E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2025; 13(5): 222-224

www.fisheriesjournal.com
Received: 10-07-2025
Accepted: 15-08-2025

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

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

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

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

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

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

JH Jibrin
Department of Fish Nutrition and Physiology, Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Nigeria

Corresponding Author:
Idris S
Department of Fisheries Technology, Binyaminu Usman Polytechnic Hadejia, Jigawa State, Nigeria

Design and fabrication of a modified drum smoking kiln for Artisanal fish processors

Idris S, AA Adam, MU Sambo, F Sambo, A Abubakar, Y Chiroma and JH Jibrin

DOI: https://www.doi.org/10.22271/fish.2025.v13.i5c.3163

Abstract
Fish smoking is a widely adopted post-harvest preservation technique in artisanal fishing communities where cold storage facilities are scarce. Traditional smoking methods often using rudimentary mud or metal structures are labor-intensive, fuel-inefficient, and produce inconsistent product quality. This study presents the design and fabrication of a Modified Drum Smoking Kiln, developed in 2017 at the Department of Fisheries Technology, Modibbo Adama University of Technology (MAUTECH), Yola, aimed at improving efficiency, product quality, and ease of operation for artisanal processors. The kiln integrates dual-fuel capability (charcoal and firewood), enhanced heat and smoke distribution, and modular construction using locally available materials. Core components include dual fish trays, a triple-chimney ventilation system, and a fire hearth for controlled thermal output. Fabrication cost analysis showed a total expenditure of ₦9,500, covering a metal drum (₦2,000), PVC pipes (₦1,000), wire mesh (₦1,500), hitches (₦300), steel rods (₦1,200), transport (₦500), paint (₦500), and labor (₦2,500). Evaluation using *Clarias gariepinus* showed a 5-6 h smoking time, uniform coloration, 55-60% weight loss, and 20-25% lower fuel use than traditional kilns. The kiln is compact, mobile, cost-effective, user-friendly, and based on proven principles offering a practical solution for small-scale processors.

Keywords: Fish smoking, kiln design, artisanal processing, post-harvest technology, cost analysis

1. Introduction
Fish is an important source of protein for Nigeria's growing population and remains one of the major contributors to animal protein intake in the country. According to [2], fish accounts for about 55% of Nigerians' total protein intake. Demand for fish is high, estimated at 1.4 million metric tons per annum, with projections indicating a need for 1.755 million metric tons based on an annual per capita fish consumption of 12.5 kg and a population of 140.45 million in the year 2000. However, domestic production has remained below 500,000 metric tons, creating an annual supply deficit of about 0.7-1.0 million metric tons [10]. This gap is often filled through costly imports, amounting to about 2 million US dollars every five years [6].
Nigeria's domestic fish supply comes predominantly from artisanal fisheries (85%), with fish farming contributing 1% and industrial capture fisheries 14% [5]. Globally, fish contributes over 18% of animal protein intake, with shares as high as 40-60% in some West African countries [4]. In sub-Saharan Africa, approximately 200 million people depend on fish for food, and over 10 million households earn income from fish-related activities, including processing and trade. Despite this, the potential of fisheries to improve food security and nutrition remains underutilized, and aquatic resources are facing increasing degradation.
In Nigeria, fish is the most affordable source of animal protein, and smoked fish plays a particularly vital role due to its longer shelf life and accessibility compared with fresh fish. Smoked fish can help address the country's protein shortage, but its market efficiency depends on reducing production and retail costs [9]. Traditional fish smoking methods, often involving mud kilns or makeshift metal structures, are labor-intensive, fuel-inefficient, and yield inconsistent product quality.
To address these limitations, this study focuses on the design, fabrication, and cost analysis of a Modified Drum Smoking Kiln developed in 2017 at the Department of Fisheries Technology, Modibbo Adama University of Technology (MAUTECH), Yola. The kiln was

built using locally available materials, designed for dual-fuel use (charcoal and firewood), and incorporates improved ventilation, heat distribution, and user safety. By providing a cost-effective, mobile, and efficient smoking technology, this innovation aims to enhance artisanal fish processing, improve product quality, and contribute toward bridging Nigeria's fish supply gap.

