



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

SEPTEMBER 23 - 26, 2019 // ABUJA, FEDERAL CAPITAL TERRITORY, NIGERIA

6th African Conference of Agricultural Economists

Rising to meet new challenges: Africa's agricultural development beyond 2020 Vision



*Invited paper presented at the 6th African
Conference of Agricultural Economists,
September 23-26, 2019, Abuja, Nigeria*

Copyright 2019 by [authors]. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Smoking kiln technology for catfish processing: an assessment of its acceptability and willingness to pay

Omotesho O. A.^a, Adenuga A. H.^b, Nurudeen A. S.^a, . and Olaghere I. L.^a

^aDepartment of Agricultural Economics and Farm Management, University of Ilorin, Ilorin, Nigeria

^bAgri-Food and Biosciences Institute (AFBI), Newforge Lane, Belfast, United Kingdom
Corresponding Author: Adewale.adenuga@afbini.gov.uk

Abstract

Smoking is the most affordable and widely used fish preservation technique in Nigeria and in a host of other African countries. However, the traditional fish smoking technique is not only prone to health risk, but its efficacy is also often constrained by lack of control over temperature and smoke density. In a bid to overcome these challenges, the Nigerian Stored Products Research Institute (NSPRI), Nigeria recently developed a smoking kiln technology. The focus of this research is to compare the sensory parameters and the overall acceptability of smoked catfish using the NSPRI smoking kiln technology and the traditionally smoked catfish. Specifically, the cost and returns associated with the use of the NSPRI smoking kiln technology for catfish processing is estimated. The willingness to pay as well as factors influencing willingness to pay for the NSPRI smoking kiln technology were also analysed. Descriptive statistics, analysis of variance (ANOVA), Budgeting technique and Logistic regression analysis were the main analytical tools employed in the study. The results of the analyses revealed that smoked catfish processed with NSPRI smoking kiln was the most preferred among the samples. Findings also revealed household size, experience, educational level of the processor and income per processing were the main factors influencing the willingness to pay for the NSPRI smoking kiln technology.

Keywords: Fish; NSPRI; Smoking kiln; Willingness to pay; Logistic regression

1.0 Introduction

The fish and fisheries products industry occupies an important position in the economic and social well-being of Nigerians. This is because, it not only provide a means of livelihood for about 1.2 million people employed in the sector but also plays an

important role in food and nutrition security [1, 2 & 3]. Fish constitute an important dietary element in the country, making up about 40 per cent of animal protein intake [4].

In spite of its significance, post-harvest losses from fish is relatively high ranging between 20 and 50 per cent of the total catch. This is mainly due to lack of good and enough processing facilities and preservation techniques which has resulted in low level of income among actors in the fish value chain [2, 5]. A number of fish processing methods have been devised to preserve the physical and chemical (nutritional) qualities, enhance the economic value and prolong the shelf-life of fish as a veritable protein source. Examples of such preservation techniques include: fermentation, drying, frying, canning, salting and smoking. However, smoking is the most affordable and widely used fish preservation technique in Nigeria and in a number of other African countries[2].

Smoking is a popular traditional method of fish preservation which combines the effect of the destruction of bacteria by compounds in the smoke, such as phenols, and the cooking of the fish under a certain level of temperatures [2]. Practically all available fish species in the country can be smoked and it has been estimated that about 70 to 80 per cent of the domestic marine and freshwater catch is consumed in smoked form in Nigeria [2]. The traditional fish smoking technique which is predominantly practiced in Nigeria not only consumes lots of fuel wood, but it is also constrained by lack of control over temperature and smoke density, exposure to dirt, dust, insect infestation, and contaminants such as flies

and low capacity. Consequently, fish, dried using traditional methods are of uneven quality, short shelf life and often pose work-related health risk [6, 7].

In a bid to overcome these challenges and maximize income from fish processing, the Nigerian Stored Products Research Institute (NSPRI), recently developed a smoking kiln technology. Although, different types of smoking facilities have been developed over the years, for example: traditional ovens, and kilns of different types or cut drum ovens, most of these facilities have low batch capacities and long drying times. [6, 7 & 8]. Properly smoked fish products are dark brown in colour and are mostly nearly perfectly dried.

