



Research Article

Sensory Evaluation and Consumer Acceptability of Farmed African Catfish (*Clarias gariepinus*) Smoked with Neem Wood and Charcoal

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ABSTRACT

Beyond nutritional and chemical considerations, the sensory properties of smoked fish are equally central to its market acceptability and consumer preference. This study evaluated the sensory characteristics and consumer acceptability of African catfish smoked using neem wood and charcoal as alternative smoking fuels. The experiment was conducted at the Department of Fisheries and Aquaculture Fish Farm Complex, Bayero University, Kano, Nigeria, using a completely randomized design (CRD) with three treatments: fresh fish (control), neem wood-smoked fish, and charcoal-smoked fish. A total of 45 pieces (15kg) of healthy catfish were processed and smoked for 6 hours. Sensory evaluation was carried out by a panel of twenty semi-trained assessors who rated appearance, flavour, texture, and taste using a 4-point hedonic scale. Data were analysed using descriptive statistics and Analysis of Variance (ANOVA) at a 95% confidence level. Results showed that charcoal-smoked fish received higher ratings for appearance (55.00% excellent) and texture (50.00% excellent), while neem wood-smoked fish achieved superior ratings for flavour (55.00% excellent) and taste (40.00% excellent). Both smoking treatments produced products that were generally rated as very good to excellent, indicating high consumer acceptability. The findings suggest that both neem wood and charcoal are suitable smoking fuels for catfish processing. However, neem wood offers additional advantages of enhanced flavour, improved nutritional quality, and greater environmental sustainability due to its availability and renewability in northern Nigeria. The study concludes that neem wood is a viable and sustainable alternative to charcoal for fish smoking without compromising consumer acceptance or product quality.

Keywords: Charcoal; Farmed fish; Neem Wood; Sensory; Smoking

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INTRODUCTION

Consumer acceptance of food products is largely determined by sensory attributes such as appearance, flavor, texture, and taste. In smoked fish production, these characteristics influence purchasing decisions, market demand, and overall product value. While nutritional quality is important, consumers often judge product quality based on sensory perception before considering nutritional benefits (Meilgaard *et al.*, 2016). Smoking is one of the oldest fish preservation techniques and remains widely practiced throughout Nigeria and other parts of Africa. The type of fuel used during smoking

significantly affects the sensory properties of the final product because different fuels produce varying smoke compositions, temperatures, and drying conditions (Alzohairy, 2021). Fish processors across West Africa continue using neem wood and charcoal interchangeably for smoking operations, making fuel selection decisions based primarily on availability, cost, and local tradition rather than nutritional considerations. However, these two smoking sources produce fundamentally different combustion environments that likely affect the nutritional composition of smoked catfish in ways that remain poorly documented. Neem wood and charcoal are

among the most commonly used fuels for fish smoking in Northern Nigeria. However, limited information exists regarding how these fuels influence sensory quality and consumer preference. This study therefore assessed the sensory characteristics and acceptability of farmed African catfish smoked with neem wood and charcoal to determine the suitability of each fuel source for commercial fish processing.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the fish farm complex of the Department of Fisheries and Aquaculture, Faculty of Agriculture, Bayero University, Kano. The farm is located at latitude 11.977616°N and longitude 8.424571°E in Kano State, Nigeria (NPC, 2006).

Experimental Design

The study employed a completely randomized design (CRD) with two treatment groups in triplicate. A total of 45 pieces (15kg) of farmed African catfish (*Clarias gariepinus*) raised in a collapsible tank under intensive system were used for the study. The experimental treatments were:

T1: Catfish smoked with neem wood (*Azadirachta indica*)

T2: Catfish smoked with charcoal

Sample Collection and Preparation

The catfish samples were purchased from Idris Uba Muhammad's fish farm located in Guringawa Quarters, Kumbotso Local Government Area, Kano State, Nigeria. A total of 45 pieces (15kg) of healthy African catfish (*Clarias gariepinus*) with average weight of 300-400 grams was acquired for the study to minimize biological variation. The fish were transported live using 50 liter's Jericans to the Department of Fisheries and Aquaculture fish farm complex at Bayero University, Kano. Upon arrival, the fish were held in a well-aerated concrete tank and acclimated for 24 hours prior to processing. The fish were healthy, free from visible abnormalities, injuries, or diseases before the commencement of the study.

Preparation of Smoking Materials

Neem wood:

Neem wood (*Azadirachta indica*) was sourced from matured neem trees within Kano metropolis. The wood was sun-dried to achieve moisture content below 20%, which ensures efficient combustion and reduced formation of undesirable compounds. The seasoned neem wood was cut into uniform sizes (approximately 15-20 cm in length and 5-8 cm in

diameter) to facilitate consistent burning characteristics during the smoking process.

Charcoal

Hardwood charcoal was purchased from the local market within Kano metropolitan. The charcoal was sourced from mixed hardwood species commonly available in northern Nigeria. Only high-quality charcoal with consistent size, minimal ash content, and uniform black color were selected for the study. The charcoal was stored in a dry location to prevent moisture absorption prior to use.

Fish Processing and Smoking Procedure

Pre-smoking Preparation

The fish were stunned with a sharp blow to the head. They were then transferred to a clean processing table where they were gutted by making a ventral incision from the anus to the gills and removing all internal organs. The gutted fish were thoroughly washed with clean water to remove blood, slime, and any remaining visceral materials. Each fish was split longitudinally along the backbone (butterfly cut) to facilitate uniform smoking and drying. The prepared fish were briefly rinsed again and allowed to drain on a clean wire mesh for 60 minutes before smoking (Ogbonnaya *et al.*, 2022).

