

# Awareness and adoption levels of improved smoking oven among fish processors in Lagos Lagoon, Nigeria

O. T. ALABI\*, O. J. OLAOYE, F. O. A. GEORGE, A. A. ADEOLA, J. O. ALABI, & W. G. OJEBIYI

(O.T.A & F.O.A.G: Department of Aquaculture and Fisheries Management,; O.J.O: Agricultural Media Resources and Extension Centre (AMREC),; A.A.A: Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR), W.G.O.: Department of Agricultural Extension and Rural Development, Federal University of Agriculture, Abeokuta, P.M.B 2240, Ogun State, Nigeria,; O.T.A & J.O.A.: Favour and Mercy Agricultural Production and Training Centre, Abeokuta, Ogun State, Nigeria)

\*Corresponding author's email: [queenomotayo@gmail.com](mailto:queenomotayo@gmail.com)

## ABSTRACT

This paper investigated awareness and adoption levels of improved smoking oven among fish processors in four fishing communities along Lagos Lagoon, Nigeria. Multi-stage sampling procedure was used to select 153 respondents who were engaged in fish smoking. Data collected using structured interview guides were subjected to descriptive and inferential analyses. Results revealed that majority of the respondents were young, married women with average fish smoking experience of 22.6 years. Majority (90.8%) of them were solely engaged in fish smoking while 9.2% combined fish smoking with other income-generating activities. All the processors used traditional smoking oven (drum, box and mud ovens). More than 66.0% of the fish processors were not aware of improved fish smoking equipment. Lack of awareness, inadequate access to the technologies, low relative advantage and lack of maintenance services and high cost of procurement were responsible for low adoption levels of improved smoking oven. Irregular visits of extension agents to the study area had negative impact on the adoption of improved traditional smoking ovens. Proper dissemination of innovations developed on improved fish processing equipment to the active fish processors in Lagos State using available communication channels is hereby advocated.

**Keywords:** Lagos Lagoon; fish processing; smoking oven; extension service; adoption  
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## Introduction

The global demand for fish as food is increasing not only due to upsurge in population rise but also because it is known as a safe source of animal protein that is widely available and affordable for all regardless of the socio-economic status (Olaoye *et al.*, 2015). Also,

the amino acid profile, low cholesterol content, numerous vitamin and mineral contents as well as fatty acid profile makes fish stand out among all the sources of animal protein (Olaoye *et al.*, 2015). Fish is usually consumed in its preserved form than as fresh (Nerquaye-Tetteh *et al.*, 2002). Of all the processing

methods often employed (either singly or in combination) by artisanal fish processors, fish smoking (curing process) remains the most common and cheapest processing method in most developing countries including Nigeria, Ghana, Cote d'Ivoire, to mention a few (George *et al.*, 2014; Olaoye *et al.*, 2015; Sakyi *et al.*, 2019).

Smoking preserves fish by fish cooking, drying, and depositing natural wood-smoke chemicals like tars, phenols and aldehydes all of which have powerful bactericidal action which prevents the growth of other micro-organisms on the flesh of the fish (Garrow & James, 1993; Sakyi *et al.*, 2019). As noted by Asiedu *et al.* (2018), smoked fish is consumed by all and sundry due to its better taste, comparably higher nutrient quality and availability at various markets (domestic rural and urban markets, sub-regional and international markets). Traditional processing of fish remains a pivotal means of making cured fish available to Nigerians and many other Africans. This is probably because fish processing activity is domiciled in the artisanal fishery sectors where majority of fish processors employ the use of traditional equipment (Inoni & Oyaide, 2007; Sakyi *et al.*, 2019). Empirical evidence has shown that majority of smoked fish processors in Nigeria employed traditional techniques and processing equipment that have been in existence for several decades such as cylindrical metal or oil-drum oven (full or half drum), mud oven, box oven, and brick kiln (Davies *et al.*, 2008; George *et al.*, 2014; Olaoye *et al.*, 2015; Odediran & Ojebiyi, 2017).

