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FOOD (FISH) SAFETY & HYGIENE USING A HYBRID SMOKING KILN

BY

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Abstract

The world over, fish foodis widely consumed across all tribes and tongues due to its high rate of protein. However, lack of proper processing of this food makes it open to microbial contamination which is hazardous to human life. Its inadequate processing means that the distribution, retailing, storing and consumption of the fish will be contaminated. To this end, this paper tends to look as the ways fish is been processed and also introduces a Microcontroller-Based Hybrid Smoking Kiln (HSK) that is basically used for fish processing and preservation under a controlled temperature. The kiln operates at a temperature range 120^0C - 200^0C to guarantee and even smoking heat and an extended fish shelf-life. The operations of the kiln is to regulate the heat at the set threshold and a servo motor that opens when the heat reaches the upper temperature threshold of 200^0C to prevent burning of the fish and closes when the heat temperature drops to the lower threshold of 120^0C to ensure an even smoking rate. The use of HSK ensures a hygienic fish processing and preservation thus guaranteeing a premium quality food security for humans. This paper seeks to address the issue of fish being smoked in a hygienic way.

Keywords: **HSK, Food Security, Hygiene, Food Processing, Food Preservation.**

INTRODUCTION

Food safety and hygiene are two key factors that prevent foodborne diseases. Food safety is hinged on the hygiene of environment and equipment used during the food processing. The safety of food needs to be guaranteed from the moment the food is grown (through farming or rearing) to when it is consumed as stated in the definition of food safety given by WHO Food safety and nutrition coordinator.

Fish as one of the most common food in the world is the source of high-quality, low-cost protein to over 200 million Africans [1], [2]. With this popularity in fish consumption, great attention needs to be put into ensuring that it is safe for consumption. However, the biggest flaw of fish is that it spoils easily after capture dueto the high tropical temperature which accelerates the activities of bacteria, enzymes and chemical oxidation of fat in the fish [3]. Hence, if prompt action is not taken few hours after capture, the fish will become unsafe, thus resulting in the distribution, retailing, storing and consumption of contaminated fish, hence, a spread of foodborne illness may result. Aside from providing protein for many, fish farming and processing also provides employment to over 10 million fish farmers and entrepreneurs [2]. However, over decades, processing of fish had evolved from primitive ways of sun drying, open air charcoal smoking, salting etc. All this methods are non-hygienic and make fish susceptible to microbial infections. However, advancement in technology has allowed efficient and stress-free usage of kiln with different convenient means of powering them

In order to reduce infections and foodborne illness from fishes, this paper tends to focus on the development of a Microcontroller-Based Hybrid Smoking Kiln that is could be fired using gas or charcoal. This kiln guarantees hygienic fish process that is free of contamination. However, it is imperative that only fresh, properly prepared fish be used for smoking. Smoking will not mask or otherwise make a poor quality or spoiled fish acceptable [5].

RELATED WORKS

Several research works have gone into fabrication of smoking kilns in order to improve on fish processing

and preservation because poor handling of fish had been said to account for about 30% to 50% loss of fish before processing. In a design, the smoking cabin is made of wood with a metal drum beneath the chamber where burning wood is the source of heat and smoke. A metal cylinder connects the drum and the smoking chamber to allow the heat flow into the compartment. A metal plate is placed above the cylinder to diffuse the hot air and provide a more even circulation in the smoking chamber. The fish is smoked on removable wooden frames with metal mesh. The effectiveness of the cabin kiln may be impacted by weather conditions, permit efficient use of the burned wood [4].

[5] Developed a motorized fish smoking kiln with locally available materials. The smoking process is based on natural convection of heated air with temperature ranging between 60^0C and 110^0C. The average volumetric capacity of the smoking chamber is 120kg. The smoking kiln was evaluated. The result showed that moisture content was reduced from 80% to 30% with an average smoking time of 60mins.

DESIGN OVERVIEW.

The smoking kiln designs had its hardware constructed using locally available materials and for the control of the smoking process an ATMEGA328 microcontroller was used. Fig. 1 shows block diagram of the design process used in designing and constructing the Hybrid Smoking.

