ASSESSMENT OF SENSORY EVALUATION AND PROXIMATE QUALITY OF SMOKED BONYTONGUE FISH (*HETEROTIS NILOTICUS* CUVIER, 1829) TREATED WITH DIFFERENT SEASONINGS FROM NORTHEASTERN NIGERIA

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ABSTRACT

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This study investigated the effects of different seasonings salt (5%), garlic (3%), and ginger (3%) on the sensory and proximate quality of smoked *Heterotis niloticus* (bonytongue fish) in Northeastern Nigeria. The results showed that garlic- and ginger-treated fish had significantly higher sensory scores than salt-treated and control samples, especially in taste, aroma, appearance, texture, and overall acceptability. Garlic-treated fish had the highest overall acceptability (7.60 ± 0.49), followed by ginger (7.50 ± 0.50), while the control scored the lowest (5.00 ± 0.45). In terms of proximate composition, garlic- and ginger-treated samples had the lowest moisture (28.90% and 28.60%) and lipid content (15.70% and 15.50%), suggesting improved shelf life. Salt-treated samples showed the highest protein content (48.30%), while all treatments had similar ash and crude fiber content. The use of natural seasonings like garlic and ginger in fish smoking not only enhances taste and aroma but also reduces moisture and fat content, improving both quality and shelf stability. It is therefore recommended that fish processors adopt these natural additives in traditional smoking processes. Training programs should be introduced to encourage their use among small- and medium-scale processors, while policy support should promote the use of indigenous spices to reduce reliance on chemical preservatives and improve public health and food security.

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Keywords: *Heterotis niloticus*, smoked fish, sensory quality, proximate composition and natural seasonings

INTRODUCTION

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Fish is an essential source of high-quality protein and micronutrients crucial for human health (FAO, 2020). It is widely consumed in Nigeria due to its affordability, availability, and high nutritional value (Eyo, 2001). Fish contributes significantly to food security, providing a substantial proportion of animal protein in the diet of many Nigerians (Olaoye and Ojebiyi, 2018). Among

various fish species, *Heterotis niloticus* (bonytongue fish) is a freshwater species valued for its taste, market demand, and adaptability to aquaculture systems (Oladejo and Akinbile, 2021).

The preservation of fish is crucial in ensuring food safety, reducing post-harvest losses, and extending shelf life. Smoking is one of the oldest and most commonly used methods of fish preservation (Adeyemi *et al*., 2017). It enhances flavor, reduces moisture content, and inhibits microbial growth, thus improving the shelf stability of fish products (Adebayo-Tayo *et al*., 2011). Traditional fish smoking methods have been widely practiced across Nigeria, with salt being the most common seasoning used in the process (Rahman *et al*., 2020).

However, in recent years, research has explored alternative seasonings such as garlic and ginger due to their potential antimicrobial, antioxidant, and preservative properties (Kumar *et al*., 2018). Garlic (Allium sativum) and ginger (Zingiber officinale) contain bioactive compounds that have been reported to inhibit bacterial growth, enhance taste, and improve the shelf life of food products (Abdullahi *et al*., 2019). Incorporating these natural seasonings in fish smoking may offer an innovative approach to improving both the sensory and proximate quality of fish.

The demand for high-quality, well-preserved fish products has grown as consumers become more health-conscious (FAO, 2020). Studies suggest that different seasonings can influence the taste, texture, and chemical composition of smoked fish (Oladejo and Akinbile, 2021). However, limited research has been conducted on how alternative seasonings like garlic and ginger affect the sensory and proximate composition of *Heterotis niloticus*. Understanding these effects is essential for improving fish processing techniques and increasing consumer acceptability.

In Northeastern Nigeria, smoked fish is a common dietary component, but there is a lack of consistency in processing techniques, leading to variations in quality (Adeyemi *et al*., 2017). Investigating the effects of different seasoning treatments on *Heterotis niloticus* will provide valuable insights into optimizing fish smoking methods. This study aims to assess the sensory evaluation and proximate quality of smoked *Heterotis niloticus* treated with salt, garlic, and ginger. However, little research has examined the effects of garlic and ginger on the sensory and proximate quality of *Heterotis niloticus*. This study aims to fill this gap by evaluating the impact of these natural seasonings on taste, texture, aroma, color, and nutritional composition of smoked bonytongue fish from Northeastern Nigeria.

MATERIALS AND METHODS

Study Area

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The research was conducted at the fish processing unit of the Federal College of Freshwater Fisheries Technology, Baga (Latitudes $11^0$51'43" N and Longitudes $13^0$13'36" E), between June and July 2025.

