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Effects of Daily Drying Time on Drying Rates efficiency of African Catfish (*Clarias gariepinus*) under UI-CORAF Smoking Kiln

Abiodun-Solanke, A. O.*[1], Akinwole, A. O.[2] and Ayano, A. E.[3]
[1]Fisheries Technology Department, Federal College of Fisheries and Marine Technology, Victoria Island, Lagos
[2]Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan
[3]Central Research and Teaching Laboratory, Bells University of Technology, Ota, Nigeria

*Corresponding Author E-mail:
tomi.solanke@fcfmt.edu.ng

Abstract

University of Ibadan CORAF smoking kiln (an improved detachable kiln fabricated by the Department of Aquaculture and Fisheries Management of University of Ibadan) was used for smoking of African catfish (*Clarias gariepinus*) as well as to assess the drying rate of the fish at different timings of the day (Morning, Afternoon and Evening) during process. A 215.5g sized catfish was used as a sample and this was dried to 60.7g. This sample with an initial moisture content of approximately 75% (wet basis) was dried to a final moisture content of 7% within 16 hrs. The mean drying rate of the fish were 2.57g/hr, 0.96g/hr and 0.37g/hr in the morning, afternoon and evening respectively. There were significant differences ($p<0.05$) in the drying rates values of the fish samples smoked at different timing of the day. Conclusively, UI CORAF kiln is very efficient in smoke drying catfish.

Keywords:
Drying rate, Clarias gariepinus, UI -CORAF kiln daily drying time

Introduction

Fish smoking is an age long practice across the world as one of the methods of fish processing and preservation. Smoke drying involves the removal of water from fish. Since water is essential for the activity of all living organisms, its removal will slow down, or stop microbiological or autolytic activity and can thus be used as a method of preservation. In recent times, smoking kilns and artificial dryers are used to obtain product of high quality.

Traditional fish smoking as practiced in Nigeria not only consumes lots of fuel wood, but it is also bedeviled by lack of control over the drying process, exposure to dirt, dust, insect infestation, contaminants and low capacity. Consequently, fish-dried using traditional methods are unstable with poor quality and very short shelf life (Davies and Davies, 2009; Kolawole *et al.,* 2010). The trade in traditional fish products such as smoked fish, from West Africa to Europe has come under increasing scrutiny from authorities both in the exporting and importing countries due to the supply of poor quality products (provide references). International trade legislation designed for relatively sophisticated industrial level processing is being applied to what is essentially a traditional process. As a result, processors and exporters fail to meet the required standards set by authorities in the country of export. Formal trade is therefore being constrained in what is, at retail level in importing countries, a high value product. Many kilns meant to be fuel efficient and produce better quality fish have been developed. Their major setback is poor adoption rate by traditional fish processors due to their high cost, complexity

of construction and consumption of fuel wood (Bala and Mondol, 2001; Akinola *et al*., 2006; Olayemi *et al*., 2012).Traditional smoking technologies as practiced conventionally has so many demerits such as high dependence on human resources, burning chars, very low quality products among others. Improved modern methods were introduced to fill in these gaps but still limiting in some characteristics hence the introduction of UI CORAF smoking kiln.

Hitherto, there has been no standard methodology for smoke drying of fish, there have been conflicting reports on the exact drying time for fish especially aquaculture products such as catfish. There is no adequate information on drying rates especially at different timings of the day. One of the main thrust of this research is to develop our indigenous and aquaculture initiatives to drive major growth, improvement and more productivity in this area of the economy.

As part of the mandate of the Department of Aquaculture and Fisheries Management of the University of Ibadan to reduce postharvest losses in food grown and consumed in the country and West Africa by CORAF/WECARD, including fish, the institution developed UI CORAF model of smoking kilns. The developed kilns have assisted considerably in the reduction of limitation in efficiency and rigorous monitoring to provide quality dried fish (Anyakora and Coker, 2007).

This paper therefore, evaluated the performance of UI CORAF kiln with respect to the drying rate and smoking at different times of the day (morning, afternoon and evening).

Materials and Methods

The Description of the Kiln

The UI CORAF kiln is a structure having a dimension of 122 x 61 x 99.7cm (L x W x H) completely insulated all round with lagging material with thickness of 1 inch to conserve heat within the drying chamber as well as preventing the operator from being exposed to serious heat. The kiln consists of the drying chamber, combustion chamber/stoker, thermometer hold and the vent. The drying chamber has six sets of tray on racks. The holding capacity of the kiln is 80 kg of fresh fish. The kiln is detachable and mounted on a stand for ease of transportation and movement. UI CORAF smoking kiln can be dismantled into parts and has a thermometer holder with an inbuilt thermometer to monitor the drying temperature as well as an oil collecting tray to prevent contact with the charcoal, the energy source. The kiln has a combustion chamber that houses the charcoal box and a direct current (DC) fan that is operated by electricity.