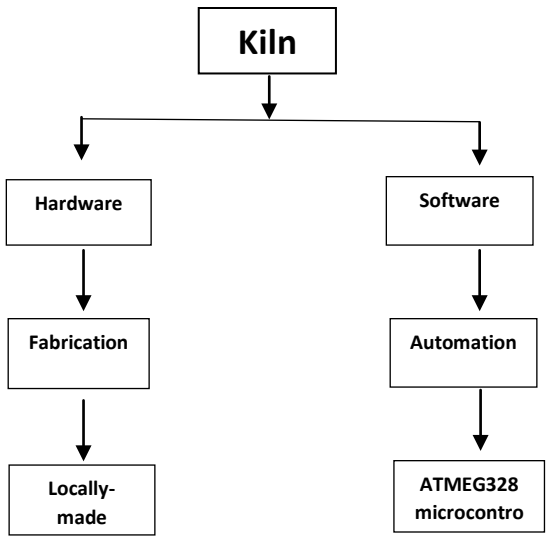


Fig. 1: Design Overview of Hybrid Smoking Kiln

1. Description of the Smoking Kiln

The smoking kiln shown in fig. 2a, was designed and constructed using AUTOCAD Software and locally available materials. The kiln is rectangular shaped with dimensions 0.5m x 0.8m x 1m. Mild steel plates were used to prevent heat conduction between the layers. To give strength to the kiln base, angle iron was used while the front door of the kiln was fabricated with temper glass for heat conservation and visibility of the smoked fish. For the fish tray as shown in fig. 2b, galvanized iron rod of about 0.2mm thickness was used to fabricate the mesh like tray. Four (4) trays were made for the four (4) layers within the kiln for fish smoking. The fish tray beneath is of collection of oil that drops during the fish smoking. This tray was made using the mild steel iron. For adequate heat circulation, a DC fan made from galvanized iron sheet was placed within the kiln (see fig.2b). A charcoal pot of 0.45m x 0.025m x 0.03m as shown in fig. 3, was fabricated using mild steel iron and angle iron. The charcoal pot is designed to contain 30g of charcoal. For gas firing of the kiln, a gas pipe was made using the mild steel iron sheet and gas vent created inside the kiln.

Fig. 2a: Hybrid Smoking Kiln

Fig. 2b: Showing the inner structure of the Kiln

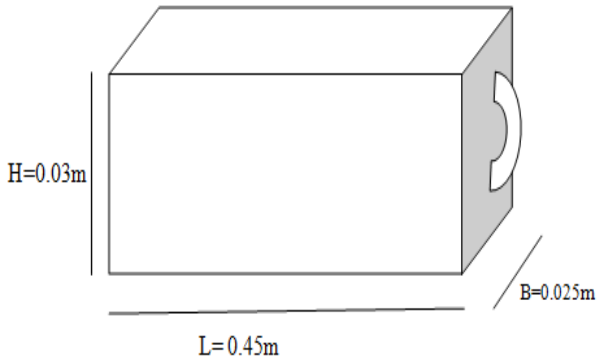


Fig. 3: Dimensions of the Charcoal Pot

2. The Automation System Design.

In designing the automation system of the smoking kiln, an Arduino Uno R3 Board, which contains an ATMEGA328 microcontroller chip was used. As shown in fig.6, the microcontroller and the DC fan were powered by a 12v, 7amps rechargeable DC battery. Connecting to the Arduino is the temperature sensor that senses the initial temperature of the kiln at startup, in order to compare it with the set temperature threshold to determine the action to be taken by the controller. Also a 4x3 matrix keypad is connected to the controller board in order to set the temperature threshold of the kiln before smoking commences. This temperature set is required for proper operation of the servo. Connecting out of the Arduino Controller board is the servo motor that opens and closes once the upper and lower temperature thresholds are reached. Also, the buzzer connects out of the controller. Its function is to alert the user that the upper temperature range had been reach and also to trigger the opening of the servo. The buzzer continues to give its sound until the temperature returns below the lower set temperature range and with then triggers the closure of the servo for smoking to continue. Lastly, the LCD connects out of the Arduino controller and it displays the temperature readings of the kiln at startup and as the temperature changes during operation. Fig. 4 shows the circuit diagram of the automation system while fig. 5, shows the positioning of the automation system at the back of the smoking kiln.

