NUTRITIONAL EVALUATION OF SMOKED DRIED FISHES AND CHARACTERIZATION OF THEIR EXTRACTABLE OIL FROM SMOKING KILN: EXPANDING FISH PROCESSING SUPPLY CHAIN

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ABSTRACT
In February 2020, Nigeria joined the world in the waves of coronavirus pandemic which snowballed into economic recession, yet to recover as at time of this report. Notwithstanding, commercial fish farming which contributes a quota to the nation's economy remains greatly affected. This study investigated an addendum on how fish farmers can expand their income from just smoke drying of catfish, tilapia and titus fish. Oil extracted in a smoking kiln was subjected to physicochemical assessments relative to soxhlet extracted oil. Smoking kiln oil extractor produced about 15, 5 and 31mlkg^{-1} of fish oil compared to soxhlet oil extraction of about 55, 25 and 115ml kg^{-1} catfish, tilapia and titus fish respectively. The smoke-dried products were analyzed for proximate composition relative to the fresh using standard methods. There was significant difference ($p<0.05$) in the proximate composition between the fresh and dried fishes with increase in protein, carbohydrate and ash contents in all smoke-dried fish species used. No significant difference ($p>0.05$) in physicochemical properties of oils extracted from soxhlet and smoke-drying method. Low free fatty acids value range from 1.96-2.05 % and peroxide value range from 3.82-6.23 mEq/Kg were observed despite fish species and oil extraction method; a reflection of good oil quality. Therefore, it is pertinent to know that fish farming can buttress the economy by making ways to safely collect or extract oil from fishes so as to cushion the effect of high cost of purchase of other oil in the market.
Keywords: Fishes, oil, characterization, post-covid, economy

INTRODUCTION
Fish, a highly nutritious source of food and income to its farmers is one of the main animal protein that is commonly accessible and more affordable than meat (Adebayo *et al.,* 2008). The demand for fish is expected to continue to grow worldwide beyond the estimated 17.9 kg per capita by the end of 2020 (Bainy *et al.,* 2015). Fishes are mainly composed of moisture, proteins and lipid with minerals content in trace amount (Adebiyi and Bawa, 2006). Increasing evidences have suggested that fish and fish oil are significant component of a balanced and healthy diet, primarily due to the low-fat content compared to animal meat and the content of fatty acids exerting a positive effect on the human, e.g., eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (USDA, 2015). Fish has low lipid content but higher water content than beef or chicken and is preferred over other white or red meat (Ackman, 1989). Fish form much of many Nigerian delicacy across all ages, socio-economic, religious and educational background (Adebayo, et al., 2008). Extract of fish oil are good source of omega-3 fatty acids which can serve as food supplements. Although, Titus fishes (*Scomber scrombus*) are imported to Nigeria as seafood or fish, however, catfish (*Clarias gariepinus*) and tilapia (*Oriochromis niloticus*) fishes are very common in Nigeria fresh waters and rivers which are farm for their nutritional and economic purposes (Olagunju *et al.,* 2012). Fish oil extraction have been achievable through some means such as soxhlet extraction methods which involves the use of solvent with health concern and as well require lot of energy. Another method is the wet reduction which involve cooking between 95-100°C followed by pressing and then centrifugation (FAO, 1986). With an oil collector pan constructed in a smoking kiln, substantial amount of oil is extractable while the fish is being smoke dried (Kamaldeen *et al.,* 2016).
The need to cushion the effect of corona virus pandemic on cost of living and economy of the nation, justifies the quest for solution to wastage of fish oil during smoking especially in a modified smoking kiln. The objective of this study is to evaluate the proximate composition of fresh and smoke-dried

catfish, titus fish and tilapia fish and then characterize their oil extract from smoking kiln and that of soxhlet extraction.

MATERIALS AND METHODS

Sample collection and preparation

African catfish (*Clarias gariepinus*), tilapia fish (*Oreochromis niloticus*) were bought from riverine area of Wudil Local Government of Kano State while Titus fish (*Scomber scrombus*) were bought form Sabongari market, Fagge LGA, Kano State. Each fish sample was dissected to remove intestines and then separately washed and drained of water with tissue paper. 10kg each of fish sample was weighed into three different improved smoking kiln designed and constructed by Kamaldeen NSPRI with oil collector pans and the smoke drying process was set-up for about 5hours.

