Nutritional and socio-economic analyses of processed catfish (*Clarias gariepinus*) using three kilns in Lagos State, Nigeria

Ogunbambo, M.M.[1]*, Akapo K.M.[1] and Chetuya O.G.[1]
[1]Fisheries Research Unit, Department of Marine Sciences, University of Lagos, Akoka, Nigeria
*Corresponding author: mmogunbambo@gmail.com, mogunbambo@unilag.edu.ng

Abstract

Smoke-drying is a major way of processing catfish and this prompted the study of nutritional and socio-economic assessment of smoke-dried catfish in Makoko fish market in Lagos State, Nigeria. Standard methods were utilised for the analyses of proximate content and the administration of 25 structured questionnaires to the catfish processors in the Fish Market. The fish smoked-dried in Traditional Drum Kiln (TDK) had the highest protein content (61.42±1.86g/100g), highest ash content (10.73±1.80g/100g) but lowest fat (3.19±0.91g/100g) and fibre content (1.84±0.36g/100g). However, the highest contents of fat (12.81±1.72g/100g), fibre (4.50±1.13g/100g) and moisture (37.58±7.10g/100g) were obtained in fish smoked-dried with Oil Drum Kiln (ODK). Fifty percent (50%) of processors who smoke-dried catfish in Makoko fish market used TDK, 30% used ODK while 20% of the processors used Lagos State Kiln (LSK). Weekly fixed cost of smoke-drying was found to be lowest using TDK at ₦500 while the highest weekly costs was found with LSK at ₦1,250. The variable costs were the same regardless of the type of kiln to be used in the smoke-drying process. The weekly profit was estimated at ₦49,750, ₦50,450 and ₦50,500 for LSK, ODK and TDK, respectively. The study showed that smoke-drying business is profitable and TDK yields more profit with good quality smoke-dried catfish.

Keywords: Smoking kilns, catfish, nutritional values, fish market, Lagos.

Received: 24 April, 2022 **Revised:** 7 July, 2022 **Accepted:** 19 August, 2022

Introduction

Low income has necessitated fish to be an affordable animal protein source in many homes in developing countries (Ikutegbe and Sikoki 2014). Fish is also highly sought after due to its relative low fat and source of other nutrients necessary for proper growth of children and maintenance of body cells (Wake and Geleto 2019). Nigeria depends heavily on fish in meeting the animal protein requirements of its teeming populace; however only about 50% of its demand is met by local supply, with the demand-supply gap filled by importation (FAO 2003; Oni 2017).

One of the many relevant factors that influence the consumption of fish is the quality of the flesh (Moruf *et al* 2020). More so, nutritional benefits from fin and shellfishes are limited by its rapidly perishable nature and vulnerability to spoilage (FAO 2016; Moruf *et al* 2021). Poor handling of freshly harvested fish poses a major challenge as 30 to 50% of freshly locally harvested fish is wasted due to high ambient temperatures that encourage rapid deterioration of the fish once dead (Oparaku and Mgbenka 2012 and Adeyeye 2016). Smoke-drying freshly harvested fish is often carried out to delay fish spoilage, add value to the fish product and is currently the most popular method of processing freshly harvested fish in developing countries like Nigeria (Abolagba *et al* 2015 and Adeyeye 2016). It is usually preferred over preservative measures like freezing due to epileptic power supply and because materials required for smoke-drying are cheaper to acquire (Ogunbambo *et al* 2018).

Smoke-drying freshly harvested fish is a popular business venture carried out in many parts of Lagos, Nigeria and is often passed on from one generation to another (Aremu *et al* 2013). There is however little documented information on the socio-economic characteristics of these processors, details of what goes into the smoke-drying from a business angle as well as a comparison of some nutritional attributes of the fish product after processing using different kilns. This study was thus aimed at assessing the proximate composition and socio-economic characteristics of smoke-dried catfish *Clarias gariepinus* using three kilns namely Traditional Drum Kiln (TDK), Lagos State Kiln (LSK) and Oil Drum Kiln (ODK) in Makoko fish market, Lagos, Nigeria.

http://dx.doi.org/10.4314/tzool.v21i1.2

Materials and methods

Collection of fish samples

Samples of smoke-dried *C. gariepinus* were purchased once a week from Makoko fish market, located in Yaba Local Government of Lagos State. Ninety (90) samples with average weight of 220±5g were collected over four weeks (May, 2017).

