

Comparative Study on the Sensory Quality of *Oreochromis niloticus* Smoked using Modified Drum, Futy, and Traditional Market Kilns

*A. A. Adam; S. Idris; M. U. Sambo; F. Sambo; A. Abubakar; Y. Chiroma

Department of Fisheries Technology, Binyaminu Usman Polytechnic
Hadejia, Jigawa State, Nigeria

M. U. Bahago
Department of Aquaculture and Fisheries Management, Nasarawa
State University Keffi

*Corresponding Author:

Abstract

This study evaluated the sensory qualities of *Oreochromis niloticus* processed with three different smoking kilns: the modified drum kiln, FUTY kiln, and traditional market smoking kiln. Thirty (30) fish samples were randomly chosen and evenly assigned to the three processing methods. The fish were gutted, cleaned, and smoked according to standard smoking procedures. A semi-trained panel of fifteen members assessed the smoked samples based on taste, texture, appearance, colour, aroma or rancidity, and overall acceptability, using a seven-point hedonic scale. Results indicated similar ratings for taste and texture among the treatments, with fish processed using the modified drum kiln and FUTY kiln (5.05 and 4.98, respectively) performing better than those from the traditional market kiln (4.88). Appearance scores were uniform across all treatments (6.00), while the modified drum kiln samples recorded the highest aroma score (6.01) and a slightly higher overall acceptability (5.31), closely matched by FUTY (5.36). The traditional market samples showed lower values, especially for aroma (4.50) and overall acceptability (4.70).

Data were analyzed using one-way ANOVA, revealing significant differences at $p < 0.05$ with a low standard error of the mean (SEM), signifying strong agreement among panelists. These findings highlight the advantage of improved smoking technologies.

Keywords:

Oreochromis niloticus, sensory evaluation, smoked fish, modified kiln, consumer acceptability

Introduction

In Nigeria, smoked fish plays a crucial role as a major source of animal protein and remains an integral part of local diets and trade. The sensory quality of smoked fish—defined by its taste, texture, aroma, colour, and general appearance—is largely shaped by the smoking method used. Several studies have emphasized that the type and design of smoking kilns strongly influence these quality parameters. For example, Orji and Ikechi (2010) reported that *Oreochromis niloticus* (tilapia) processed using a modified drum kiln exhibited better colour, taste, and texture than those prepared

with traditional kilns. Likewise, Olopade, Taiwo, and Agbato (2013) observed that conventional drum smoking enhanced flavour, tenderness, and texture, although it could slightly affect crude protein content when compared with other fish species such as *Sarotherodon galilaeus*.

Despite existing research, limited comparative evidence is available on how improved and traditional smoking technologies influence the sensory characteristics of *O. niloticus*. This study bridges that gap by evaluating fish processed with three distinct smoking kilns: the modified drum kiln, the FUTY kiln, and the traditional market smoking kiln. Through a structured sensory evaluation involving a 15-member semi-trained panel using a seven-point hedonic scale, the research aims to provide practical insights into how modernized smoking techniques can enhance the sensory quality and consumer acceptance of smoked tilapia.

Materials and Methods

Study Location

The experiment was carried out at the Department of Fisheries, Modibbo Adama University of Technology, Yola, where both the modified drum and FUTY smoking kilns are situated and in active use. Smoked fish samples representing traditional practices were obtained from a local fish market in Geriyo, Adamawa State.

Fish Sample Collection and Preparation

Thirty (30) live specimens of *Oreochromis niloticus* with similar size and weight were randomly selected and allowed to acclimatize before processing. The fish were carefully slaughtered using humane procedures, then gutted, thoroughly washed, and divided into three equal groups of ten (10) fish each. These groups corresponded to the three smoking treatments: the modified drum kiln, the FUTY kiln, and the traditional market smoking kiln. Each batch was processed using its respective smoking technique in accordance with standard

fish smoking procedures to ensure uniformity and reliability of results.

