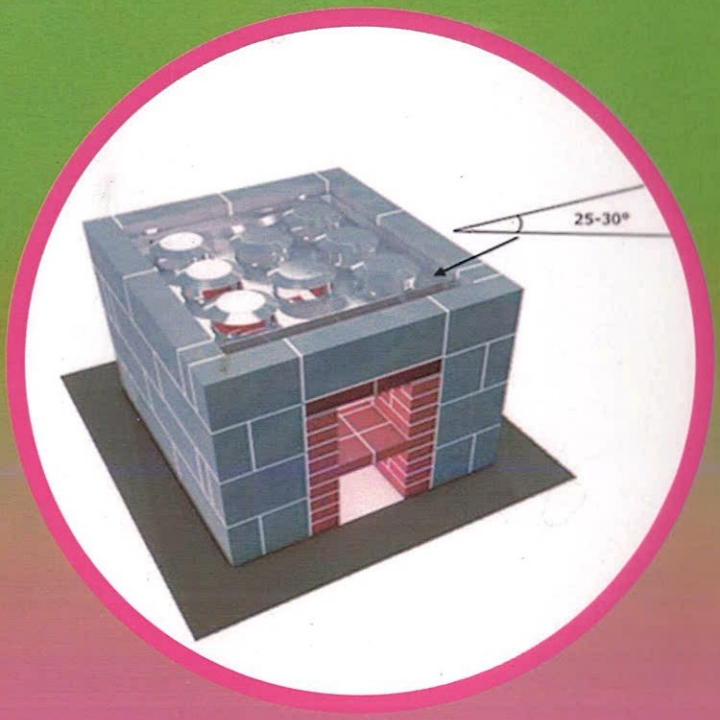
MODIFICATION OF AHOTOR AND CHORKOR SMOKING OVENS

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH – FOOD RESEARCH INSTITUTE



Healthy FoodAfrica

Luke
NATURAL RESOURCES INSTITUTE FINLAND

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Fisheries Commission (FC)

Ministry of Fisheries and Aquaculture Development (MoFAD)

National Fish Processors and Traders Association (NAFPTA)

Development Action Association (DAA)

Food and Drugs Authority (FDA)

Ghana Standards Authority (GSA)

Department of Marine and Fisheries Sciences, University of Ghana (UG)

Tema Metropolitan Assembly (TMA)

Feed the Future Ghana Fisheries Recovery Activity (GFRA)

CSIR – Food Research Institute (CSIR-FRI)

CSIR – Water Research Institute (CSIR-WRI)

Labour Productivity Centre

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Project Background

The Council for Scientific and Industrial Research (CSIR), in partnership with Finland's Natural Resources Institute, is implementing the HealthyFoodAfrica EU Horizon 2020 project in Ghana. The project focuses on promoting Africa's nutrition by enhancing the diversity, sustainability, resilience, and connectivity of fish food systems. The CSIR is represented jointly by the Water Research Institute (CSIR-WRI) and the Food Research Institute (CSIR-FRI). The overall goal of HealthyFoodAfrica (HFA) is to make food systems in ten (10) African cities in six (6) countries across three African macro-regions more sustainable, equitable, and resilient by reconnecting food production and food consumption in effective ways. For the project to have a long-term impact, it paid attention to extracting and disseminating lessons learned, training people, and finding the appropriate and effective governance arrangements, technologies, and business models.

It is expected that HFA will contribute to sustainable food production and consumption patterns in ten (10) African cities and achieve sustainable food and nutrition security globally. Overall project impact will contribute to a range of sustainability issues, including social, economic as well as environmental sustainability, and will contribute towards a number of the United Nations (UN) Sustainable Development Goals (SDGs), as well as the EU-Africa Partnership on Food and Nutrition Security and Sustainable Agriculture (FNSSA) and the EU FOOD 2030 strategy and national and local development goals.

HFA is organized into Work Packages (WPs) i.e. 1 to 9, with Work Package 6 (WP6) (under which this activity falls), focusing on developing novel food products, tools, and processes to support innovative agri-business models. CSIR-FRI is therefore collaborating with all relevant stakeholders to co-generate and share knowledge to explore and develop novel tools, processes, and nutritious food products.

The project is working in collaboration with the Fisheries Commission (FC), Ministry of Fisheries and Aquaculture Development (MoFAD), Ghana Standards Authority (GSA), Food and Drugs Authority (FDA), Feed the Future Ghana Fisheries Recovery Activity (GFRA), Fish Processing Associations, Academia, Metropolitan and Municipal Assemblies, and other relevant stakeholders to promote safe fish production in Ghana.