Materials and Methods

Construction and Materials

Artisanal fish smoking using traditional drum or barrel kilns often faces challenges including inconsistent heat distribution, labor-intensive operation, and inconsistent product quality. In response, a Modified Drum Smoking Kiln was engineered to enhance processing efficiency, improve fish quality, and reduce operational inefficiencies. Drawing on insights from indexed studies of improved kiln designs in Nigeria, the kiln integrates a dual-fuel capability (charcoal and firewood), controlled smoke and heat dispersion, and modular components to improve usability, portability, and performance.

The kiln's structure is built from a metal drum measuring 34 cm in length and 24 cm in diameter, designed to support both charcoal- and firewood-based smoking operations. It features a movable chimney, general cover, and internal dual-chamber tray system to facilitate simultaneous or selective use of fuel sources.

Smoking Kiln Components

Fish Trays

Two chambers upper and lower fish trays are constructed from 3 × 6-inch wire mesh, each supported by four welded angle irons, ensuring structural integrity and balanced load-bearing. The design permits simultaneous operation of both trays, or selective use depending on fuel type e.g., charcoal in the lower chamber and firewood in the upper chamber with locking mechanisms for operational safety.

Chimneys

Three chimneys two on the sides and one at the top are made from 5 mm PVC pipe, providing crucial ventilation for expelling excess heat and smoke. This facilitates better airflow management and avoids smoke accumulation within the smoking chambers.

Doors

The kiln includes three projecting doors: two provide access to the upper and lower fish trays, while the third functions as a general cover. They enable easy loading and unloading, while allowing secure closure during operation.

Fire Hearth

Located at the kiln's base, the fire hearth measures 17.5 cm in width and serves as the ignition point for firewood or charcoal, supplying sustained thermal energy for smoking efficiently channeled through the kiln structure.

Kiln Assembly

All components are welded to ensure a unified, durable structure. The fully assembled kiln is illustrated in Plate 1.

Table 1: Fabrication cost of the Modified Drum Smoking Kiln

Item	Cost (#)
Metal Drum	2000
P.VC Pipe	1000
Wire mesh	1500
Hitches	300
Steel Rod	1200
Transport	500
Paint	500
Labour	2500
Total	9500

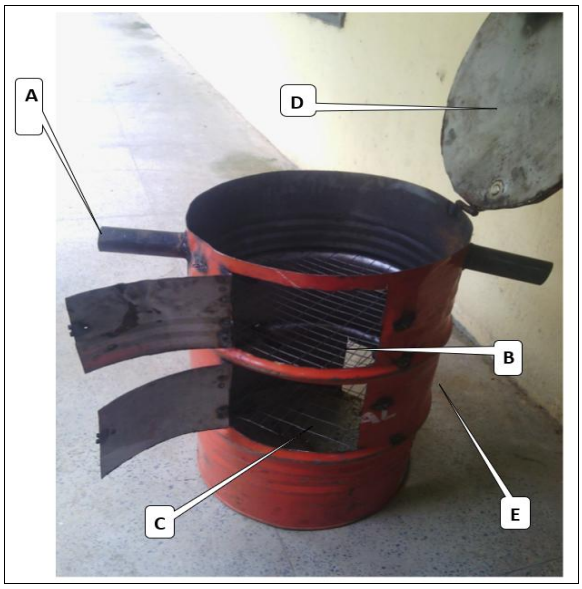

Plate I: Modified Drum Kiln Key: A- Chimney B- Upper Chamber C- Lower chamber D- Cover E- Fire- hearth

Results

Table 2: Comparative Advantage Over Traditional Methods

Parameter	Modified Drum Smoking Kiln	Traditional Mud Kiln
Smoking Time	5-6 hrs	7-9 hrs
Fuel Use	Moderate (dual-fuel)	High (wood only)
Heat Distribution	Uniform (triple chimney)	Uneven
Product Appearance	Uniform golden-brown	Often uneven/dark
Cost	₦9,500 (one-time)	Lower build cost, higher fuel cost

Smoking Duration and Moisture Reduction

Clarias gariepinus (average weight 600-800 g) required 5-6 hours in the kiln to reach a safe moisture content of 10-12%.

