



**THE DESIGN AND CONSTRUCTION OF A CHARCOAL-POWERED FISH
SMOKING KILN: A SUSTAINABLE SOLUTION FOR SMALL-SCALE PROCESSORS
IN NIGERIA**

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ABSTRACT

This paper focuses on the design and construction of a charcoal-powered fish smoking kiln aimed at improving fish preservation methods in local communities. Fish, being a vital source of high-quality protein, requires efficient and hygienic preservation techniques to reduce post-harvest losses and ensure food safety. The charcoal-powered smoking kiln was developed using mild steel sheets for the main structure and lagged with 25 mm thick fiber insulation to minimize heat loss and enhance energy efficiency. The smoking trays were fabricated from galvanized wire mesh to support uniform smoke distribution and drainage of fish oils. Key fabrication processes involved measuring, marking out, cutting, bending, and welding to assemble a kiln with dimensions of 915 mm × 610 mm × 1220 mm, fitted with front-access doors for easy loading and unloading of fish. The kiln operates within an enclosed chamber that retains heat effectively, ensuring consistent smoking conditions. Performance evaluation was conducted using three different fish samples, and the rate of heat transfer, smoking duration, and overall drying efficiency were analyzed. The result demonstrated that the charcoal-powered kiln provides a cost-effective, durable, and efficient method for fish preservation, making it suitable for small-scale fish processors in rural and semi-urban areas.

Keywords: Charcoal-powered kiln, Fish Smoking, Fish Preservation, Energy-efficient Design, Small-scale Processing.

INTRODUCTION

Fish is an essential component of the Nigerian diet and economy. It serves as a major source of high-quality protein and provides livelihoods to millions of people involved in fishing, processing, and marketing (Al-Jufaili & Opara, 2006). However, its high perishability poses a challenge to effective distribution and consumption, especially in the absence of reliable electricity and refrigeration (Davies & Davies, 2009).

Traditional methods of fish smoking, such as the use of open drums and firewood, are widely used in rural communities. These methods, however, are associated with energy loss, health hazards, and inconsistent drying quality (Bolaji, 2005). In light of this, the need for a sustainable, low-cost, and energy-efficient solution becomes critical.

This study addresses these issues by designing and constructing a charcoal-powered smoking kiln that ensures efficient heat utilization, uniform smoke distribution, and improved hygiene during fish processing.

LITERATURE REVIEW

Preservation of fish through smoking is not a new technique; however, the application of improved technologies can significantly enhance its effectiveness. According to Blackwell (2014), the smoking process not only dehydrates fish but also imparts flavor and color, extending shelf life and consumer appeal.

Several researchers have emphasized the limitations of traditional smoking methods, including under-drying, exposure to contamination, and health risks (Akinola et al., 2006; Maga, 2000).

Advanced smoke kilns, as recommended by Alakali et al. (2013), incorporate insulation, temperature control, and effective airflow mechanisms.

There are three primary methods of fish smoking: cold smoking, hot smoking, and smoke-drying. Smoke-drying, which combines cooking and drying, is best suited for long-term preservation and is widely practiced in sub-Saharan Africa (Doe, 1998). The choice of materials, heat source, and chamber design significantly influence drying efficiency and product quality.

METHODOLOGY

Design Considerations

The kiln was designed with a dual-compartment rectangular box measuring 915 mm × 610 mm × 1220 mm. The inner chamber is fabricated with mild steel and lagged with 25 mm fiber insulation to reduce heat loss. Four galvanized mesh trays are included to hold fish, and a separate combustion chamber holds the charcoal.

Material Selection

Mild steel was chosen for its durability, heat resistance, and ease of fabrication. The trays were made from galvanized wire mesh to support oil drainage and even smoke distribution. Castor wheels were added for portability.

Fabrication Process

The following equipment was used:

- Electric arc welding machine
- Cutting and bending machines
- Grinding and surface finishing tools

Key fabrication steps included measuring, cutting, welding, grinding, and painting. The construction ensured structural integrity and efficient operation of all components.

RESULTS AND DISCUSSION

Performance Evaluation

Three fish types were tested: catfish, codfish, and herring. Smoking times ranged from 1 to 2 hours, with final internal temperatures reaching above 70°C—ideal for proper drying.

Fish Type	Quantity	Smoking Time	Final Temp (°C)	Charcoal Used
Catfish	10 pcs	2 hours	92.78°C	230g
Codfish	12 pcs	1hr 25 mins	84.31°C	330g
Herring	10 pcs	1 hour	73.38°C	280g

Herring smoked fastest due to its lower fat and moisture content, while catfish required the most time and energy.

Efficiency

The enclosed, insulated design reduced heat loss and optimized fuel use. The kiln accommodated up to 100 medium-sized fish, making it suitable for commercial use in small-scale settings.

CONCLUSION

The constructed charcoal-powered smoking kiln proved to be effective, affordable, and practical for fish preservation in areas lacking electricity. Its dual-chamber design allows for efficient smoke circulation and temperature control, ensuring uniform drying.

The kiln addresses key preservation challenges and offers a sustainable solution to fish processors in rural and semi-urban communities.

RECOMMENDATIONS

1. **Policy Support:** Government agencies should support the dissemination of such technologies through training and subsidies.
2. **Community Training:** Awareness programs should educate fish processors on the use and maintenance of improved smoking kilns.
3. **Further Innovation:** Future improvements could include integrated temperature sensors and adjustable smoke vents.

REFERENCES

Akinola, A., Akin, A., & Bola, A. (2006). Fish preservation techniques in Nigeria. *Journal of Fisheries Technology*, 2(1), 99–103.

- Alakali, J. S., Faasema, J., & Utongo, N. (2013). Design and evaluation of improved fish kiln. *Journal of Food Processing and Preservation*, 37(5), 413–418.
- Al-Jufaili, M. S., & Opara, L. U. (2006). Post-harvest fisheries handling in Oman. *Journal of Fisheries International*, 1(2–4), 144–149.
- Blackwell, W. (2014). *Seafood Processing Technology, Quality and Safety*. Chichester: Institute of Food Science and Technology.
- Bolaji, B. O. (2005). Performance of a simple solar dryer. *Proceedings of Engineering Technology Conference*, Minna, Nigeria, 8–13.
- Davies, R. M., & Davies, O. A. (2009). Fish processing technologies in Bayelsa, Nigeria. *European Journal of Scientific Research*, 26(4), 539–548.
- Doe, P. E. (1998). *Fish Drying and Smoking: Production and Quality*. CRC Press.
- Gomes-Guillen, M. C., & Jorge, G. E. (2009). Alternative species for cold smoking. *International Journal of Food Science and Technology*, 44(8), 1525–1535.
- Maga, J. A. (2000). *Smoke in Food Processing*. Boca Raton, FL: CRC Press.