CSIR-FRI has refurbished its fish processing centre into a compliance facility to serve as a model for training fish processors in safe and hygienic fish handling and processing. The facility has been granted Safe Fish Compliance Certification allowing fish smoked from the facility to be considered safe for consumption and gain access to other African markets under the African Continental Free Trade Area (AfCFTA) agreement and has plans of obtaining certification for European markets as well. This facility will also aid in the transfer of knowledge and technology, as well as the development of value-added fish products.

As part of the activities, a fish smoking oven technology performance survey was conducted to investigate the shortcomings of the current technologies to inform improvement options for the existing technologies. This document details the improvements to the existing technologies based on end users' and stakeholders' feedback.

Findings from Improved Oven Survey

In July 2021, a team from CSIR-FRI conducted a survey into improved fish smoking technology adoption and performance across some fishing communities in Ghana. The survey was conducted in the following fishing communities: Nungua, Tema New Town, Anomabo, Elmina, Ankaful, Apam, Keta, Fantekope, Aflao, Denu, Agordeke, and Dzemeni.

The findings from the survey showed that, in general, all respondents who used the improved oven/stove (Ahotor) frequently were satisfied with its use of less fuelwood. This oven saves fuelwood. The improved oven produces less smoke, so smoked fish tastes good and gives the fish a golden-brown colour. Furthermore, the improved oven (Ahotor) users recorded fewer or no burns and accidents and less irritation of the eyes during operation and were willing to purchase more or recommend it to other fish processors. However, despite the advantages of the improved oven (Ahotor), respondents were unwilling to discard the Chorkor smoker. Half of those interviewed said they would use the old Chorkor smoker to supplement the improved one. Ninety-five per cent (95%) of respondents were of the view that the Chorkor smoker can smoke more capacity than the improved oven (Ahotor), and the other 5% said the Chorkor smoker is faster than the improved one in terms of speed.

According to the findings, 85% of respondents asserted that they would be happy and interested in owning an improved version of the current improved oven (Ahotor), particularly when the problem of heat distribution, speed, and capacity is solved. These findings underpin the need for technological improvements.

The survey was followed up with a stakeholder workshop to discuss the findings and seek opinions on the needed improvement. The stakeholders' discussion indicated that getting an improved Ahotor smoking oven was imperative and suggested that the HFA project assist in resolving the issues. In addition to lowering the amount of polycyclic aromatic hydrocarbons (PAHs), their key goals were to increase energy efficiency, capacity, and time efficiency. A charcoal briquette chamber and an integrated greener fuel alternative like a liquified petroleum gas (LPG) system were two notable additions suggested. To reduce PAH levels, they also suggested altering the Chorkor oven to include a fat collector. The original Ahotor Oven, developed by USAID funded SFMP, has been modified by the HFA Project, with technical support from Mr. Emmanuel Kwarteng to enhance its adoption.

Technology Improvements on Existing Technologies

Based on the survey findings, WP6 commissioned research and development work to improve the performance of existing oven technologies and address their shortcomings in an effort to optimize Ghana's production of healthy and safe fish. The Ahotor and Chorkor ovens were the two main fish smoking technologies, redesigned to increase energy efficiency, capacity, time efficiency, technological cost, ease of operation, emissions, and PAH levels.

The Ahotor Oven

The Ahotor oven is made up of a combustion chamber that is fitted centrally to a chorkor-like outer shell, with fish processing trays above, just like a traditional oven. Above the combustion chamber, a fat/oil collecting tray (Figure 2) is fitted that allows the hot gases to flow up through to the fish while preventing any fat from dropping down onto the fire. A primary air inlet supplies oxygen into the combustion chamber to enhance the efficient combustion of fuelwood.

The secondary air inlet located on top of the fuelwood entrance introduces cool air into the smoking chamber to meet with hot gases from the combustion chamber to enable even circulation of air and heat in the smoking chamber. The grate located in the combustion chamber improves combustion by reducing smoke emissions. For the purpose of this research, three different designs of Ahotor ovens were produced (A combination of Gas, Charcoal & Fuelwood; Charcoal only; and Fuelwood only). The walls of the ovens were tiled to improve hygiene (optional).

