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Proximate Evaluation and Consumer's Acceptability of *Clarias gariepinus* Cured With *Citrus sinensis* Extracts

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ABSTRACT

The aggregate demand for seafood with minimal additives has increased over the years. *Citrus sinensis* is a common fruit that generates a lot of waste which needs to be put to beneficial use. The study investigated the acceptability of processed *Clarias gariepinus* after immersion in the extracts and their proximate compositions evaluated. The samples were immersed in *C. sinensis* peel extract and marinated with spices. These samples were used to prepare fresh catfish pepper-soup (CPS), smoked catfish using charcoal (SCC) and smoked catfish using gas (SCG) in the various forms they are widely accepted and requested for in the Northern of the Country. Samples from each batch were taken for proximate analysis. The sensory evaluation showed that SCG had better flavor, texture and general acceptability than the SCC and the CPS. The result of the proximate analyses of the samples showed that the moisture content of the SCC is lower (10.04%) than that of SCG (14.80%) while the crude protein (55.34%) and crude fiber (14.22%) of the SCC where higher than the contents found in SCG samples (52.80% and 13.29%). Therefore, it is concluded that SCG immersed in *Citrus* extract is a more acceptable variant than other processed samples in this study but the SCC retains more nutrients.

INTRODUCTION

In Nigeria, fish is eaten fresh and smoked and forms much-cherished delicacies that cut across socio-economic, age, religious and educational barriers (Adebayo-Tayo et al., 2008) and it's a cheap but rich source of protein commonly consumed compared to other sources of animal proteins due to the higher cost (Akinjogunla et al., 2017). The importance of fish in the world cannot be over-emphasized as it is a source of food and income for many people (Akinjogunla et al., 2021). The various enzymatic reactions taking place in seafood before and after harvest lead to changes in the sensory and nutritional properties that invariably reduce the shelf-life of the products (Olatunde & Benjakul, 2018).

Smoking of fish species is one of the oldest and most common methods of fish preservation in many

developing countries, second is sun-drying (Kumolu-Johnson et al., 2010). About 70 - 80 % of the marine and freshwater catches harvested locally are consumed in smoked form as estimated by Adeyeye & Oyewole (2016). The African catfish, *Clarias gariepinus* is among the most commonly cultured (both inside and outside its range of tropical and subtropical environments) (Adewolu et al., 2008) and smoked finfish in Nigeria (Akinola et al., 2006).

Some of the natural plant spices generally used in food preservation include garlic (*Allium sativum Linn.*), sweet orange peels (*Citrus sinensis*), cloves (*Syzgiuma romaticum*) and ginger (*Zingiber officinale roscoe*) (Oluborode et al., 2010) and their addition had enhanced the qualities of fishes during storage (Özyurt et al., 2012). Nigeria produces about 930,000 tons of citrus fruits annually from an estimate of about 3 million hectares (Muhammad, 2017). Orange peel flavonoids exhibit antioxidant, antimicrobial, anti-carcinogenic, antiviral, anti-allergic and anti-inflammatory activities (Debbarma et al., 2013), even in higher quantities than the seeds. Orange peel apart from yielding a large quantity of essential oils, also improves the drying rate of fish and the efficiency of smoking. A report by Vijayan et al. (2021) showed that catfish cured with orange rinds enriched the shelf-life of products by 120 days of storage.

This research aimed to study the effects of sweet orange, *C. sinensis* – L. Osbeck, 1757 (peel) extracts on the proximate composition and sensory assessment of the economically and commercially important African catfish, *C. gariepinus* - Burchell 1822 in various forms of processing conditions through secondary data collection to bring about the utilization of supposed waste plant products and encourage the need to look more inward in our quest to develop healthy methods of preservation and processing of our limited seafood.

MATERIAL AND METHODS

Collection and Preparation of Fish Samples and Plant Materials

A total of forty -five (45) African catfish samples *C. gariepinus* were randomly obtained from the concrete tanks for grow-out fish sizes at the Department of Fisheries and Aquaculture fish farm, Bayero University Kano. The total weight was measured using a sensitive weight balance calibrated in grams (g) while the total length was measured using a meter rule calibrated in centimeters (cm). The measured fish species had an average mean weight of 42.21g and an average total length of 24.56 cm while the orange (*C. sinensis*) rinds/peels were collected from orange sellers at Yan Lemo fruits market, Kano State, Nigeria. The fish were gutted and washed before being placed on wire mesh and allowed to drip naturally for 40 minutes while the orange rinds were washed and shade-dried at room temperature. The dried peels were milled using local mortals to obtain the powdered form. 300 g of the powered plant (orange peel) was soaked in 150 ml of distilled water for 24 h at room temperature and extracted according to the methods of Hegazy & Ibrahium (2012). The extract was filtered through a Whatman no.2 filter paper to remove peel particles.

