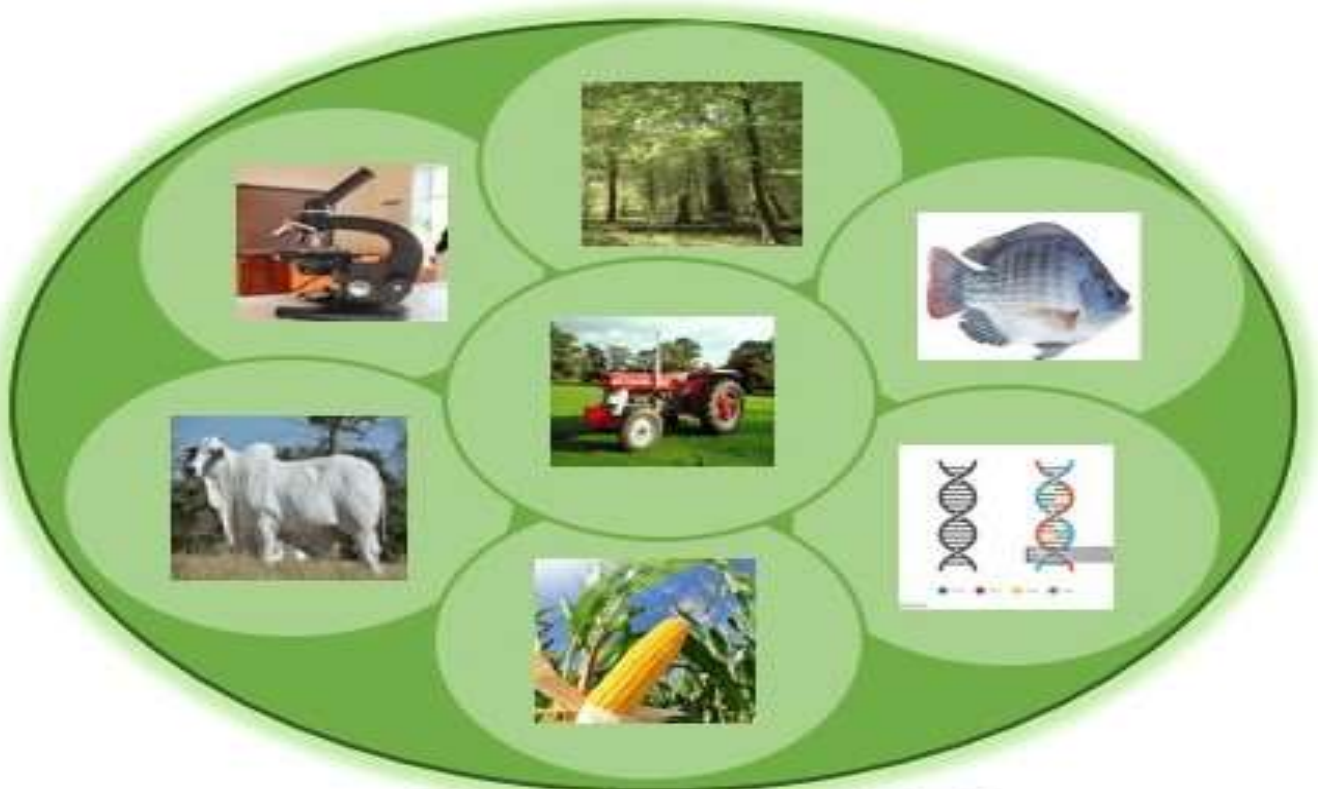




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CONTACT:

The Editor,
Kebbi Journal of Agriculture and Natural Sciences,
Faculty of Agriculture,
Kebbi State University of Science and Technology Aliero,
PMB 1144, Birnin kebbi, Nigeria.
Email: kejaanseditor@ksusta.edu.ng, kejaans.foa@gmail.com.
Phone: +234 8039370546

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Editors

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The Kebbi Journal of Agriculture and Natural Sciences has the sole aim of providing an intellectual platform and ideas for scholars, by promoting interdisciplinary studies related to agriculture and natural science through publishing the latest scientific research findings that are of direct policy implications and beneficial to the research community. Consequently, the journal covers all aspects of Crop Science, Animal Science, Agricultural Economics, Agricultural Extension and Rural Development, Food Science, Fisheries and Aquaculture, Biotechnology, Soil Science and Agricultural Engineering, Forestry and Environment, Wildlife, Agricultural Education, Agro-allied Industries as well as all Natural Science researches related to Agriculture.

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DETERMINATION OF THE EFFECT OF SALT AND GARLIC ON THE BIOCHEMICAL COMPOSITION (PROXIMATE COMPOSITION) OF SMOKED-DRIED (*CLARIAS GARIEPINUS*)

*D.Y. Bawa and ^{1&2}Abdulrahman. D.