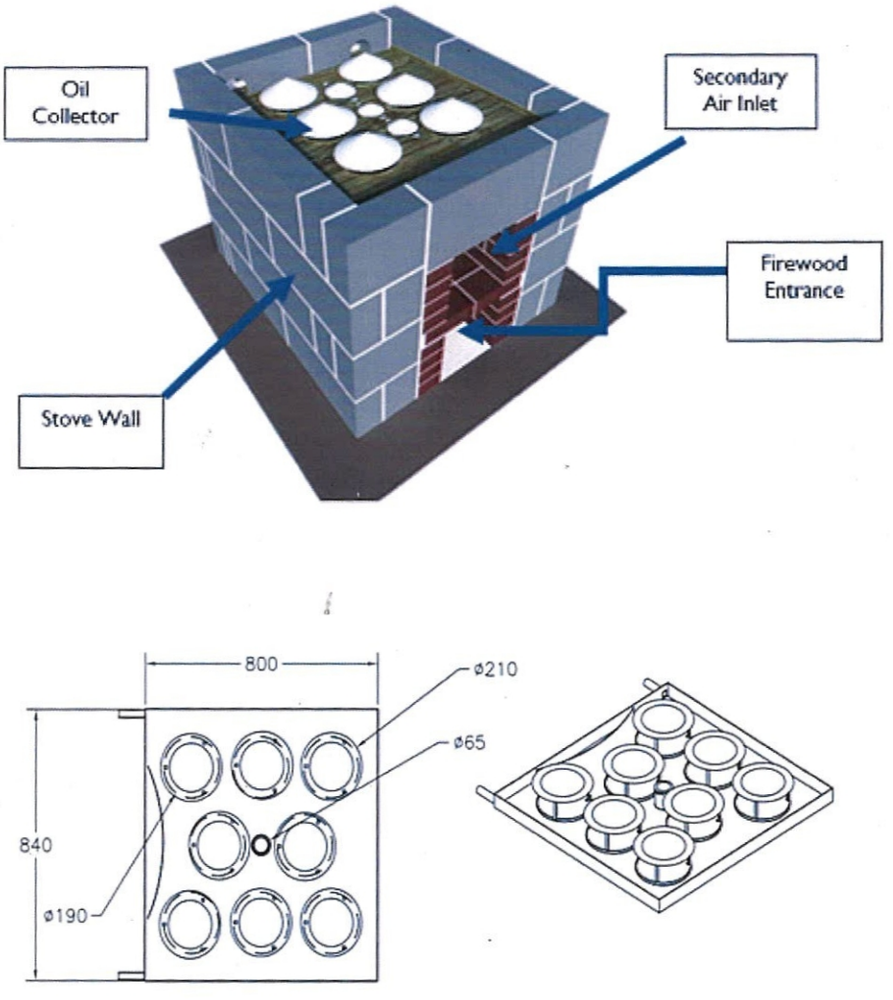


Figure 2: The Fat/oil collector design

The Ahotor Oven with increased Combustion Chamber Size

The Ahotor oven has been redesigned based on end users' feedback. The design is expected to address two major concerns from the survey – time efficiency and the capacity of production. The dimensions of the combustion chamber and combustion tube have been increased by a factor of 0.25% to accommodate more fuel and ensure increased transmission of heat for rapid cooking and increased capacity. The impact of these two performance parameters on emissions, energy efficiency, ease of operation, and PAH levels will be evaluated.

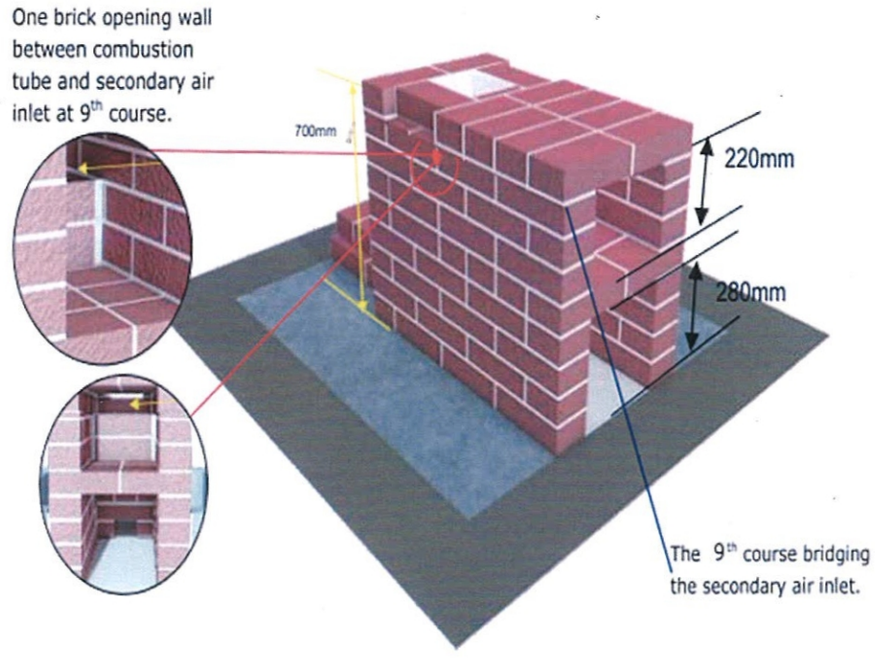


Figure 3A: Modified Ahotor oven with fat collector (3D Drawing)

Figure 3B: Modified Ahotor oven with fat collector at CSIR-FRI

The Gas, Charcoal & Fuelwood type Ahotor Oven

The improvement work focused on increasing the range of adoption by different end users. The combustion has been modified to include a chamber for charcoal briquettes as well as a built-in LPG system, allowing fish processors to use a variety of fuel alternatives. This is also expected to significantly reduce PAH levels as cleaner fuel options are provided. Depending on what the end user wants, a fuel mix option could be used to improve the taste and texture preference.