Experimental Design and Treatments

This study employed a completely randomized design (CRD) to assess the effects of different seasoning treatments on the sensory and proximate quality of smoked *Heterotis niloticus*. The experimental treatments include:

1. Control (No seasoning, smoked only)
2. Salt-treated (Salt at 5% w/w of fish weight)
3. Garlic-treated (Garlic at 3% w/w of fish weight)
4. Ginger-treated (Ginger at 3% w/w of fish weight)

Each treatment replicated three times, and fish samples were randomly assigned to these groups to minimize bias.

Sample Collection and Preparation

Live adult *Heterotis niloticus* specimens of about 300g to 450g were purchased from Gamboru fish market and transported in ice-packed containers to the laboratory to maintain freshness. The fish was gutted, cleaned, and divided into four experimental groups. The fish samples were marinated with the designated seasoning, allowed to sit for 3 hours for proper absorption, and then smoked using a traditional smoking kiln at 60-80°C for 8 hours (Eyo, 2020; Rahman *et al*., 2021).

Sensory Evaluation

Sensory evaluation was conducted using a 9-point hedonic scale (1 = dislike extremely, 9 = like extremely) and assessed appearance (color, surface texture), Aroma (smokiness, seasoning impact), Taste (flavor intensity, seasoning balance), Texture (firmness, juiciness, chewiness) and Overall acceptability. A panel of 10 trained sensory evaluators (Lecturers and technologists) assessed the smoked fish samples. Each panelist received coded fish samples under controlled conditions (white light, room temperature, no distractions).

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Proximate Analysis

The proximate composition of smoked *Heterotis niloticus* was analyzed following AOAC (2019) standard procedures to determined Moisture content, Crude protein, Crude lipid, Ash content and Crude fiber. Each analysis was conducted in triplicate for accuracy.

Statistical Analysis

The data obtained were analyzed using SPSS (Statistical Package for the Social Sciences) version 25. Descriptive Statistics such as Mean and standard deviation used for sensory and proximate data. One-Way ANOVA was used to determine significant differences between treatments. Post-hoc Tukey's Test was applied were ANOVA shows significant differences to identify which treatments differ. The Results was considered significant at $p < 0.05$.

RESULTS

Sensory Evaluation of Smoked *Heterotis niloticus*

The sensory scores of smoked *Heterotis niloticus* treated with different seasonings are presented in Table 1. Significant differences ($p < 0.05$) were observed across treatments in all evaluated attributes.

Table 1: Sensory Attributes of Smoked *Heterotis niloticus* Treated with Different Seasonings (Mean ± SD)

Treatment	Appearance	Aroma	Taste	Texture	Overall Acceptability
Control	5.10 ± 0.32^{c}	4.80 ± 0.42^{c}	4.60 ± 0.70^{c}	5.00 ± 0.47^{bc}	5.00 ± 0.45^{c}
Salt (5%)	6.30 ± 0.48^{b}	6.10 ± 0.60^{b}	6.20 ± 0.63^{b}	6.10 ± 0.40^{ab}	6.20 ± 0.55^{b}
Garlic (3%)	7.40 ± 0.51^{a}	7.60 ± 0.52^{a}	7.50 ± 0.60^{a}	6.90 ± 0.38^{a}	7.60 ± 0.49^{a}
Ginger (3%)	7.10 ± 0.57^{a}	7.40 ± 0.43^{a}	7.30 ± 0.41^{a}	6.80 ± 0.44^{a}	7.50 ± 0.50^{a}

Values with different superscript letters within a column differ significantly ($p < 0.05$)

Proximate Composition of Smoked *Heterotis niloticus*

The proximate composition of the differently treated fish samples is shown in Table 2. Significant differences ($p < 0.05$) were observed in moisture, protein, and lipid content.

Table 2: Proximate Composition (%) of Smoked *Heterotis niloticus* (Mean ± SD)

Treatment	Moisture Content	Crude Protein	Crude Lipid	Ash Content	Crude Fiber
Control	32.80 ± 0.58^{a}	44.90 ± 0.55^{c}	18.20 ± 0.46^{a}	3.20 ± 0.18^{a}	1.10 ± 0.14^{a}
Salt (5%)	30.40 ± 0.40^{b}	48.30 ± 0.48^{a}	17.00 ± 0.32^{b}	3.30 ± 0.14^{a}	1.00 ± 0.11^{a}
Garlic (3%)	28.90 ± 0.49^{c}	46.50 ± 0.62^{b}	15.70 ± 0.33^{c}	3.10 ± 0.12^{a}	1.00 ± 0.13^{a}
Ginger (3%)	28.60 ± 0.43^{c}	46.20 ± 0.50^{b}	15.50 ± 0.28^{c}	3.20 ± 0.15^{a}	1.00 ± 0.10^{a}

Values with different superscript letters within a column differ significantly ($p < 0.05$).