1. Department of Forestry and Fisheries, Kebbi State University of Science and Technology, Aliero
2. Department of Fisheries technology, Kebbi State Polytechnic, Dakingari

Corresponding author: bawadal505@gmail.com +2348038199626

ABSTRACT

*This study aimed to investigate the impact of salt (sodium chloride) and garlic (*Allium sativum*) treatments on the biochemical composition of smoked *Clarias gariepinus* (African catfish). The fish samples were analyzed for moisture, ash, protein, fat, fiber, and nitrogen-free extract according to AOAC (2003) methods. Based on the result, Garlic-treated fish had the highest protein content (34.17%) and the lowest moisture content (4.06%), indicating garlic's superior effectiveness in protein preservation and moisture reduction. Salt-treated fish exhibited the highest ash content (14.04%), suggesting salt's contribution to mineral content. The combination of salt and garlic resulted in the highest lipid content (29.13%), highlighting the synergistic effect of these two additives in lipid retention. It is concluded that garlic is most effective for protein preservation, while salt enhances the mineral content of smoked fish. The combination of salt and garlic provides the best lipid retention. These findings support the use of garlic and salt as key preservatives for optimizing the biochemical quality of smoked fish.*

Keywords: African catfish; proximate; garlic, salt and protein

Introduction

Preservation of fish is essential for extending shelf life, maintaining nutritional quality, and preventing spoilage, especially in regions where fresh fish is scarce (Fellows, 2009). *Clarias gariepinus* is a widely consumed species, known for its high nutritional value, particularly its protein and lipid content. Smoking is one of the oldest preservation methods, known for reducing moisture and improving the shelf life of fish. However, the use of additives such as salt and garlic can further enhance the preservation process by altering the biochemical composition of smoked fish (Bai et al., 2019).

Salt (sodium chloride) is a traditional preservative that works by drawing moisture out of the fish through osmosis, thereby reducing microbial activity and enhancing mineral content. It also affects the protein structure and lipid stability during smoking (Kyung, 2012). Garlic, on the other hand, is known for its antimicrobial and antioxidant properties. It has been used in food preservation to inhibit the growth of spoilage organisms and protect against lipid oxidation (Sharma, et al., 2019).

Understanding the effects of salt and garlic on the biochemical composition of smoked *Clarias gariepinus* is crucial for optimizing preservation

techniques. This study investigates the impact of these treatments on moisture, protein, lipid, and ash content, with the aim of identifying the most effective method for maintaining and improving the nutritional value of smoked fish.

Materials and Methods

Study Area: The study was conducted at the Department of Forestry and Fisheries, Kebbi State University of Science and Technology, Aliero. Aliero is situated in Kebbi state at approximately 12.2783° N latitude and 4.4517° E longitude.

Sample Collection: The fish species (*Clarias gariepinus*) was obtained from aliero central market located in Aliero town, with 4 kg of table-sized fish divided into four batches: A (control, no treatment), B (treated with salt), C (treated with garlic), and D (treated with a mix of salt and garlic). Both salt (sodium chloride) and garlic (*Allium sativum*) were sourced from the central market Aliero.

Smoking Kiln Description: The kiln is constructed using a 200-liter metal barrel as the main structure. The barrel is modified to serve as the smoking chamber. Inside, it is equipped with three hard smoking trays made from perforated metal sheets to hold the fish. The barrel is fitted with a metal cover to regulate the smoke release and maintain the required temperature for efficient fish smoking. A chimney outlet is placed at the top to ensure proper smoke circulation. Air vents are installed at the base of the barrel to control airflow and maintain the required temperature. Kiln Dimensions: Total Height: 1.2 meters (including chimney), Barrel Height: 88 cm, Barrel Diameter: 58 cm, Tray Height Interval: 20 cm between each tray, Firebox Height: 32 cm.

Smoking Kiln Preparation: The trays were cleaned with detergent and coated with groundnut oil to prevent fish from sticking.

Fuel Source: Firewood from sheanut tree (*Vitellaria paradoxa*) was used to produce heat and smoke for drying the fish samples.

Plant Material Preparation: Fresh garlic was peeled, washed, and ground into a paste for use in treatments.

Fish Sample Preparation: Fish samples underwent gutting, washing, and salting to reduce bacterial activity. Four treatments were prepared: control (Batch A), brine solution (Batch B), garlic paste (Batch C), and a salt-garlic mixture (Batch D). Samples were soaked for 15 minutes in each treatment.

Smoking Process: The treated fish samples were dried in a smoking kiln, with heat and smoke levels adjusted regularly to avoid charring. Smoking continued for 48 hours until constant weight was achieved.

Proximate Analysis

The fish samples were analyzed for moisture, ash, protein, fat, fiber, and nitrogen-free extract according to AOAC (2003) methods:

1. Moisture Content: Determined by drying 2 g of fish at 105–110°C for 3 hours.

2. Ash Content: Measured by igniting 2 g of fish at 500–600°C for 3 hours.

3. Crude Protein: Determined by digesting a sample with sulfuric acid, followed by distillation and titration to calculate nitrogen content, multiplied by a factor of 6.25.