The Chorkor Oven

The Chorkor Oven was developed and introduced in 1969 by FAO and the CSIR-FRI. Although it was originally designed for use in Ghana, the Chorkor oven has since gained widespread adoption in most Western, Central, and Eastern African countries. The Chorkor oven became popular because of low construction costs, durability, large production capacity, and uniformity of smoked products due to ease of operation (Nerquaye-Tetteh, 1989). To date, the Chorkor oven is the most dominantly used fish smoking technology in Ghana.

Modification to the Chorkor Oven

Under this project, the Chorkor oven has been modified to improve PAH levels and hygiene. The oven has been redesigned with the introduction of a fat collecting system aimed at reducing fat drippings to the fire during smoking. The fat collector introduced is expected to channel all forms of drippings out of the oven and thereby reduce smoke production and emissions.

The design maintained the original dimensions and materials of the technology. The performance parameters of the new design will be tested against

PAH performance. A successful outcome of the test will significantly improve safe fish production in Ghana since over 80% of fish processors in Ghana process their fish using the Chorkor oven.

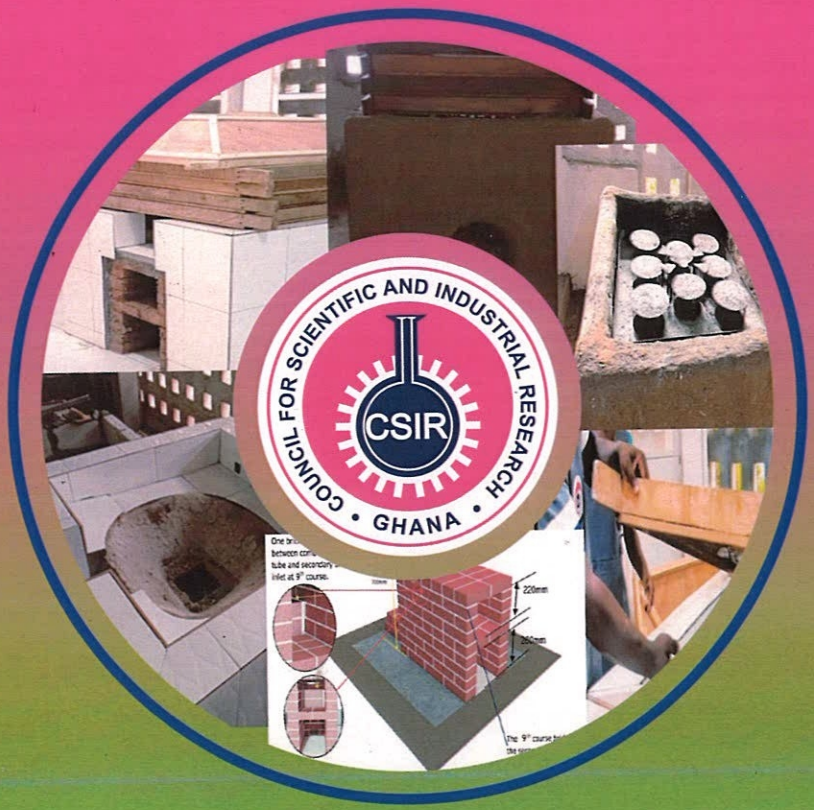
Figure 4: Modified chorkor oven with fat collector at CSIR-FRI

Capacity Building

Enhancing the capacity of fish processors, who are mainly women and artisans is crucial. It is essential to provide these people with the knowledge and skills required to adopt modern, safer, and environmentally friendly methods such as these modified smoking ovens to address the health and safety issues of traditional fish smoking. Initiatives that build capacity have the potential to improve the lives of those who depend on the fishing sector by empowering local communities, fostering economic growth, and contributing to the sector's overall development. These efforts can also improve the quality of the products produced.

Conclusion

Recent innovations in fish smoking technologies are mainly inspired by quality and safety requirements for fish. These technologies attempt to reduce all forms of microbiological and chemical contamination of fish. To ensure that smoked fish products are free of microbiological contamination, ovens are constructed using materials that can withstand repeated washing, such as stainless steel, galvanized plates, and, in certain circumstances, tiles. In the design, spaces with the potential to harbour microorganisms are also avoided. Adoption and use of these technologies are very crucial to the safety of fish production in the country. These designed technologies incorporate a blend of user expectations and safety concerns in fish processing.



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Healthy FoodAfrica

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