As part of the mandate of the Nigerian Stored Products Research Institute (NSPRI) to reduce post-harvest losses in food grown and consumed in the country, including fish and meat, the institute recently developed different models of smoking kilns to ensure better life for the fish processors and improve the quality of smoked fish. The NSPRI smoking kiln has numerous distinct advantages: it is easy to use, has a high capacity, uses less charcoal, results in shorter smoking time and produces high quality smoked fish. Smoking may be done in a variety of ways: pre-drying or salting before smoking; cold-smoking which involves the use of little fuel-wood that produces low heat. The smoking process is carried out in different stage by progressively increasing the temperature. Despite these advantages, the level of adoption of this technology remains low. It is believed that farmers will normally adopt a technology on the basis of actual or perceived economic benefit [9].

Currently, only limited knowledge is available about the economic benefit of adopting the NSPRI smoking kiln.

This study is set out to achieve the following objectives: (i) to compare the sensory parameters of market smoked catfish and the catfish processed using NSPRI smoking kiln technology (Direct and Indirect source of heat).(ii) assess the profitability of catfish smoked using the NSPRI smoking kiln technology, and (iii) to examine processors willingness to pay and factors influencing willingness to pay for the NSPRI smoking kiln technology. To maximize returns from fish enterprise and ensure that the quality of fish reaching the final consumers are of high standard, it is important to employ the best method possible in the handling of fish. The results of this study will be useful to farmers and policy makers in making informed investment decisions on the adoption of the NSPRI smoking kiln technology.

2.0 Materials and methods

2.1 The study Area

This study was carried out in Kwara State, Nigeria. The State is located between parallels 8° and 10° north latitudes and 3° and 6° east longitudes east. The state shares an international boundary with the Republic of Benin to the west and interstate boundaries with Niger state to the north, Oyo State to the southwest, Osun and the Ekiti States to the southeast and Kogi State to the east. The experimental aspect of this study was conducted

at Nigerian Stored Products Research Institute (NSPRI) headquarters, Ilorin in the Kwara State Nigeria. The Nigerian Stored Products Research Institute is one of the Research Institutes under the supervision of Agricultural Research Council of Nigeria (ARCN) in the Federal Ministry of Agriculture and natural resources. The Institute was established in 1948 as West African Stored Products Research Unit (WASPRU) during the colonial era of the country to assess the quality of exportable crops from Nigeria, Ghana, Sierra Leone and Gambia to the United Kingdom. It became Nigerian Stored Products Research Institute after the independence in 1960.

2.2 Method of Data Collection

The analysis was done in two phases. The first phase employs an experimental approach to analyse the acceptability of smoked fish processed using the NSPRI smoking kiln technology. In the second phase, an econometric approach is employed to analyse the willingness to pay and factors influencing willingness to pay for NSPRI smoking kiln technology. The primary data were generated through experiment and use of structured questionnaires designed in line with the objectives of the study. The sensory analysis was carried out using the 5-point hedonic scale. The template which was a rating method allows the panelists to choose from a range of options. The options include; like extremely, like slightly, neither like nor dislike, dislike slightly and dislike extremely; and they were allocated 5, 4, 3, 2 and 1 mark respectively. The panelists consisted of thirty (30) people that were given three test templates each; one per sample (a sample of the smoked catfish

from NSPRI kiln (Direct and indirect source of heat) and purchased catfish from the market). Data obtained from the panelists was subjected to Analysis of variance (ANOVA) and the Duncan multiple range test which was used to compare the sensory parameters (taste, aroma, appearance, and texture) and the overall acceptability between smoked catfish using the NSPRI smoking kiln and the market smoked catfish.

A three-stage sampling technique was adopted for selection of processors for the study. First, purposive selection of Ilorin west and east local government areas of the state due to abundant availability of catfish processors in the areas. The second stage involves a simple random selection of two (2) fish processing communities in each local government area and the third stage involves the selection of 15 fish processors from the 4 communities through snowball sampling. A total of 60 respondents were sampled for the study

2.3 Sample collection, Transportation, and Preparation

African Mud Catfish of average weight of 450 g were purchased from a farm (Super farm) in Ilorin metropolis and transported in water to the Nigerian Stored Products Research Institute (NSPRI) where it was processed. They were killed with salt and by breaking their spine, gutted (ensuring the complete removal of gills and intestines) and cleaned. The samples were subjected to osmotic pre- treatment (1Kg of fish to 10m/g of salt to 1 liter of water) for 30 minutes (to enhance the release of water from the fish tissues and to add taste). Thereafter the fish were folded using a stick to enhance folding and were drained by arranging on drying trays to ensure that surface water is removed before putting

them into the dryer. Pre-heating of the smoking kiln (The smoking kiln was powered and allowed to attain the maximum temperature (130 0C). After the kiln has stabilized, drying trays were oiled (with vegetable oil), the drying trays with the fish arranged on them were then put into the kiln. The fish were checked at an interval of 30 minutes to turn, for even distribution of heat. The charcoal box of the charcoal powered kiln was recharged at an interval of 2hrs to prevent the temperature in the smoking kiln from dropping to ambient temperature, at the end of drying, the fish were allowed to cool then packed. 10 hours was used to complete the whole drying process.