Description of smoking kilns and fish processing

The first kiln, traditional drum kiln (TDK) used in Makoko fish market is a cylindrical metal drum with dimensions of 72cm height, 187cm circumference and 55cm diameter. It is built by local welders and had a circular opening of diameter 36cm carved out at the bottom which serves as the vent in which the fuel (firewood) is arranged to supply heat. A circular wire rack with a diameter of 76.5cm is then placed on top of the traditional drum (Plate 1a). The TDK has a carrying capacity of about 12kg, containing 40-50 catfish if each fish weighs an average of 250g. The fresh catfish is often times arranged on a single layer with an additional layer placed on top of the first layer, separating the two layers using empty evaporated milk cans.

The second kiln, Lagos State Kiln (LSK) was built inside the fish market at Makoko as a government intervention towards alleviating some of the challenges of supply-demand fish deficit in Lagos State, where it is rented out to fish processors. The kiln has a rectangular shape with inner dimensions measuring 60×60cm in length and width and height from outside measuring 120cm. The internal wall is made from galvanized iron sheet, lagged with 2.54cm asbestos particles and covered with half inch plywood. It is composed of a single unit compartment for drying, heating and smoking with four removable trays (with capacity of 10kg each) made from 25.81cm^2 wire mesh placed on 2.54 cm angle iron (Plate 1b). The LSK has a carrying capacity of 40kg, containing 120-160 catfish if each fish weighs an average of 250g.

The third kiln, Oil Drum Kiln (ODK) is made from metal sheet by local welders and has dimensions of 65cm height, 374cm circumference and 110cm diameter (Plate 1c). A rectangular opening of 35cm by 20cm was cut out at the bottom and serves as the vent through which the firewood fuel is arranged to supply heat. A circular wire rack with a diameter of 163.0cm is placed on top of the kiln and fresh fish to be smoke-dried is arranged on it to be processed. The ODK has a carrying capacity similar to the TDK described above.

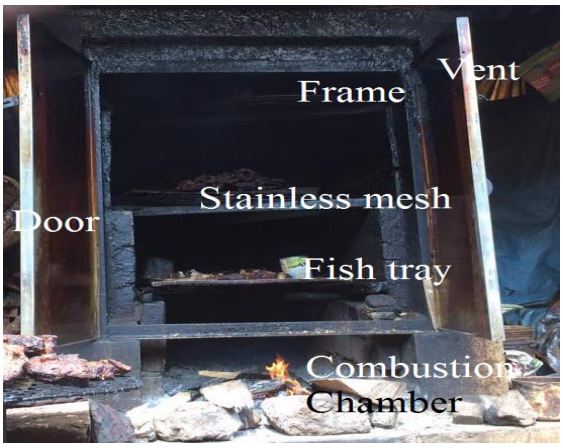
Analytical procedures

Samples of smoke-dried catfish from the three kilns were ground separately in an analytical micro-mill and sieved in 20 mesh sieves. Then, the samples were characterized regarding the contents of moisture, fats, proteins, fibre and ashes according to AOAC (2006).

Questionnaire Administration

Twenty fish processors were randomly selected at Makoko fish markets for this study. Structured questionnaires were then administered through personal interviews and were used to collect data on parameters such as attribute (age and educational) of the fish processors, type of processing kiln as well as costs of smoke-drying the fish, weekly profits etc.

(a)



(b)

(c)

Plate 1: (a) Traditional Drum Kiln (TDK) (b) Lagos State Kiln (c) Oil Drum Kiln with Smoking Fish

Statistical analyses

The weekly number of smoke-dried fish (WNSF) was calculated using the for formula;

$$\text{WNSF} = \text{No. of fish in a basket} \times \text{No. of baskests bought per week}$$

Weekly Revenue (WR) was calculated using the formula;

$$WR = WNSF \times \text{selling price}$$

Weekly profit (WP) was computed using the formula:

$$WP = WR - TWC$$

Where TWC is total weekly cost

Statistical analysis was performed using Microsoft Excel 2010 and SPSS (Version 21; IBM; USA) software packages. Analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) were used to test the differences in the means of the proximate parameters at significance level of 0.05%. Mean and frequency were used to summarize the socio-economic characteristics of the respondents and the economic + characteristics of catfish smoke-drying business.