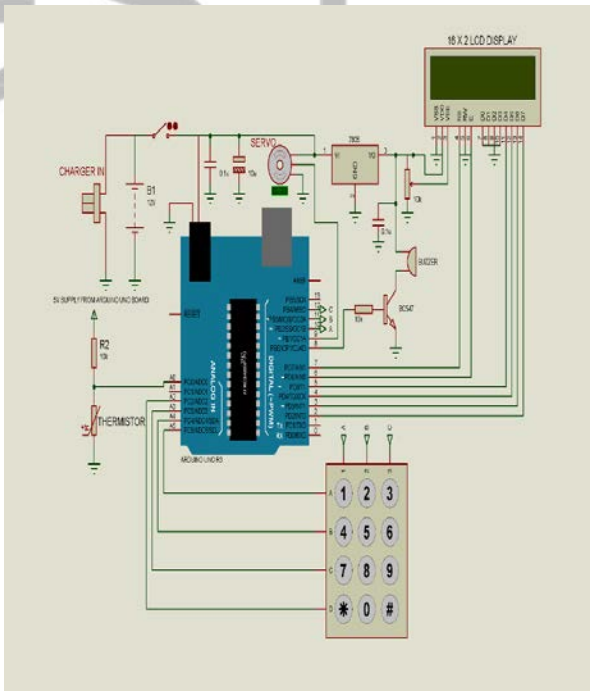


Fig. 4: Circuit diagram of theATMEG328Microcontroller

Fig. 5: Diagram using the position of the Microcontroller-Based Automation Unit.

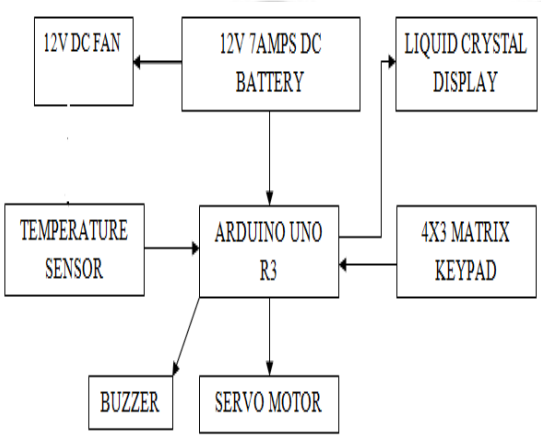
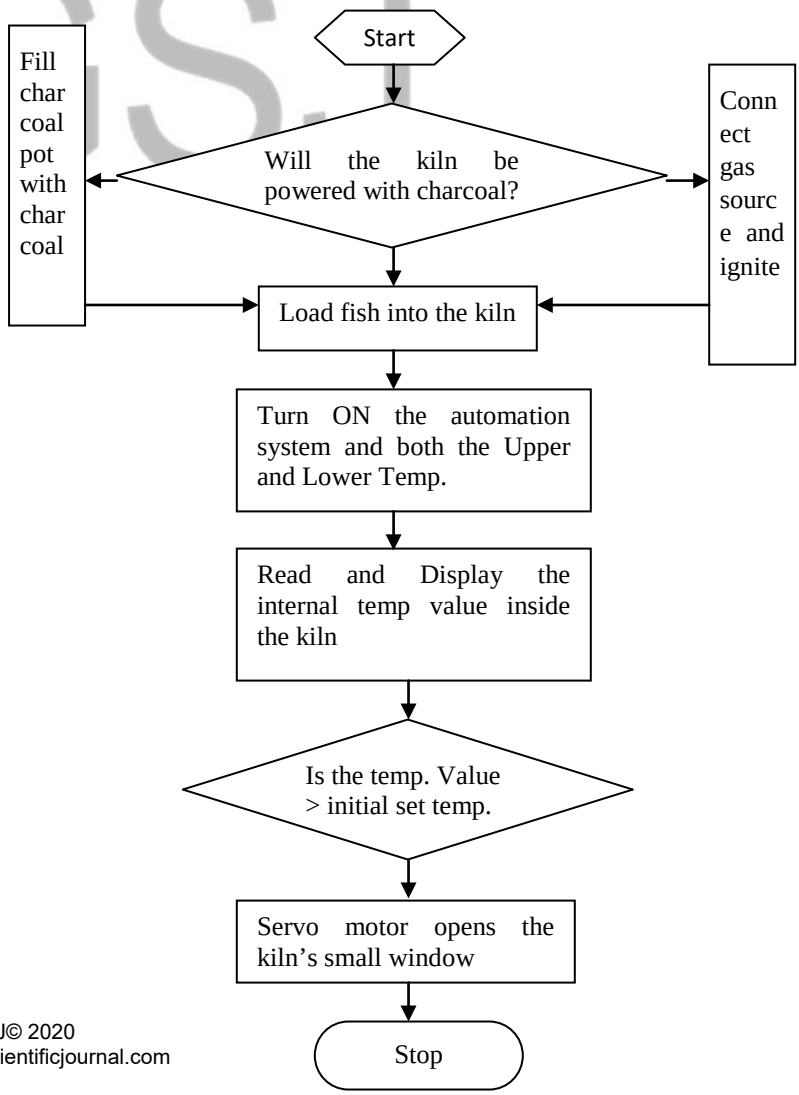