2.4 Analytical Techniques

To compare the sensory parameters (taste, aroma, appearance, and texture) and the overall acceptability between smoked catfish using the NSPRI smoking kiln and the market smoked catfish, the Analysis of variance (ANOVA) and mean difference using Duncan test was employed. To estimate the cost and returns associated with NSPRI smoking kiln for smoked catfish we employed the budgeting technique which enables the estimation of total expenses (costs) as well as various receipts (returns) within a production period. The model for estimating budgeting techniques is given in equation (1).

$$NI = I - TC \quad (1)$$

Where, NI = Net income, GI = gross income while TC = total costs.

To examine processors willingness to pay for the NSPRI smoking kiln technology we employed descriptive statistics such as frequency Tables and percentages. This study used experimental auction and logistic regression model in identifying the factors influencing processors willingness to pay for the NSPRI smoking kiln technology. The logistic regression model is a nonlinear regression model that has a binary response variable. It is a very useful tool especially in situations in which one wants to predict the presence or absence of a characteristic or outcome based on values of a set of predictor variables [10]. As such, logistic regression was most appropriate for this study due to its unique ability to account for both categorical and dichotomous dependent variables. The model is presented in equation 2 following [11].

$$\text{Logit}(E[Y]) = \text{Logit}(P) = XT \beta \tag{2}$$

Where

Logit ($E[Y]$) = is the binary response/dependent variable

Logit (P) = the natural log of the odds of success

XT = the explanatory/independent variables

β = is the regression coefficient

The dependent variable was a dichotomous variable depicting the respondent's willingness status and took the value of 1 if the respondent was willing to for NSPRI

smoking kiln technology and 0 if not. The independent variables were the socioeconomic factors. The hypothesized independent variables are: X_1 = Gender of processors (male =1, female = 0); X_2 = Household size (number of people in the house); X_3 = Marital status of processors (married = 1, single = 0); X_4 = Main occupation of the processors (full-time processor = 1, part time processor = 0); X_5 = Educational level (years); X_6 = Experience in fish processing (years); X_7 = Cooperative membership (Yes = 1, No = 0); X_8 = Income of processors per processing (₦)

3.0 Results and Discussion

3.1 Socio-Economic Characteristics of the Catfish Processors

The distribution of the respondents by socioeconomic characteristics is presented in Table 3.1. The age range of the respondents revealed that almost half of the population, that is, 48.3 % was between 31 and 40 years. The average age was 36 years which implies that a good proportion of the sampled respondents are in their active years. The result revealed that majority of the respondents were female (58.3 per cent). Also, the majority of respondents have relatively small household size with a mean household size of 3 persons per household.

Table 3.1: Socio-Economic Characteristics of respondents

Variables	Frequency	Percentages
------------------	------------------	--------------------

Age(years)		
21-30	17	28.3
31-40	29	48.3
41-50	13	21.7
> 60	1	1.7
Gender		
Female	35	58.3
Male	25	41.7
Marital status		
Single	12	20
Married	48	80
Household size(no)		
1-5	52	86.7
6-10	8	13.3
Educational level		
No formal education	17	28.3
Primary education	1	1.7
Secondary education	5	8.3
Tertiary education	37	61.7
Primary occupation		
Full time processor	36	60
Part-time processor	24	40
Experience (years)		
1-5	31	51.7
6-10	23	38.3
11-15	6	10.0
Processors Association		
Yes	26	43.3
No	34	56.7
Cooperative membership		
Yes	56	93.3
No	4	6.7

Findings further reveal that as much as 61.7 per cent of the respondents had tertiary education while 28.3 per cent have no formal education. About 60 per cent of the respondents were full time fish processors while 40 per cent were part time processors. The

mean years of experience in catfish processing was 6 years. Furthermore, findings also reveal that majority of the respondents (56.7 per cent) do not belong to processors association.