Results

The proximate compositions of smoke-dried catfish using three kilns are shown in Tables 1. The fish smoked-dried in TDK had the highest protein content (61.42±1.86 g/100g), highest ash content (10.73±1.80g/100g) but lowest fat (3.19±0.91g/100g) and fibre content (1.84±0.36 g/100 g). However, the highest contents of fat (12.81±1.72g/100g), fibre (4.50±1.13g/100g) and moisture (37.58±7.10g/100g) were obtained in fish smoked-dried with ODK. The values of protein and moisture in LSK and TDK fish were not significant different ($p>0.05$) but solitarily showed significant difference ($p<0.05$) to the protein and moisture of fish smoke-dried in ODK.

Table 1: Mean proximate composition of processed *Clarias gariepinus* using three kilns

Proximate (g/100 g)	LSK	ODK	TDK
Protein	56.08±2.42^{a}	40.73±3.40^{b}	61.42±1.86^{a}
Fat	12.45±0.51^{a}	12.81±1.72^{a}	3.19±0.91^{b}
Fibre	2.72±0.22^{ab}	4.50±1.13^{a}	1.84±0.36^{b}
Ash	3.64 ±0.25^{a}	4.85±1.34^{a}	10.73±1.80^{b}
Moisture	25.03±1.14^{a}	37.58±7.10^{b}	23.94±1.53^{a}

values with different superscripts across row are significantly different at ($p<0.05$)

Table 2 shows demographic attributes of the respondents (catfish processor) in Makoko fish market in Lagos State. The age bracket 30-39 years was most in number, 13 (52%) while the age groups > 50 years was the least respondents, 3 (12%). During the studies, all the processors who smoke-dried catfish in the market were women, 5 (20%) were single, 9 (36%) were married, 4 (16%) were widowed and 7 (28%) were divorced. Only 7 (28%) of these respondents had no formal education while 18 (72%) respondents had formal education ranging from primary to the secondary education and none with tertiary education. The primary school education, 12 (48%) however had the highest number of respondents interviewed. The modal weekly earnings 7 (28%) of the respondents ranged ₦31,000-40,000 while the least numbers of respondents, 2 (8%) earned in the range of ₦61,000-70,000.

The percentage of kiln type used for the fish smoking is presented in Figure 1. Fifty percent (50%) of processors who smoke-dried catfish in Makoko fish market used TDK, 30% used ODK while 20% of the processors used LSK. Table 3 shows the economic attributes of catfish smoke-drying business in Makoko fish market. Weekly fixed cost of smoke-drying kiln was found to be lowest using TDK at ₦500 while the highest weekly costs was found with LSK at ₦1,250. The variable costs were the same regardless of the type of kiln to be used in the smoke-drying processing. The weekly profit was estimated at ₦49,750, ₦50,450 and ₦50,500 for LSK, ODK and TDK, respectively.

Table 2: Socio-Economic characteristics of catfish processors in Makoko fish market in Lagos State

Variables	Frequency	Percentage (%)
Age (Years)		
20 – 29	4	16
30 – 39	13	52
40 – 49	5	20
Above 50	3	12
Total	**25**	**100**
Sex		
Male	0	0
Female	25	100
Total	**25**	**100**
Marital Status		
Single	5	20
Married	9	36
Widowed	4	16
Divorced	7	28
Total	**25**	**100**
Level of Education		
No formal schooling	7	28
Primary School	12	48
Secondary School	6	24
Tertiary	0	0
Total	**25**	**100**
Weekly Income from Fish-smoking (₦)		
<20,000	3	12
21,000-30,000	3	12
31,000-40,000	7	28
41,000-50,000	4	16
51,000-60,000	6	24
61,000-70,000	2	8
	25	**100**

Discussion

The results indicate that the catfish smoked-dried in TDK had the best proximate content (highest protein, highest ash and lowest moisture contents) compared to ODK and LSK. Protein content in the smoke-dried fish increased with decreasing moisture content, agreeing with Kumolu-Johnson (2010) that protein nitrogen may not have been lost during drying resulting in increase in protein concentration as the moisture reduced. According to Lawal-Are *et al* (2022), the lower the moisture content of the product to be stored, the better the shelf stability of such product. The protein values of catfish smoke-dried using ODK was however reduced, suggesting that ODK does not conserve nutrients compared to the other smoke-drying kilns. The open pit used in ODK with no regulating mechanism may have exposed the fish to high amounts of smoke probably leading to the increase in Benzo (a) pyrene, resulting in decreased protein content in smoked fish from this kiln (Katola and Kapute 2017).