4. Crude Lipid: Measured using the AOAC method, where fat was extracted using petroleum ether.

Data collection: collected data of the proximate composition analysis was calculated and compiled using the Descriptive method of statistics

Results and Discussion

The study found that salt and garlic treatments affected the proximate composition of smoked *Clarias gariepinus*. Garlic-treated fish had the highest protein content (34.17%) and lowest moisture content (4.06%), suggesting garlic's superior preservation properties in maintaining protein and reducing moisture. Salt-treated fish had the highest ash content (14.04%) due to salt absorption, while the combination of salt and garlic had the highest lipid content (29.13%) due to their combined effects on lipid preservation.

Table 1: Proximate Composition of the Experimental Smoked *Clarias gariepinus* after Preservation

Treatments	PROXIMATE COMPOSITIONS (%)			
	MOISTURE	PROTEIN	LIPID	ASH
Control	5.82	30.01	27.70	9.91
Salt	6.04	30.30	23.01	14.04
Garlic	4.06	34.17	21.53	11.05
Salt and garlic	6.53	23.52	29.13	13.19

Moisture Content

Salt and garlic effect: The moisture content varied across treatments, with garlic-treated fish having the lowest moisture content (4.06%) and the salt and garlic-treated fish having the highest (6.53%). This difference is attributed to salt's hygroscopic nature and garlic's antimicrobial properties. Salt promotes water retention to some extent, whereas garlic acts as a drying agent. These findings support the osmotic dehydration theory, where salt pulls water to the surface but may not eliminate all moisture. Garlic's antimicrobial properties reduce microbial activity and water retention (Kyung, 2012).

The use of garlic contributed to better dehydration (lower moisture content) compared to salt or the combination of both. This indicates that garlic may be more effective in preserving the biochemical quality of smoked fish by minimizing water activity, thus reducing spoilage potential.

Protein Content

Salt and garlic effect: The highest protein content was observed in garlic-treated fish (34.17%), suggesting garlic's effectiveness in protecting protein from degradation during smoking. Salt and garlic-treated fish, however, had the lowest protein content (23.52%). The interaction between salt and garlic could have negatively impacted protein stability, possibly due to the denaturation effects of salt coupled with garlic's strong antioxidant activity. This outcome aligns with protein stability theory, which highlights garlic's ability to inhibit protein oxidation during thermal processing (Sharma et al., 2019).

Garlic treatment is superior in preserving protein content in smoked fish. The combination of salt

and garlic may interfere with each other, resulting in reduced protein levels.

Lipid Content

Salt and Garlic Effect: The salt and garlic-treated fish had the highest lipid content (29.13%), whereas garlic-treated fish had the lowest (21.53%). The higher lipid content in the combined treatment is likely due to garlic's antioxidant properties, which reduce lipid oxidation, combined with salt's role in fat absorption during smoking. This aligns with lipid protection theory, where garlic's antioxidants protect fats from oxidation while smoking preserves the lipid content (Bai et al., 2019).

Garlic effectively reduces lipid degradation during smoking, making it a beneficial treatment for preserving fat content in fish. The salt and garlic combination provides a synergistic effect, leading to higher lipid retention.

Ash Content

Salt and Garlic Effect: The salt-treated fish had the highest ash content (14.04%), due to the high mineral content from the salt. The ash content of the garlic-treated fish (11.05%) was higher than the control, likely because garlic retains some minerals. The mineral retention theory explains that salt enhances the mineral content of foods through absorption into the tissues.

Salt significantly increases the ash content, indicating that it contributes to the mineral profile of the smoked fish. Garlic also slightly enhances ash content, although to a lesser extent than salt.

The findings recommend the followings:

For Protein Preservation: Garlic should be the preferred treatment for preserving protein content

in smoked fish, particularly for consumers seeking high-protein diets.

For Mineral Content: Salt treatment is recommended for enhancing the mineral profile of smoked fish, particularly for products targeting mineral fortification.

For Lipid Retention: A combination of salt and garlic is recommended to maximize lipid retention, which is important for energy-dense smoked fish products.

Conclusion

Garlic enhances protein retention and reduces moisture, making it a superior preservation method for maintaining the nutritional quality of fish. However, salt provides higher ash content, contributing to the mineral profile, while the combination of both increases lipid retention.

Garlic is more effective in preserving protein and reducing moisture in smoked fish, while salt significantly enhances the ash content, contributing to the fish's mineral profile. The combination of salt and garlic offers the best lipid preservation, suggesting a synergistic effect on fat retention. Each treatment demonstrates distinct biochemical advantages, with garlic being superior for protein and moisture preservation, and salt for mineral content.

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