Description of Smoking Kilns

Modified Drum Smoking Kiln

The modified drum smoking kiln was developed to increase processing efficiency, enhance product quality, and minimize operational losses. Inspired by findings from peer-reviewed research on improved smoking kiln technologies in Nigeria, the design incorporates a dual-fuel system that allows the use of both charcoal and firewood. It also includes features for better regulation of smoke and heat distribution, as well as modular components that promote ease of use, mobility, and overall performance. Structurally, the kiln is fabricated from a metal drum measuring approximately 34 cm in length and 24 cm in diameter, constructed to accommodate both charcoal- and firewood-based smoking processes. The unit is fitted with a detachable chimney, a general top cover, and an internal dual-chamber tray assembly, which enables either simultaneous or independent utilization of the fuel sources depending on operational needs (Idris *et al* 2025f)

Futy Kiln: Futy Smoking Kiln, it was made of light metal steel in form of a rectangular box having four legs as stand Plate II. The rectangular box has the dimension of 99cm-45cm, and the legs suspended the box from the ground. Joseph (2008) stated that the "FUTY" Smoking Kiln fashioned with a door of a projecting design when pulled outside has three trays made of metallic wires and rods and 10cm apart. At the bottom of the box are perforated holes that allow the inflow of smoke and heat in order to be trapped in the smoking chamber. The box has a cover at the surface with perforated holes occupying 119cm² (17cmx7cm) at the middle of the cover which is the chimney of the processor. The chimney allows excess heat and smoke out of the smoking chamber. At the surface of the chimney of metal sheath is suspended on four pipes to prevent inflow rain

water into the smoking chamber. Charcoal is ignited and placed at the bottom of the box, producing smoke and heat which will pass through the perforated holes under the box into the smoking chamber and reaching the maximum temperature, excess smoke and heat will be seen leaving the chamber through the chimney. Sogbesan et al. (2012).

Market Kiln: The traditional market kiln represents conventional smoking practices. These kilns are built with mud or metal and firewood, often lacking consistent temperature control or hygienic smoke flow systems.

Sensory Evaluation

A total of fifteen semi-trained panelists, consisting of staff and students familiar with smoked fish, participated in the sensory assessment. The exercise took place in a clean, well-ventilated room with adequate lighting and controlled testing conditions. Each assessor was provided with coded samples from the different treatments, presented in random order to avoid bias. Evaluations were based on a 7-point hedonic scale ranging from 1 (dislike extremely) to 7 (like extremely). The sensory qualities examined included taste, texture, appearance, colour, aroma or rancidity, and overall acceptability.

Statistical Analysis

The sensory data obtained were analyzed using a one-way analysis of variance (ANOVA) to determine significant differences ($p < 0.05$) among the treatment groups. The standard error of mean (SEM) was calculated to estimate the level of consistency among panelists.

Results and Discussion

The sensory evaluation of smoked *Oreochromis niloticus* processed with three kiln types—modified drum kiln, FUTY kiln, and traditional market kiln—showed notable variations in organoleptic properties among treatments (Table 1).

Taste and Texture

Taste and texture are key factors determining consumer preference and overall product quality. Fish processed with the modified drum and FUTY kilns obtained higher taste scores (5.05 and 4.98, respectively) and similar texture values (5.05 and 4.98) compared with samples from the market kiln (4.88 for both parameters). Although the differences were not large, assessors expressed a mild preference for fish smoked using improved kiln designs. The low standard error of mean (0.04) for these traits indicates strong agreement among panel members. These observations are consistent with the report of Karim et al. (2007), who found that modernized smoking systems enhance product uniformity and improve flavour appeal.

Appearance

All treatments achieved an identical score for appearance (6.00), implying that the external outlook of the smoked fish was equally attractive across kiln types. This similarity may be linked to comparable pre-smoking preparation and near-uniform smoking time applied during processing. Muhd et al. (2016) emphasized that appearance often forms the first impression guiding consumer decisions, and the uniform results obtained here suggest adequate control of processing conditions.