Fig. 6: Block diagram of the Automation System

3. Working Operation of The Hybrid Smoking Kiln

Basically, the working operation deals with how the kiln temperature is automatically controlled. Fig. 7 shows the flowchart representation of how the smoking kiln. At start, the user decides on whether to use charcoal or gas (since it its hybrid Kiln) to fire the kiln. Based on the selected firing method, the kiln is fired and fish is loaded into the kiln. Once the kiln is loaded, the automation system is turned on, this is followed by system initialization. After the system startup, the user set the upper and lower temperature threshold for the smoking process using the 4x3 matrix keypad. Then the system reads the current internal temperature and displays its value on the LCD. The mi9crocontroller then compares the displayed value with the set temperature range. If the value is greater than the upper set temperature range, the buzzer comes on and triggers the servo motor to open the vent for the internal heat to be released. The vent remains open until the internal temperature drops below the lower set temperature value. Once the temperature falls below the lower value, the buzzer stops and triggers the servo motor to close the vent. This process continues until the fish is properly smoked to the level desired by the user. The user is at liberty to reset the temperature threshold any time within the smoking operation.



RESULT AND DISCUSSION

The result of the performance test carried out on the smoking kiln at loading condition using "Catfish" as the specimen and fired using both charcoal and gas at different time of a during of four (4) hours apiece is as shown below.

1. Performance test using Charcoal and two (2) Catfish.

Two (2) catfish weighing 0.8kg and 0.7kg respectively were used with charcoal as the source of fire. These fishes were smoked for a 4 hours duration and the weight loss after each hour was taken. Table 1 shows the initial weight of the fish before smoking and the weight loss on hourly bases.

S/N	Initial weight(Kg)	Weight after one hour (Kg)	Weight loss (Kg)	Weight after two hours (Kg)	Weight loss (Kg)	Weight after three hours (kg)	Weight loss (Kg)	Weight after four hours (Kg)	Weight loss(Kg)
1	0.8	0.73	0.07	0.68	0.05	0.62	0.06	0.58	0.04
2	0.7	0.64	0.06	0.57	0.07	0.53	0.04	0.5	0.03

Table 1: Performance test using Charcoal

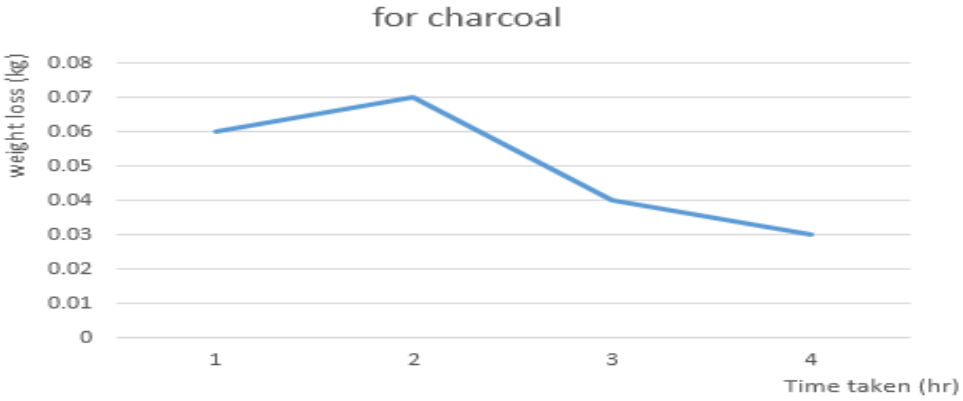


Fig 8: Graph Showing the Weight Loss of Fish 2 using Charcoal

2. Performance test using Gas and Four (4) Catfish.

Performance test using Charcoal and four (4) Catfish.