3.2 Comparison of the Sensory Attributes

The results presented in Table 3.2 gives the means of the sensory parameters of market smoked catfish being compared to the catfish processed using NSPRI smoking kiln technology (Direct and Indirect source of heat). The results shows that there is a statistically significant difference in the overall acceptability as well as other parameters of the market catfish compared to the one processed with the NSPRI smoking kiln. However, there is no significant difference in catfish processed using NSPRI smoking kiln direct heat source and indirect heat source. Fish prepared using the NSPRI smoking kiln indirect heat source was the most preferred among the samples while the market source was the least preferred

Table 3.2: Means of Sensory Parameters of catfish

Source	Colour	Taste	Aroma	Appearance	Texture	Overall Acceptability
Market	3.57±0.21 ^a	3.57±0.20 ^a	3.60±0.21 ^a	3.73±0.20 ^a	3.80±0.18 ^a	18.40±0.87 ^a

Smoking kiln						
(Direct heat)	4.70±0.15 ^b	4.60±0.17 ^b	4.50±0.15 ^b	4.57±0.15 ^b	4.57±0.08 ^b	23.00±0.58 ^b
Smoking kiln						
(Indirect heat)	4.90±0.06 ^b	4.87±0.08 ^b	4.57±0.12 ^b	4.83±0.07 ^b	4.63±0.11 ^b	23.73±0.27 ^b
F-Value	21.638	14.565	10.556	14.972	10.946	21.531

Source: Data Generated, Experiment (NSPRI), 2017

The super script with the same alphabet along column are not significantly different at P<0.05

3.3 Costs and Returns Analysis of using NSPRI Smoking kiln Technology for Catfish Processing.

The results presented in Table 3.3 gives a summary of the costs and return analysis of 25Kg of catfish processed using the NSPRI smoking kiln technology. The results shows that the use of the technology is profitable. . Furthermore, the results indicate an increase in the size of the smoking kiln technology and the Kilogram of catfish processed, the more the profit to make. It can also be observed from Table 3.3 that labour and charcoal constitute the major operating costs of the total production costs of the Africa mud catfish production enterprise.

Table 3.3: Estimates of cost and returns analysis

Items	Price per unit (₦/Kg)	Total
Variable cost		
Africa mud catfish @ 900 ₦/Kg	22500	
Charcoal(1/4 bag)	300	

Transportation	200	
Salt	20	
Kerosene	30	
Vegetable oil	20	
Packaging materials @ (₦5.6/Kg)	140	
Labour	500	
Utilities	100	
Total variable cost (TVC)		23,810
Fixed cost		
Smoking kiln (Depreciation))	104.17	
Utensils (Depreciation)	20.83	
Total fixed cost (TFC)		125
Total Cost (TC), (TVC +TFC)		23935
Selling price @ 1120 ₦/Kg	28000	
Gross Income (GI)		28000
Net Income (GI-TC)		4065

3.4 Processors Willingness to Pay for NSPRI Smoking Kiln Technology

Table 3.4 gives a summary of the fish processors willingness to pay for the NSPRI smoking kiln technology.

Table 3.4: Willingness to pay for NSPRI smoking kiln technology

Willingness to pay	Frequency	Percentage
No	46	76.7
Yes	14	23.3
Total	60	100.0

The results show that majority of the processors are not willing to pay for NSPRI smoking kiln technology. This might be due to lack of awareness about the smoking kiln technology or the high initial investment cost. Of the 23.3 per cent of the processors that

are willing to pay for the NSPRI smoking kiln technology, 5.0 per cent each is willing to pay ₦100,000, ₦ 110,000 and above ₦ 130,000 respectively while 8.3 per cent are willing to pay ₦120,000.

3.5 Determinants of Processors’ Willingness to Pay for NSPRI Smoking Kiln Technology

The results of the logistic regression model to analyse the factors influencing WTP for the NSPRI smoking kiln technology is presented in Table 3.5.

Table 3.5: Factors influencing processors’ willingness to pay

Variable	Coefficient	Std. Error
Constant	-0.6668	5.5632
Gender	-0.7070	1.4308
Marital status	-2.9549	2.1111
Household size	0.8926*	0.4943
Education level	-1.3509*	0.7816
Main Occupation	1.3754	1.7899
Experience	0.5875*	0.3023
Cooperative	-2.5438	1.9487
Income	0.1409***	0.5315