Materials and Methods

A total of 40 kg of African catfish, *Clarias gariepinus* were used for each batch of smoking. The weight range of the fish smoked was 200 to 250g for catfish and uniformity of fish size were ensured in selection of fish for smoking . The fish was prepared by gutting, cleaning in fresh clean water and soaked (10 minutes) in 10% saline solution. They were weighed and initial weight recorded. The fish was smoked in one piece (whole) in horse shoe shape.

The Smoke-drying Procedure

The charcoal compartment/stoker was loaded with a known weight of charcoal (5kg), properly fired and placed inside the fish smoking kiln to attain smoking temperature (120 -140^{o}C). The fish was then arranged on the trays within the smoke-drying chamber. The fish was cooked and smoke dried until dryness is achieved after a constant weight is noticed while weighing the fish at known intervals. Known

mass of charcoal (2kg) was added continuously at an interval of one hour during the smoking process and the temperature of the drying chamber was continuously monitored using the thermometer (as shown in Figure 1) installed in the thermometer holder. The smoking/drying was stopped when the fish is properly dried to a constant weight after which the heating chamber (charcoal pot) was removed.

The ambient and surrounding condition of the processing room was recorded at every 30 minutes interval all through the experiment using a digital envira station (B-1132 Envira Station Wireless Weather Station Model DWS-220 #EnviraStation) shown in Figure 1 below. This result was confirmed at the Geographic Information System Department of the University. The weighing scale used for this experiment is the Ultra Ship, Model Ultra – 75 with maximum capacity 75lbs/34kg with minimum capacity of 2 lbs shown in Figure 2.

Statistical Analysis

The data obtained from the experiment i.e the readings from the thermometer, weighing scale and the vira station were subjected to descriptive analysis and ANOVA using SPSS version 16 at 95% confidence level (P=0.05).

Calculation

The rate of moisture removal (drying rate) was calculated from the data recorded during drying. The drying rate was calculated according to Ichsani and Dyah- (2002) as Equation 1.

$$\mathbf{R = (dM/dt) = m_i - m_f / t} \quad \text{.....(eq.1).}$$

Where; R is the drying rate in g/hr, dM is the change in mass (g), dt is the change in time (hr) and t is the total time (hr), m_i and m_f are the initial and final mass of fish samples respectively in gram.

Results

Figure 1 shows the Temperature profile of the UI CORAF smoking kiln at different timing of the day (Morning, Afternoon and Evening). The drying temperature in the smoking kiln rose from ambient (37°C) to 72°C, 100°C and 140°C after two hours. The highest temperature obtained in the kiln during the smoke-drying process was 145°C.

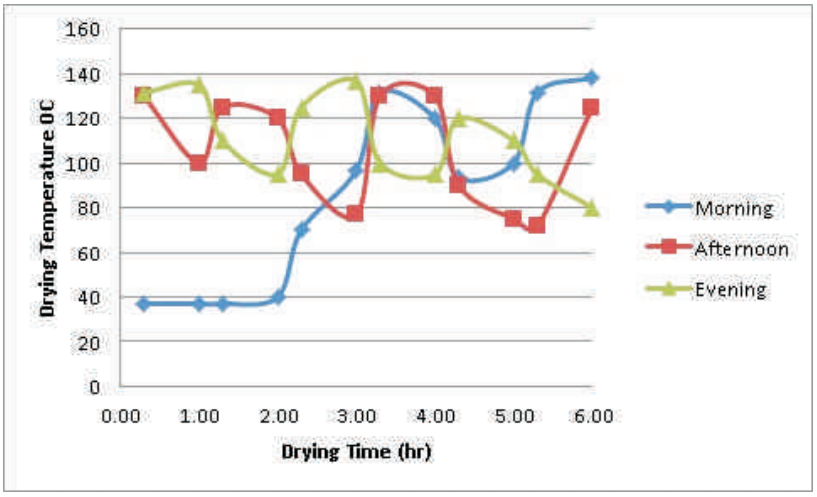

Figure 1: Temperature profile of UI CORAF kiln at three timings of the day

Figure 2 shows the drying rate curve of the fish sample dried in the kiln during different timing in a typical day. There was an initial constant rate drying during which the highest drying rate values were 3.62g/hr, 1.81g/hr and 1.19g/hr in the morning, afternoon and evening respectively. The drying rate reduced considerably during the drying process till the fish became dry.