Proximate analysis

Proximate composition was determined on each of fresh and smoke-dried fish sample to estimate percentage moisture, crude fiber, ash, protein, fat and carbohydrate contents according to methods of Association of Analytical Chemists 2006.

Characterisation of Oil from Soxhlet and Smoking Kiln

Oil extracted from each of the three fish samples during smoking in the smoking kiln and that from soxhlet apparatus was subjected for quality test for free fatty acid, saponification, peroxide and iodine values and relative densities as described in a recommended and official manual of American Oil Chemists' Society (AOCS Method 942.27).

Statistical analysis

Experimental analysis was carried out in triplicates and expressed as means ± standard deviation. Data were analyzed using a one-way analysis of variance (ANOVA) using SPSS 16.0 version 2007 and the P-value determined the statistical significance set at 95% confidence level.

Table 1. Proximate Composition of fresh and smoked dried catfish, Titus fish and Tilapia fish

Parameter	Fresh			Smoke-dried		
	Cat fish	Titus fish	Tilapia fish	Cat fish	Titus fish	Tilapia fish
Moisture	41.02±3.12^{a}	33.57±7.11^{b}	28.08±2.01^{c}	12.11±0.99^{d}	20.03±1.59^{e}	19.99±3.09^{f}
Crude protein	29.12±0.01^{b}	30.03±3.20$_{c}$	29.89±2.88^{d}	43.82±5.02^{e}	45.05±6.11^{f}	32.23±3.02^{g}
Crude lipid	8.95±0.21^{c}	10.07±1.01^{d}	6.05±0.03^{e}	5.19±0.07^{f}	7.07±0.02^{g}	4.62±0.03^{h}
Ash	3.34±0.05^{d}	3.12±0.04$_{e}$	2.86±0.02^{f}	7.45±0.01^{g}	3.32±0.01^{h}	7.03±0.88^{i}
Crude fiber	2.38±0.01^{e}	2.25±0.03^{f}	7.81±0.55^{g}	3.22±0.01^{h}	2.01±0.01^{i}	6.96±0.05^{j}
NFE	15.19±1.02^{f}	20.96±2.21^{g}	25.31±3.10^{h}	28.21±2.09^{i}	22.52±7.00^{j}	29.17±4.21^{k}

Values are means± SD of triplicate determinations. NFE: Nitrogen Free Extract. Mean values in same row with different superscripts are significantly different ($p< 0.05$).

RESULTS AND DISCUSSION

The nutritional value of food product is not determined only by the parameters and the culinary treatment but also by the type of processed fish (Bainy, 2015). Table 1 above shows the disparities in the proximate compositions based on the type of fish under the same treatment. There is significant difference ($p<0.05$) between the fresh and smoked fishes in all cases. Protein, ash, and carbohydrate contents tend to increase in the smoke-dried fishes than in their fresh form. Fat and moisture content were on decline on thermal treatment (smoking). Moisture content dropped from between 28 -41% for tilapia and cat fish respectively at fresh forms to 12-19% cat fish and tilapia fishes respectively after being smoke-dried. Protein was highest both in fresh and smoke-dried having 33% increased trend for titus and catfish compare to 9% increase for tilapia. None of the fishes in this study is in the category of lean fish (5% fat) (Ackman, 1989). Data obtained for protein, fat, ash and carbohydrate are in tandem with reports of Bainy *et al.*, (2015) and Bastias *et al.*, (2017) for catfish and titus fishes.

The physicochemical properties of ether oil extract (soxhlet method) and that of collection pan of smoking kiln is as depicted above in table 2. No significant difference in FFA between fish species and the method of oil extraction. Free fatty acid ranged from 1.97 to 2.05% and as such values in this study is in consonant with that of Abiona *et al.*(2015). Low FFA value indicates a good oil quality.