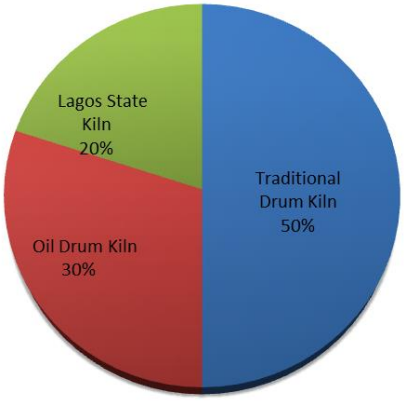


Figure 1. Percentage of smoking kiln used in Makoko fish market in Lagos State

Table 3: Economic characteristics, weekly costs and profit schedule for catfish smoke-drying business in Makoko fish market, Lagos State

Variables	LSK	ODK	TDK
Fixed Costs ₦			
Cost of Kiln	5,000 (monthly rent)	6,600 (3 months lifespan)	6,000 (3 months lifespan)
Weekly depreciated cost of kiln	1,250	550	500
Variable Costs per Week ₦			
20kg Fresh Fish Basket containing about 80 fish @ 250g each	30,000	30,000	30,000
3 baskets/week = 60kg	90,000	90,000	90,000
Condiments/week	2,000	2,000	2,000
Packaging	1,000	1,000	1,000
Total Weekly Costs	**94,250**	**93,550**	**93,500**
Weekly Revenue ₦			
Weekly Smoke-dried number of fish	240	240	240
Selling Price/Smoke-dried fish	600	600	600
Weekly Revenue ₦	144,000	144,000	144,000
Weekly Profit ₦	49,750	150,450	50,500

In the present study, TDK was the most used kiln for smoke-drying, similar to the work of Danba *et al* (2020) who found smoke-drying using drum kiln to be the most popular in Taraba State and Olatinwo *et al* (2020) who found traditional kiln to be the most popular for smoke-drying catfish in Kwara State.

The age group mostly engaged in fish processing as reported by this research confirms that the active labour age (30-39 years) was engaged in smoke-drying in Makoko fish market. All the respondents were women showing that the business of smoke-drying is gender sensitive in favour of women in Makoko fish market. This finding agrees with the works of Peprah (2012) and Agbebi and Adetuwo (2018) who found high percentages of women in smoke-drying business in various fishing communities in Ghana and Nigeria, respectively. The high number of processors in Makoko fish market with formal education in this study, contrasts with the findings of Olatinwo *et al* (2020) who found that majority of fish processors had no formal education in Kwara State.

The revenue earnings from catfish smoking varied with the type of kiln used. The study showed that processors made highest weekly profits with TDK at Makoko fish market. Agbebi and Adetuwo (2018) and Danba (2022) also found that catfish smoke-drying business is most profitable with traditional drum kiln in Ondo and Taraba States, respectively.

Conclusion

This study showed that smoke-dried catfish is a good source of animal protein and that the business can be ventured into with a relatively small amount of capital to yield profit. Furthermore, traditional drum kiln yields

more profit with good quality smoke-dried catfish compared to the other kilns studied.

Acknowledgment

The authors would like to acknowledge Professor I. C. Onyema and Dr. R.O. Moruf for the review of this work.

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Citation: Ogunbambo, M.M, Akapo, K.M. and Chetuya, O.G. 2022. Nutritional and socio-economic analyses of processed catfish (*Clarias gariepinus*) using three kilns in Lagos State, Nigeria. http://dx.doi.org/10.4314/tzool.v21i1.2

The Zoologist, 21: 8-12 December, 2022, ISSN 1596 972X.
Zoological Society of Nigeria