2 = Like slightly; 1 = Neither like nor dislike; Decision = 3.00; Range = 2.95 - 3.95.

Table 8. Comparative evaluation of the highest sensory mean values recorded for the various treatments

Parameter	Treatments	Mean Sensory score	Ranking
	T1	4.08 (20g)	1
	T2	3.86 (20g)	3
	T3	3.68 (30g)	5
Appearance	T4	3.74 (20g)	4
	T5	3.58 (30g)	6
	T6	3.88 (20g)	2
	T7	3.68 (10g)	5
	T1	3.76 (30g)	4
	T2	4.16 (20g)	1
	T3	3.8 (10g)	3
Texture	T4	3.8 (10g)	3
	T5	3.66 (10g)	5
	T6	3.62 (10g)	6
	T7	4.08 (20g)	2

appearance mean value, while fish immersed in 20 g recorded the lowest (3.5) appearance mean value. However, fish immersed in 20 g mixed garlic and turmeric recorded the highest (4.08) texture mean value and the lowest at 10 g (3.56) texture mean value. The highest (3.68) taste mean value was recorded in fish immersed in 30 g mixed garlic and turmeric, while it was the least (3.46) in fish immersed in 10 g and 20 g mixed garlic and turmeric, respectively. Fish immersed in 10 g mixed garlic and turmeric recorded the highest (3.96) flavour mean value, while the lowest (2.88) flavour mean value was

recorded in fish immersed in 30 g mixed garlic and turmeric.

DISCUSSION

The results on sensory evaluation showed a high acceptance of the *C. gariepinus* smoked product treated with different levels of ginger, garlic and turmeric, as well as samples treated with salt among the respondents. This study showed that the spices added contributed to

Table 8. Contd.

Parameter	Treatments	Mean Sensory score	Ranking
	T1	4 (20g)	3
	T2	4.22 (20g)	1
	T3	3.6 (10g)	6
Taste	T4	3.78 (20g)	4
	T7	4.1 (30g)	2
	T6	3.78 (20g)	4
	T7	3.68 (30g)	5
	T1	3.78 (30g)	3
	T2	3.78 (10g)	3
	T3	3.7 (20g)	4
Flavour	T4	3.54 (10g)	5
	T5	3.48 (30g)	6
	T6	3.92 (20g)	2
	T7	3.96 (10g)	1

Decision rule: Any mean of sensory parameter scores equal or less than 2.95 were considered not important while mean equal or greater than 3.00 were considered very important and accepted.

consumer acceptability. There was also a high acceptance of the cured samples of ginger, garlic and turmeric, as shown in all the sensory parameters except for the 30 g concentration of combined garlic and turmeric, whose mean sensory score falls below the acceptable range. Generally, the sensory mean value fluctuates as the concentration of the spices increases. These findings show that curing with the addition of spice had a positive influence on smoked fish organoleptic (Ndife *et al.,* 2022).

The high texture and taste mean values recorded in fish immersed in 20g of ginger in this study agree with the findings of Kumolu-Johnson and Ndimele (2011) as well as Ekelemu *et al.* (2021). The sensory values of *C. gariepinus,* as rated by panellists immersed in ginger, tasted better than other samples for all parameters except for texture. The findings in this work disagree with the work of Ekelemu *et al.* (2021), where ginger-treated samples were rated low for texture. The high sensory mean values as recorded in the comparative assessment for flavour in Table 8 can generally be attributed to the combination of spices as reflected in the findings of Agbontale *et al.* (2020), who opined that naturally flavoured smoked catfish tastes better. Most of the panellists, according to the results, agreed that indigenous spiced smoked catfish gives off a better appearance, taste and texture. This implies that physical appearance is an important feature of food samples (Onwuka, 2018),

Conclusion

The preservation and processing of fish should be done with a minimum loss in sensory quality (appearance, flavour, taste, odour, texture), as well as its nutritive value. Fish processing and preservation are very crucial aspects of the fisheries and aquaculture sector. Customarily, fish farms and landing (jetty) sites are located far from the market, which poses a high risk to fish market value. It can be concluded that spices impacted the sensory value in cured smoked *Clarias gariepinus* with a better taste. Furthermore, to improve the storage quality of smoked *Clarias gariepinus*, it is suggested that mixed spices be explored for fish curing before smoking.

Recommendations

Based on the findings in this study, the following recommendations are made:

1. A combination of natural spices should be used in fish curing during fish post-harvest handling based on consumers' preferences.
2. Awareness programme on beneficial uses of these spices for public use should be funded by the Government through the extension officers in government parastatals or non-governmental organisations (NGOs).
3. Preservation and processing of fish should be taken seriously by fish handlers so as to prevent waste and economic loss.
4. Further research should be carried out on the phytochemical and medicinal properties of these spices on fish postharvest handling, as well as an investigation of factors and their combinations in order to achieve stable quality of smoked fish.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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