The tendency of oil to go rancid is a measure of its peroxide value (CDR, 2008). PV range from 3.82 - 6.23 mEq/Kg of fish oil sample in all cases as shown in table 2 above. Thus, oils obtained can withstand the storage for long before rancidity (Adeniyi and Bawa 2006). Meanwhile, IV is within normal value of 120-180%, which are the measure of double bond composition and fall within reports of Adebiyi and Bawa (2006)

Table 2. Characterization of Fish Oil Extracted Through soxhlet and Smoking kiln

Oil Extract	FFA(%)	PV(mEq/Kg)	SV(mgKOH/g)	IV(%)	RD
SOX_{CAT}	2.00±0.02^{a}	6.23±0.52^{b}	155.98±10.10^{f}	128.88±12.20^{e}	2.02±0.05^{g}
SMK_{CAT}	1.97±0.01^{a}	3.88±0.11^{c}	155.96±8.02^{f}	129.00±11.02^{e}	2.25±0.08^{g}
SOX_{TT}	1.99±0.03^{a}	6.22±0.07^{b}	155.98±10.03^{f}	128.79±7.08^{e}	2.12±0.02^{g}
SMK_{TT}	2.01±0.02^{a}	3.87±0.02^{e}	155.87±11.02^{f}	128.99± 9.07^{e}	2.15±0.01^{g}
SOX_{TL}	2.03±0.01^{a}	6.21±0.21^{b}	156.01± 9.02^{f}	128.69V10.20^{e}	1.99±0.33^{g}
SMK_{TL}	2.05±0.02^{a}	3.82±0.02^{d}	155.88±11.20^{f}	129.01±12.03^{e}	2.00±0.55^{g}

Values are means ± SD of triplicate determinations. Mean values in same column with the same superscript are not significantly different. FFA= free fatty acids, PV= Peroxide value, SV= Saponification value, IV= Iodine value, RD=Relative density. SOX =Soxhlet, SMK= smoking kiln, CAT= catfish, TT= Titus fish, TL= Tilapia fish.

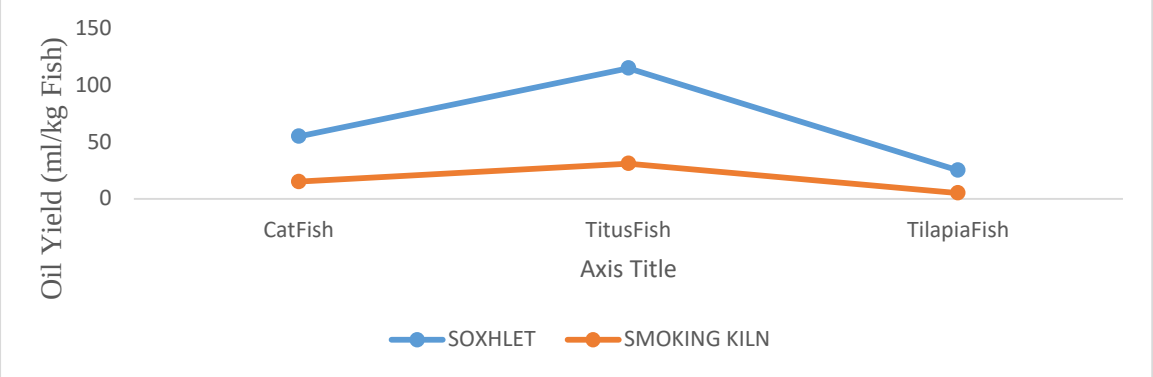

Figure 1. Relative Oil Yield (ml/Kg) of Fish Species Through Soxhlet and Smoking Kiln

The figure above shows that irrespective of the method of oil extraction, the trend in oil yield is as: Titus fish> Catfish> Tilapia fish.

CONCLUSION

The nutritional values of catfish, Titus fish and Tilapia fish were analyzed as fresh and as smoke-dried and also their oil through soxhlet extraction methods and smoking kiln oil collector pan. The oils have been characterized to be of good qualities and of better yield. Therefore, fish farming should be more encouraged to add up to oil production in the processing value chain to help in quick economic recovery.

RECOMMENDATION

From this study, it is recommended that more research into how fish oil is best extracted and the fatty acids profiles should be conducted. Also, policy makers and relevant agencies should promote the market of fishery not just for consumption but also for the economy of its oil.

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