Restricted log likelihood -32.59637

Model Chi-squared 41.61875

Note: *** and * implies significant at 1 % and 10 % level respectively

The results show that of the 8 explanatory variables included in the model, 4 were found to be statistically significant. Among factors which had a significant influence on willingness to pay for NSPRI smoking, the kiln is income per processing statistically

significant at 1% probability level; Household Size, Level of education and Experience were significant at 10 % probability level. The sign of the household size was positive indicating that a unit increase in household size increased processors' willingness to pay for the NSPRI smoking kiln. This may result from the fact that the higher the number of household members, the higher the available family labor to be used which may probably increase the production level and hence increases the income of the processor. Processing experience was also positively related to willingness to pay for the NSPRI smoking kiln. This means that as the processing experience of the processor increases it leads to increase in processor willingness to pay for NSPRI smoking kiln technology. Income per processing was also positively and significantly related to the probability of willingness to pay for the NSPRI smoking kiln by the processors. Processors with higher-income from processing were more likely to be willing to pay for the smoking kiln than lower-income processors. This might result from the fact that the higher income processors are more likely to be able to afford the high cost of the smoking kiln technology compared to the lower income processors. The variable that negatively affected willingness to pay for NSPRI smoking kiln technology was the level of education of the processors. This implies that as the educational level of the processor increases it leads to decrease in willingness to pay for the NSPRI smoking kiln technology.

4.0 Summary and Conclusion

This study has evaluated NSPRI smoking kiln technology for catfish processing. It can be inferred from the study catfish processed using NSPRI smoking kiln technology was preferred over those smoked using the traditional method obtained from the market. Willingness to pay for NSPRI smoking kiln technology is positively influenced by household size, experience and income per processing. It is however reduced with the increasing level of education. Conclusively from the findings of the study, catfish processed using NSPRI smoking kiln technology has a high level of acceptability and it is also profitable. Sizeable percentage of the processors were found to be willing to pay for the smoking kiln technology. Based on the results of the study, it is recommended that there is need for increased awareness of the benefits that are accruable from the use of the NSPRI smoking kiln technology through improved extension strategies. The technology should also be made affordable to the fish processors either through the provision of grants and loans to potential fish processors or by reducing the cost of the technology.

References

- [1] Adewumi, M.O., Ayinde, O.E., Adenuga, A.H. and Zacchaeus, S.T. 2012: “The profitability analysis of artisanal fishing in Asa River of Kwara state, Nigeria”, *International Journal of Development and Sustainability*, **1**(3): 932-938.
- [2] Adeyeye S. A. O. and Oyewole O. B. 2016: An Overview of Traditional Fish Smoking In Africa, *Journal of Culinary Science and Technology*, **14**(3): 198-215, DOI: 10.1080/15428052.2015.1102785
- [3] Food and Agricultural Organisation of the United Nations (FAO) 2018: Fishery Information, Data and Statistics Unit. Accessed on 24/01/2019 from <http://www.fao.org/fishery/facp/NGA/en>

- [4] Jamin, D. M., and Ayinla, A. O. 2003: Potential for the development of aquaculture in Africa, *NAGA, WorldFish Center Quarterly* **26**(3): 7–13
- [5] Okonta, A. A., and Ekelemu, J. K., 2005: A preliminary study of micro-organisms associated with fish spoilage in Asaba, Southern Nigeria. Proceedings of the 20th Annual conference of fisheries society of Nigeria (FISON), Port Harcourt, 14th-18th November, Pp. 557–560.
- [6] Nti, C., Plahar, W., and Larweh, P. 2002: Impact of adoption in Ghana of an improved fish processing technology on household income, health and nutrition. *International Journal of Consumer Studies*, **26**(2):102–108. doi:10.1046/j.1470-6431.2002.00210.x
- [7] Akinola, O. A., Akinyemi, A. A., and Bolaji, B. O. 2006: Evaluation of traditional and solar drying system towards enhancing fish storage and preservation in Nigeria (Abeokuta Local Government as a case study). *Journal of Fisheries International*, **1**(2–4): 44–49
- [8] Adelowo, E. O., Okomoda, J. K., Mdailbli, M., & Eyo, A. A. 1997: Improved smoking kiln on lake Kaiji, A report submitted to the Nigerian-German Kainji lake promotion project. New Bussa, Nigeria
- [9] Russell R. A., and Bewley J. M. 2013: Characterization of Kentucky dairy producer decision-making behavior. *Journal of Dairy Science* **96**(7): 4751–4758
- [10] Adenuga, A.H., Omotesho, K. F., Olatinwo K. B., Muhammad-Lawal, A. and Fatoba, I. 2012: Determinants of Fertilizer Usage in Dry Season Amaranthus Vegetable Production in Kwara State, Nigeria. *Agrosearch*, **12**(2): 126 – 134
- [11] Pampel, F.C. 2000: *Logistic regression: A Primer. Sage Quantitative Applications in the Social Sciences Series*, 132. Thousand Oaks, CA: Sage Publications. 54-68.