Four (4) catfish weighing 1kg, 1kg, 0.8kg and 1kg respectively were used with gas as the source of fire. These fishes were smoked for a 4 hours duration and the weight loss after each hour was taken. Table 1 shows the initial weight of the fish before smoking and the weight loss on hourly bases.

Table 2: Performance test using Gas

S/N	Initial eight (Kg)	Weight after an Hour (Kg)	Weight loss (Kg)	Weight after two (2) Hour (Kg)	Weight loss (Kg)	Weight after three (3) Hour (Kg)	Weight loss (Kg)	Weight after four (4) Hour (Kg)	Weight loss (Kg)
1	1	0.7	0.3	0.5	0.2	0.4	0.1	0.2	0.1
2	1	0.7	0.3	0.45	0.25	0.38	0.07	0.3	0.1
3	0.8	0.6	0.2	0.4	0.2	0.3	0.1	0.15	0.15
4	1	0.75	0.25	0.5	0.2	0.41	0.09	0.3	0.11

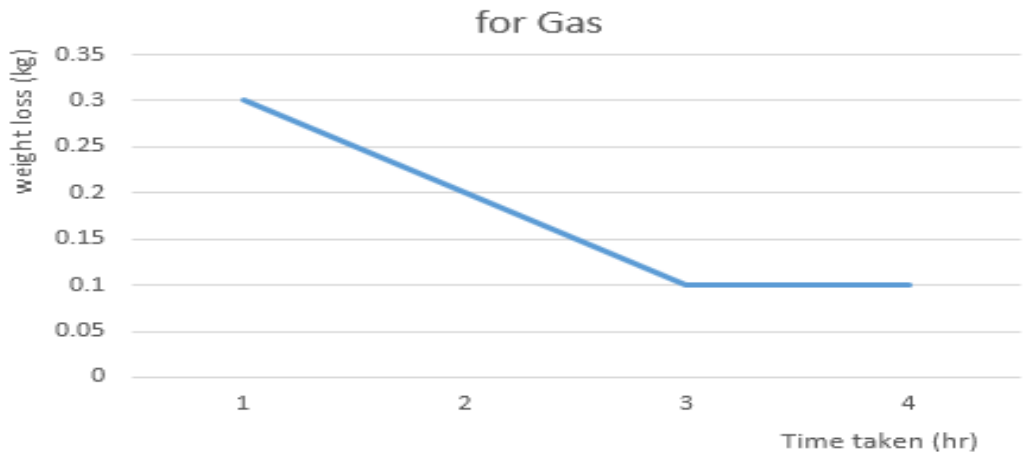


Fig 9: Graph Showing the Weight Loss of Fish 2 using Charcoal

From the graphs shown, fig 8. Shows an initial raise in the weight loss after the secon hour of smoking with charcoal, it is as a result in the inconsistence of the heat generated by charcoal. However, after the charcoal fire had become intense and the heat had circulated uniformly, the weight loss begins to show a regular decline with a weight loss of 0.4 and 0.3kg respectively. However, for the gas fire, as shown in fig. 9, the weight loss shows a consistent decline in weight loss from 0.3kg to a constant value of 0.1kg. For both source of fire, there shows a region where the is no weight loss regardless of the time of smoking. This point is taken as the equilibrum point where the fish moisture content is equal to the amount of heat applied to it. At this point the fish will just be preserved by keeping it warm.

CONCLUSION

I conclusion, review of literatures had shown that the primitive ways of smoking through sun drying, salting and open air smoking makes the fishes open to germs and contamination thereby giving rise to foodborne illness from fish. However, the use of kilns have provided an hygienic way of smoking fishes without making them prone to microbial infections.

In the same vien, the use of this Hybrid Smoking Kiln provides means of smoking fish using either charcoal or gas. The use of gas however gives a more intense smoking than charcoal. When the fishes smoked with the two fire source where shelfed after smoking it was discovered that the gas smoked fish had a week longer shelf life than the charcoal smoked fish that lasted about six (6) days before the fish begins to show signs of contamination.

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