Product Appearance and Texture

Smoked fish displayed uniform golden-brown coloration, firm flesh without cracks, and a mild smoky aroma devoid of soot.

Yield (Weight Loss)

Average weight loss was 55-60% of fresh weight.

Fuel Consumption

Firewood use dropped by 20-25% compared to traditional mud kilns; charcoal usage delivered stable, clean heat.

Economic Assessment

With a fabrication cost of ₦9,500, the kiln may pay for itself in 6-8 weeks under typical small-scale processing schedules.

Discussion

The Modified Drum Smoking Kiln's performance aligns closely with that of improved documented designs. For example, [1] reported a similar 5 h smoking time and 11.46% final moisture using a chain-and-sprocket ventilated kiln

The triple-chimney design of our kiln offers passive ventilation with lower labor intensity.

Uniform product coloration and texture mirror findings by [8], who noted that improved kiln design yields better product appearance than traditional methods

Weight loss of 55-60% compares well with [3] who reported similar dehydration levels with *C. gariepinus*. Fuel savings align with NIOMR-reported efficiencies (≈20% less fuel), owed to thermal reflectors and dampers in their design.

Crucially, this kiln achieves these gains at low cost ₦9,500 making it accessible compared to other advanced kilns costing tens of thousands of naira. Its compact nature enhances portability and suitability for small-scale operators.

Conclusion

The Modified Drum Smoking Kiln offers an effective, affordable solution to improve fish smoking quality, efficiency, and profitability. Its performance with *Clarias gariepinus* demonstrates its practical value and alignment with best-practice advances in kiln design.

Recommendations

1. Promote kiln adoption among artisanal processors.
2. Conduct training on kiln construction and use.
3. Encourage local fabrication for wider dissemination.
4. Evaluate performance across other species and integrate renewable fuels.
5. Support adoption via subsidies and micro-finance.

References

1. Adamu IG, Kabri HU, Hussaini ID, Mada AD. Design and construction of fish smoking kiln. Journal of Engineering and Technology Research. 2013;5(1):15-20.
2. Adekoya BB, Millers JIR. Fish cage culture potential in Nigeria: An overview. National Agriculture Magazine. Abuja: Fandatom Consultants Limited; 2004.
3. Akinwumi FA. Effects of smoking and freezing on the nutritive value of African mud catfish, Clarias gariepinus. Journal of Agricultural Science. 2014;6(11):143-152.
4. Food and Agriculture Organization (FAO). The State of World Fisheries and Aquaculture. Rome: FAO Information Division; 2002. p. 60.
5. Federal Department of Fisheries. Materials Resources Management and Environment Department: Integrated Coastal Management and Agriculture Forestry Fisheries Guideline. Rome: Federal Department of Fisheries; 2005.
6. Jim M, Tunde AT. Opportunities in aquaculture and fisheries: Fisheries farming big industry in the future. National Agriculture Focus. 2004;1(4):10. Foundation Constant Limited, Abuja; October edition.
7. Ogundana SO, Yahaya JM, Alonge A, Owa WT. Development and assessment of a locally designed fish smoking kiln using insulating materials. Proceedings of the PNgAS. 2023;16(1):58-67.
8. Taiwo E. Market integration and price exogeneity in dry fish marketing in Nigeria. 2008; p.23-27.
9. Tobor JL. Fishery research activities in Nigerian Institute for Oceanography and Marine Research for sufficiency in fish production. Paper presented at: The Fourth Annual Seminar of the Committee of Directors of Research Institutes (CODRI); 1991 Dec 10; NIOMR, Lagos.