Smoking Process

The smoking of both treatments was carried out at 70-90°C for 6 hours. The smoking process described by Adeyeye *et al.* (2019) was adopted as follows;

Neem Wood Smoking (T1)

The traditional smoking kiln was prepared by loading seasoned neem wood into the combustion chamber. The wood was ignited and allowed to establish a steady combustion with moderate smoke generation. Fish samples were arranged on wire mesh trays placed approximately 60-80 cm above the heat source (Adeyeye *et al.*, 2019).

Charcoal Smoking (T2)

For charcoal smoking, the kiln was prepared by loading high-quality hardwood charcoal into the combustion chamber. The charcoal was ignited and allowed to reach optimal burning temperature. Fish samples were arranged on wire mesh trays at the same distance (60-80 cm) from the heat source as the neem wood treatment to ensure comparability.

For both smoking treatments, fish were turned at regular intervals during the smoking process to ensure even drying, uniform smoke penetration, and consistent color development on all surfaces. The smoking process was continued for 6 hours until the fish achieve the desired level of dryness, characterized by firm texture, reduced moisture content, and characteristic smoked appearance.

After smoking, the fish were removed from the kiln and allowed to cool on clean wire mesh trays in a well-ventilated indoor area for approximately 48 hours before packaging and analysis.

Sensory Evaluation

Sensory evaluation of the smoked catfish samples was conducted using a panel of twenty (20) semi-trained panelists drawn from staff and students of the Department of Fisheries and Aquaculture, Bayero University, Kano. The Panelists were selected based on their familiarity with smoked fish products and willingness to participate. Each panelist evaluated coded samples from all treatment groups (T1 – Neem wood-smoked and T2 – Charcoal-smoked) under uniform conditions of adequate lighting and ventilation. Samples were served at room temperature in clean white plates labelled with three-digit random codes to prevent bias. Panelists were provided with potable water for rinsing between samples.

The sensory attributes evaluated included Appearance, Flavor, Texture, and Taste. Each attribute was scored using a 4-point hedonic scale as follows: 4 = Excellent, 3 = Very Good, 2 = Good, and 1 = Fair. Panelists recorded their scores on structured evaluation forms. The mean scores for each attribute were computed for each treatment group and compared statistically (Ibrahim and Mohammed, 2023).

Data Analysis

Data collected for sensory analyses were subjected to descriptive statistics using statistical package SPSS version 20. Where significant differences are found ($P < 0.05$), post-hoc tests were conducted to identify which specific treatment means differ significantly from each other. Statistical significance was accepted at the 95% confidence level ($P < 0.05$).

RESULTS AND DISCUSSION

The results obtained in Table 1 presents the sensory evaluation ratings for both smoked fish treatments. Charcoal-smoked fish received significantly ($P < 0.05$) higher ratings for excellent in appearance (55.00%) and texture (50.00%), while Neem-smoked fish recorded significantly ($P < 0.05$) higher ratings for excellent in flavour (55.00%) and taste (40.00%). For texture, most panelists rated Neem-smoked fish as very good (60.00%), compared to excellent (50.00%) for charcoal-smoked fish. No panelist rated either treatment as fair for texture or flavour for Neem-smoked fish, indicating that both treatments produced sensorially acceptable products overall.

Charcoal-smoked fish was preferred for appearance and texture, while Neem-smoked fish scored higher for flavour and taste. These findings agree with Akinola *et al.* (2021), who reported that charcoal-smoked products scored higher for appearance while wood-smoked products scored higher for flavour. The superior flavour of Neem-smoked fish is consistent with Darvishi *et al.* (2021), who demonstrated that volatile phenolic compounds from natural wood smoke significantly enhance the sensory acceptability of smoked fish. The firmer texture of charcoal-smoked fish is directly linked to its lower moisture content, as greater dehydration produces a firmer product, this is consistent with observations by Bezbaruah and Deka (2021).

Charcoal produces fish with better appearance, and texture. While Neem wood yields fish with higher flavour. From a sustainability perspective, Neem wood is a widely available and renewable resource in Nigeria, offering a viable, ecologically responsible alternative to charcoal, whose production contributes to deforestation (Akinola *et al.*, 2023). The results support Neem wood as a viable alternative smoking fuel that enhances the flavour quality of smoked catfish without compromising sensory acceptability.

Table 1: Description of the ratings of the sensory evaluation of the different smoked fish

Treatment	Parameter	Excellent (F)	%	V. Good (F)	%	Good (F)	%	Fair (F)	%
Neem	Appearance	2	10.00	9	45.00	7	35.00	2	10.00
	Flavour	11	55.00	6	30.00	3	15.00	0	0.00
	Texture	5	25.00	12	60.00	3	15.00	0	0.00
	Taste	8	40.00	6	30.00	5	25.00	1	5.00
Charcoal	Appearance	11	55.00	7	35.00	2	10.00	0	0.00
	Flavour	3	15.00	8	40.00	6	30.00	3	15.00
	Texture	10	50.00	8	40.00	2	10.00	0	0.00
	Taste	7	35.00	9	45.00	4	20.00	0	0.00

F = Frequency; % = Percentage of Panelists (n = 20)

CONCLUSION

The study showed that both neem wood and charcoal are effective smoking fuels for African catfish (*Clarias gariepinus*), producing products with high consumer acceptability. Charcoal-smoked fish was preferred for appearance and texture, while neem wood-smoked fish received higher ratings for flavour and taste. Therefore, both fuels can be used successfully for fish smoking. However, neem wood offers additional advantages due to its availability, renewability, and potential to enhance flavour. Therefore, fish processors are encouraged to adopt neem wood as a sustainable alternative to charcoal. Further studies should investigate its effects on shelf life, nutritional quality, economic viability, and consumer preferences using larger sample sizes.

Conflict of interest

Authors declare that there is no conflict of interest, and therefore, given consent for the publication of the article.

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