The smoking process started at 8.00am in the morning and it dried continuously till 11.30 pm in the evening. Constant weight was achieved at 11.30 pm in the evening as shown in Table 1. The total drying time for smoke drying catfish of an average weight of 200-250g is 15 hours and 30 minutes during wet season using the UI CORAF smoking kiln.

Table 1: The time, temperature and drying rate of catfish smoking by University of Ibadan CORAF kiln

Time (hr)	Ambient Temp (oC)		R. Humidity (%)		Charcoal wt (kg)	Ave. Temp (oC)	Temp. in tray 3 (oC)			D. Rate (g/hr)
	In	Out	In	Out						
8.00	26.9	28.1	78	72	5	40	40	40	40	
8.30	27.0	28.3	76	73		72	72	72	72	
9.00	27.0	29.2	76	74		100	95	95	100	3.62
9.30	27.2	29.3	74	74		140	130	135	130	
10.00	27.9	29.5	73	75	2	130	120	120	120	2.06
10.30	28.5	30.5	65	62		100	95	95	90	
11.00	30.1	30.9	59	55		100	100	100	100	2.02
11.30	30.7	31.7	55	50		140	130	135	130	
12.00	31.0	31.8	45	43	2	145	135	140	140	1.81
12.30	31.3	32.0	45	40		140	130	130	130	
13.00	31.3	32.0	45	40		100	100	100	100	0.83
13.30	31.8	32.1	51	45		130	125	125	125	
14.00	31.8	32.2	52	46	2	130	120	120	120	0.93
14.30	31.7	32.1	53	46		100	95	95	95	
15.00	31.7	32.2	53	47		80	75	75	75	1.19
15.30	31.7	32.3	54	50		135	130	130	130	
16.00	31.6	32.1	55	50	2	140	130	130	130	0.57
16.30	31.5	32.1	55	50		100	90	90	90	
17.00	31.3	31.9	59	54		75	75	75	75	0.41
17.30	31.2	31.9	60	56		75	70	70	70	
18.00	31.2	31.8	61	58	2	130	125	125	125	0.20
18.30	29.7	31.1	63	60		140	130	130	130	
19.00	29.5	31.0	62	60		140	135	135	135	0.16
19.30	29.4	30.9	62	60		120	110	110	110	
20.00	29.3	30.0	64	60	2	100	95	95	95	0.41
20.30	29.0	30.0	64	59		130	125	125	125	
21.00	28.0	30.0	66	60		140	135	135	135	1.19
21.30	28.0	30.0	68	62		100	100	100	100	
22.00	28.0	29.8	70	64	2	100	95	95	95	0.41
22.30	27.9	29.6	72	66		130	120	120	120	
23.00	27.7	29.5	73	66		120	110	110	110	0.19
23.30	27.6	28.3	74	67		100	95	95	95	
24.00	27.0	28.0	74	70						