DISCUSSION

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The results reveal that garlic- and ginger-treated samples had significantly higher scores in all sensory attributes compared to the control and salt-treated samples. Garlic-treated fish had the highest overall acceptability (7.60 ± 0.49), closely followed by ginger-treated fish (7.50 ± 0.50). This can be attributed to the presence of flavor-enhancing compounds such as allicin in garlic and gingerol in ginger, which enhance taste and aroma (Kumar *et al*., 2018; Abdullahi *et al*., 2019). These findings support those of Oladejo and Akinbile (2021), who noted improved sensory profiles in fish treated with natural spices.

Control samples scored the lowest across all parameters, indicating the limitations of smoking without any seasoning. Salt-treated samples performed moderately well, reflecting salt's basic flavor-enhancing role, although lacking the complexity of garlic and ginger flavors.

Moisture content was significantly lower in ginger- (28.60 ± 0.43%) and garlic-treated fish (28.90 ± 0.49%) than in control (32.80 ± 0.58%), supporting the findings of Akinwumi *et al*. (2014), who reported that natural spices reduce water activity and improve shelf life in smoked fish. This reduction may be due to the antimicrobial and hygroscopic nature of ginger and garlic, which limits microbial growth and moisture retention. Ahmed *et al*. (2020) similarly observed that ginger-treated fish retained less moisture due to enhanced dehydration during smoking. However, Eyo (2001) documented higher moisture levels (>35%) in traditionally smoked fish, showing a contrast with this study, likely due to differences in seasoning and smoking duration.

Protein content was highest in salt-treated samples (48.30 ± 0.48%), consistent with the report of Tobor (1990), which highlighted salt's role in protein retention during smoking. Garlic- and ginger-treated fish also retained high protein levels (46.50 ± 0.62% and 46.20 ± 0.50%, respectively), supporting Oladejo and Akinbile (2021), who found comparable protein retention across salt and spice treatments in *Heterotis niloticus*. In contrast, Olusegun and Adepoju (2015) observed lower protein content in ginger-treated fish, suggesting that spice concentration and exposure time may influence nutrient retention.

Lipid content was significantly reduced in garlic- (15.70 ± 0.33%) and ginger-treated fish (15.50 ± 0.28%) compared to control (18.20 ± 0.46%), likely due to oxidative effects of these spices as antioxidants. This aligns with Kumar *et al*. (2018) and Rahman *et al*. (2020), who found that garlic and ginger minimize lipid oxidation in meat and fish products. However, contrary findings were presented by Gokoglu and Yerlikaya (2015), who reported no significant change in

fat content with spice application, indicating that the effect might depend on smoking intensity and fish species.

Ash and fiber contents remained relatively unchanged across treatments (3.10–3.30% ash; 1.00–1.10% fiber), which corresponds with the findings of Akande and Tobor (1992) and Adebayo-Tayo *et al*. (2011), who also reported minimal variation in ash and fiber in smoked freshwater fish regardless of treatment type.

CONCLUSION

This study established that the use of natural seasonings such as garlic and ginger significantly improved both the sensory and nutritional quality of smoked *Heterotis niloticus*. Garlic-treated samples were most preferred in terms of aroma, taste, and overall acceptability. Proximate analysis showed that garlic and ginger treatments reduced moisture and lipid content, thereby potentially extending shelf life and enhancing food safety. Salt-treated fish retained the highest protein levels but scored lower in sensory evaluations than garlic and ginger treatments.

RECOMMENDATION

Based on the results of this study, it is recommended that fish processors adopt natural seasonings such as garlic and ginger during the smoking of *Heterotis niloticus* to enhance the sensory appeal (taste, aroma, texture, and color) and improve proximate quality by reducing moisture and lipid content while retaining protein. These treatments not only improve consumer acceptability but also contribute to longer shelf life and safer fish products. Therefore, training programs should be organized for small- and medium-scale fish processors across Northeastern Nigeria to encourage the adoption of spice-enhanced smoking methods. Policymakers and extension agents should also promote the use of indigenous natural preservatives to reduce dependency on chemical additives, enhance value addition in fish processing, and support nutrition-sensitive agriculture for improved public health and food security.

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