Experimental Design

Fish samples of *C. gariepinus* reared in concrete ponds were allocated into three treatment groups based on popular demands within the environs where this study was carried out; each treatment consisted of 15 samples of fish and soaked for 30 minutes into the orange peel crude extract. The first treatment was smoked with gas, the second sample was smoked on charcoal and the third samples were used to prepare fresh catfish pepper soup. The smoked-dried fish was packaged in cartons to prevent dust, dirt and flies. The sensory evaluation of the treatments was later carried out.

Proximate Analysis and Sensory Assessment

The proximate analysis of fresh and smoked fish was carried out according to the official methods of analysis described by the Association of Official Analytical Chemists (AOAC, 2005). The sensory evaluation of the immersed samples (smoked and fresh) with orange peel extract was carried out using a 9-point hedonic scales method of Lim (2011) with key indicators ranging from 1–9 representing dislike extremely; dislike very much; dislike moderately; dislike slightly; neither like nor dislike; like slightly;

like moderately; like very much and like extremely respectively. Coded samples accompanied by questionnaires were presented to the panels. A 5-member trained test panel was used for the assessment. The comparison was carried out on organoleptic characteristics such as taste, texture, color, odor and overall acceptability/general comment as described by Freitas et al. (2019).

Data Analysis

The data obtained were subjected to descriptive statistics, frequency and percentage method in tabular forms, one-way analysis of variance (ANOVA) and a statistical significance was set at $p<0.05$ least significance difference (LSD) and Post-hoc deacon using statistical packaged for social sciences (SPSS) ver. 16.1.

RESULTS AND DISCUSSION

Table 1 shows the extent of the acceptability of fresh catfish pepper soup and smoked catfish with gas and charcoal. The majority of the respondents accepted smoked catfish with gas. The mean score of the sensory evaluation reveals that smoked catfish retained a very good score for appearance, taste, texture, color and general acceptance. The overall acceptability mean score in fish smoked with oven gas was higher than in the treatment smoked with charcoal.

The mean proximate composition (*C. gariepinus*) is presented in Table 2 where the ash content, moisture content, crude protein, crude fiber, ether extracts, dry matter, and nitrogen-free extracts were recorded.

Table 1. The summary of the hedonic scale assessment of *C. gariepinus*

Sensorial Evaluation	Parameters	Excellence	Very Good	Good	Fair
Physical Appearance	Gas	45%	45%	10%	0%
	Charcoal	30%	55%	15%	0%
	Pepper-soup	20%	30%	40%	10%
Taste	Gas	40%	60%	0%	0%
	Charcoal	35%	60%	5%	0%
	Pepper-soup	30%	50%	20%	0%
Aroma	Gas	35%	55%	10%	0%
	Charcoal	45%	45%	10%	0%
	Pepper-soup	22%	22%	56%	0%
Texture	Gas	65%	30%	5%	0%
	Charcoal	55%	35%	10%	0%
	Pepper-soup	5%	25%	50%	20%
General Appearance	Gas	50%	50%	0%	0%
	Charcoal	30%	55%	15%	0%
	Pepper-soup	55%	35%	0%	0%

Table 2. Proximate composition of fresh and smoked *C. gariepinus*

PARAMETERS (%)	Fresh (Pepper Soup)	Charcoal	Oven Gas
Ash	1.00 ± 0.03^{a}	3.88 ± 0.10^{b}	3.46 ± 0.05^{c}
Moisture	77.24 ± 0.99^{a}	10.04 ± 1.74^{b}	14.80 ± 0.34^{c}
Crude Protein	40.31 ± 0.7^{a}	55.34 ± 0.42^{b}	52.80 ± 0.34^{c}
Crude Fiber	16.00 ± 0.64^{a}	14.22 ± 0.15^{b}	13.59 ± 0.04^{c}
Ether Extract	11.00 ± 0.28^{a}	13.29 ± 0.14^{b}	13.47 ± 0.07^{b}
Dry matter	22.76 ± 0.99^{a}	88.96 ± 1.74^{b}	85.92 ± 0.034^{b}
NFE	31.69 ± 1.05^{a}	13.27 ± 0.14^{b}	16.68 ± 0.45^{c}