Colour

In terms of colour, the FUTY and market kilns achieved slightly higher ratings (6.00) than the modified drum kiln (5.78), though the variation was statistically insignificant. Colour development in smoked fish generally depends on smoke concentration, heat intensity, and duration of exposure. The findings suggest that FUTY and market kilns may have produced deeper coloration, possibly due to longer or more intense smoking. Nonetheless, Olayemi et al. (2019) cautioned that excessive heat or smoke can obscure freshness cues, highlighting the need for a balanced smoking regime to maintain desirable product appearance.

Aroma and Rancidity

Aroma and rancidity scores varied considerably among the treatments. The modified drum kiln produced the highest aroma rating (6.01), followed by the FUTY kiln (5.66), while the market kiln yielded the lowest score (4.50). The superior aroma quality from the modified drum kiln can be attributed to controlled combustion and efficient smoke circulation, which reduce the likelihood of off-flavours. This agrees with Yawale et al. (2024), who reported that improved drum-type kilns enhance the sensory quality of smoked fish by minimizing excessive smoke deposits.

General Acceptability

Overall acceptability followed a similar trend: samples from the FUTY kiln recorded the

highest mean score (5.36), closely followed by the modified drum kiln (5.31), whereas the market kiln produced the least acceptable product (4.70). Though the differences were minor, the results reflect a consistent preference for products processed using improved kiln technologies. As observed by Obande et al. (2020), consumer acceptance is shaped by the combined influence of sensory traits, and even small enhancements in aroma, colour, or texture can significantly affect market preference.

Table 1: Mean Sensory Scores of Smoked *Oreochromis niloticus* Processed Using Three Kiln Types

Smoking Kilns	Taste	Texture	Appearance	Colour	Aroma/Rancidity	General Acceptability	SEM
Modified Drum	5.05	5.05	6.00	5.78	6.01	5.31	0.04
FUTY Kiln	4.98	4.98	6.00	6.00	5.66	5.36	0.04
Market Kiln	4.88	4.88	6.00	6.00	4.50	4.70	0.02

Conclusion

This study assessed the sensory qualities of *Oreochromis niloticus* smoked using three different kiln types—modified drum kiln, FUTY kiln, and the traditional market smoking kiln. The results demonstrated that all kilns produced fish with generally acceptable organoleptic properties, though some parameters differed significantly among treatments.

The modified drum kiln achieved the highest aroma score (6.01) and showed competitive performance in taste, texture, and overall acceptability (5.05 and 5.31, respectively), reflecting better smoke regulation and lower rancidity development. Similarly, the FUTY kiln yielded high-quality smoked fish, with the best general acceptability score (5.36) and strong ratings for colour and appearance. By contrast, fish processed in the market kiln, while visually

appealing, consistently received the lowest scores for aroma (4.50) and general acceptability (4.70), likely due to uneven smoke exposure and limited control of processing variables.

Overall, these findings highlight the importance of adopting improved kiln technologies to enhance consumer satisfaction, ensure product consistency, and preserve post-harvest fish quality. The low SEM values recorded across parameters indicate strong agreement among panelists, confirming the reliability of the sensory outcomes.

Recommendations**1. Adoption of Improved Kilns**

Fish processors should be encouraged to utilize advanced smoking systems such as the modified drum and FUTY kilns to improve

product quality, hygiene, and market competitiveness.

2.Training and Extension Services

Government agencies and research institutions should organize capacity-building programs for small- and medium-scale fish processors, focusing on the operation, maintenance, and benefits of improved kiln technologies.

3.Policy Support and Subsidies:

Policy frameworks and subsidy schemes should be developed to make improved smoking kilns more affordable and accessible, particularly within rural fishing communities.

4.Further research

Future investigations should integrate microbiological and nutritional analyses of smoked fish to provide a more comprehensive evaluation of processing technologies and their implications for food safety.

5.Consumer Awareness

Public awareness initiatives should be promoted to educate consumers on the advantages of smoked fish produced with improved technologies, particularly in terms of quality, safety, and health benefits.

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