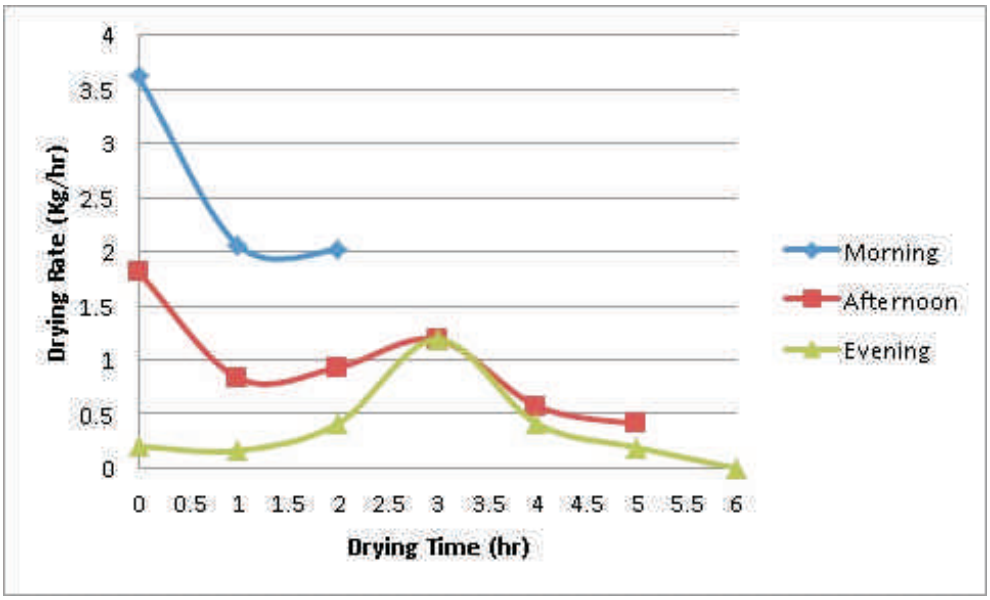

Figure 2: The drying rate curve against the drying time

Discussion

The temperature profiles of the kiln indicated that the kiln was able to attain the required temperature for fish smoke drying since the temperature attained was well above the ambient temperature which allowed for evaporation of moisture from the fish. Generally, the drying temperature increases as the drying approaches the desired moisture content due to the reduction in the moisture content of the fish samples. This confirms the results of previous studies by Olayemi *et al*. (2013) who pointed out that as the moisture content of the fish decreases, the drying temperature increases because the drying air no longer carries much moisture. The drying curve (Figs 1 and 2) shows that drying of fish like any other agricultural material occurs in the constant rate and falling rate period. The drying phase started off with a constant rate and progresses into the falling rate period as more moisture is removed from the fish samples. This shows that moisture is the driving force for the falling rate period as also reported by Omodara and Olaniyan (2012).

There is no significant difference nor any relationship between the temperature attained in the smoking kiln during smoking and the ambient conditions as noticed when the data was analysed. From this, it can be inferred that the heat generated within the kiln is strictly determined by the charcoal or energy source loading into the smoking chamber of the kiln.

There are significant differences in the drying rate of the fish smoked at different timings of the day. This shows that as the curve depicting the morning session is steeper than those of the smoking process during the afternoon and evening sessions. This has been explained above.

It can be concluded that UI CORAF smoking kiln is very effective and efficient in smoke drying fish especially fatty fish like catfish as the whole process took an average of 15 hours and 30 minutes during the wet season. In comparison with some other kilns used in the same processing room that takes nothing less than 32 hours, UI CORAF kiln is much faster and more efficient. This drying time can be significantly reduced during the dry season of the year when there is very low relative humidity with the air very dry.

References

Abba, A. 2007. "The potentials of aquaculture sector in Nigeria". Seminar paper presented at workshop on Fish Farming Organized by Federal Department of Fisheries (FDF) and Fisheries Society of Nigeria (FISON) in Ilorin.

Akinola, O. A., Akinyemi, A. A. and Bolaji B. O. 2006. Evaluation of traditional and solar fish drying systems towards enhancing fish storage and preservation in Nigeria J. Fish. Int., Pakistan 3(4):44 - 49.

Ames, G., Clucas, I., and Paul, S. S. 1999. Post-harvest losses of fish in the Tropics. Natural Resources Institute. Overseas Development Administration. pp 11.

Anyakora, C. and Coker, H. 2007. Assessment of polynuclear aromatic hydrocarbon content in four species of fish in the Niger Delta by gas chromatography/mass spectrometry. *African Journal of Biotechnology,* 6 (6):737-743.

Bala, B. K. and Mondol, M. R. A. 2001. Experimental investigation of solar drying of fish using solar panel dryer. Drying Technology. 19: 427 – 436.

Davies, R. M. and Davies, O. A. 2009. Traditional and improved fish processing technologies in Bayelsa State, Nigeria. *European Journal of Scientific Research.* Vol.26 No.4, pp.539-548.

Ichsani, D and Dyah, W. A. 2002. Design and experimental testing of a solar dryer combined with kerosene stoves to dry fish. *American Society of Agricultural and Biological Engineers* (ASABE), 1 -3.

Jallow, A.M. 1995. Contribution of improved chokor oven to artisanal fish smoking in The Gambia: In Workshop on Seeking Improvements in Fish Technology in West Africa. IDAF Technical Report. No: 66.

Kolawole, O. D., Williams, S. B. and Awujola, A. F. 2010. Indigenous fish processing and preservation Practices among Women in South-western Nigeria. *Indian Journal of Traditional Knowledge.* 9(4):668-672.

Olayemi, F. F., Raji, A. O, Oyelese, O. A, Oyewole S. N., and Omodara M. A. 2013. Effective smoking kiln for developing country. *International Journal of Scientific and Engineering Research,* 4(1):847-853.

Omodara, M. A., Olaniyan, A. M. and Afolayan, S. S. 2012. Effects of drying temperatures on the drying rate and quality of African Catfish. *African Journal of Agricultural Research and Development*, 5(2):52-60.

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