Note: Mean ± Standard Error; values with different superscripts across row are significantly different at ($P < 0.05$)

Table 2 shows that the percentage of ash is highest in smoked *C. gariepinus* using charcoal and oven gas compared to the fresh type. Ash content is generally influenced by the fish size (Akinjogunla et al., 2017). The ash content in this study increased in the fish samples from different preservation methods except in the fresh fish sample. This contradicts the earlier report of Oluwaniyi & Dosumu (2009) who reported a reduction in ash across all preservation methods while Oladipo & Bankole (2013) reported that smoked (oven gas) fish has more ash content than fresh (pepper soup) *C. gariepinus*. Smaller-sized fish species and lean fishes like tilapia tend to have higher ash content due to the higher bone-to-flesh ratio (Kapute et al., 2013).

On the other hand, the percentage of moisture is significantly lower in the smoked types compared to the fresh type. There was a high moisture content in the fresh fish sample (catfish pepper soup) compared to the smoked fish sample (charcoal smoked and oven gas smoked). This report is similar to the report of Oparaku & Ojike (2013) that also documented high moisture content in fresh fish. The fresh (pepper soup) had the highest moisture content because water was absorbed into the fish in the process of boiling. The mean deviation analysis can be used to identify significant differences in the composition of *C. gariepinus* between the different smoking methods. According to Ezembu & Onwuka (2015), the lowest moisture in sun-dried fish was within the acceptable limit for the prevention of microbial spoilage because water activity determines the storage life of fish (Daramola et al., 2007).

The highest crude protein content of 55.34% was obtained from smoked catfish with charcoal while the lowest value of 40.31% was obtained from fresh (pepper soup) catfish. Looking at the crude protein percentage, we can see that the deviation from the mean for smoked *C. gariepinus* using charcoal is higher than for the other types. This suggests that smoking with charcoal may have a greater impact on the protein content of the fish compared to smoking with oven gas or the fresh type. This finding is in line with the reports from Aladetohun & Ndimele (2010).

According to documented reports of Okereke et al. (2014), the smoking process in fish samples reduces moisture contents and increases the protein content in them through heat desiccation thereby improving the nutritional value of the processed fish product. Reduced protein content in fresh catfish (pepper soup) observed in this study has also been reported by Akinwumi et al. (2013). Catfish samples used in this study were smoked using an open fire (traditional smoking kiln) where the hotness and smoke production give room for little or no human interference to enable regulation or control. The higher level of protein in the smoked catfish (oven gas or charcoal) in this study also agrees with earlier reports by Chukwu (2009) and Olabinjo et al. (2017). Low protein in the fresh catfish pepper soup could therefore be explained by the fact that protein contents decrease with an increase in moisture content (Akinjogunla et al., 2017). The high composition of proteins from the present study can account for good sources of protein for the consumer.

The fiber content of fish samples decreased in the smoked samples (gas or charcoal) of *C. gariepinus* in the present study. The smoked fish with oven gas had the most reduced fiber content, and this could be because the fire might have destroyed the fiber content during the smoking process.

Observed low-fat content in smoked fish in this study has been earlier reported by other authors (Chukwu, 2009). Increased fat in oven gas appeared to be directly related to low moisture content. This agrees with an earlier study documented by Daramola et al. (2007), attributing increased fat content to loss in moisture content.

Charcoal smoked fish in this study appears to be the most nutritious due to its high protein and fat content which were all previously reported in several studies (Daramola et al., 2007; Chukwu 2009; Farid et al., 2014).

CONCLUSION

Sweet orange peel extract can be utilized in fish smoking at various concentrations. Fish immersed in sweet orange peel and smoked using charcoal were more attractive in color and texture, compared with those smoked using gas and while the smoked catfish using oven gas had higher values of the proximate composition contents. The use of this method of

processing will guide to enhance fish value chains, minimize deterioration damages of smoked fish and provide supplementary business opportunities for investors as well as refining the freight worth of smoked-dried African catfish. Results from this work have shown that catfish, (*C. gariepinus)* preserved with sweet orange rinds/peels extract is a good quality (in terms of appearance, taste, and overall acceptability) product, which can be improved upon with further studies.

Compliance with Ethical Standards

Authors' Contributions

VFA: Conceptualization, Supervision, Data curation, Formal analysis, Writing – review & editing

NIS: Investigation, Methodology, Formal analysis, Writing – original draft.

All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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Data Availability

The data that support the findings of this study are available from the corresponding author on request.

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