However, the major shortcoming of traditional smoking ovens hinged on the poor-quality smoked fish as evidenced by higher polycyclic aromatic hydrocarbons (PAHs) concentration which is of safety,

public health concerns and inefficient due to excess fuel consumption. Previous studies by Silva *et al.* (2011) and Ake Assi *et al.* (2014) established a positive link between the use of the traditional smoking oven and higher PAHs concentration in smoked fish. In view of this, interventions aimed at addressing this issue include developing improved smoking ovens and intensifying efforts towards the adoption of improved fish processing techniques. Improved smoking oven such as Chorkor oven and smoking kilns has several superior advantages over traditional smoking oven which include high-quality smoked fish products, higher productivity, large smoking capacity, shorter smoking duration, better fuel-use efficiency, and lower PAHs concentration in smoked fish. It also reduces fish processors' exposure to health hazards and injuries (Sakyi *et al.*, 2019). However, the existing information reflects low level of adoption of improved fish processing technologies among smoked fish processors in some parts of Lagos State, Nigeria (Odediran & Ojebiyi, 2017). This is worrisome due to its implications on food security and food safety. Therefore, it is prudent to assess the awareness and adoption level of improved traditional fish smoking oven among fish processors in Lagos Lagoon. Arising from the above, the objective of this study was to investigate the adoption level of improved fish smoking oven among fish processors in Lagos State; and the impact of fisheries extension services on the adoption level of improved traditional fish smoking oven in the study area. The following hypotheses were tested: i). Socio-economic characteristics of fish processors have no significant impact on the adoption of improved traditional fish smoking oven, and ii). The adoption of improved traditional fish smoking oven did not depend on the effectiveness of extension services.

## Materials and Methods

### *Description of the study area*

The research was conducted in Lagos State, located in the South-Western part of Nigeria on the narrow coastal plain of the Bight of Benin (Olaoye *et al.*, 2016). Lagos Lagoon is a tropical, coastal estuary located in the heart of Lagos metropolis and is the largest of the four lagoon systems in the state. It cuts across the southern part of the metropolis, connecting to the Atlantic Ocean by Commodore Channel in the west and south and Lekki Lagoon in the east (Okusipe, 2004). The lagoon is located between longitudes 3°23' and 3°40' E, and latitudes 6°22' and 6°38' N (Phillips *et al.*, 2012). It measures over 50 km and varies in width from 3 to 13 km at its widest point thus covering an area and perimeter of 6354.708 km<sup>2</sup> and 285 km, respectively. The Lagos Lagoon consists of three main segments, viz; Lagos Harbour, the Metropolitan end and Epe Division segments. The lagoon is shallow in most places, usually 2-4 m deep, except at the entrance at the Commodore channel where it is 10 m deep (Okusipe, 2004). The map of Lagos Lagoon showing the study area is presented in Fig. 1. Study area co-ordinates were taken using Global Positioning System (GPS) software while the map was drawn using ArcGIS Software (ESRI Inc., Redlands, California, United States of America).

### *Study design, sampling procedure and sample size determination*

The study adopted the multistage sampling technique which comprises both the non-probability (purposive) and probability (simple random) sampling techniques. Four fishing communities along Lagos lagoon were purposively selected based on high intensity of fishing and fish processing. The purposively selected communities were Epe,

Ejinrin, Agbowo-Ikosi, and Bayeku. Extension personnel and fish processors association leader of each location were consulted to know the total number of registered fish processors. Thereafter, 70.0% of registered fish processors were selected from each community using a simple random sampling technique which resulted in a sample size of 153 fish processors out of 218 registered fish processors.

### *Data collection instruments, pretesting and data collection*

The instrument used for the gathering of primary data was a validated and pre-tested interview guide. The interview guide was divided into four with Section A containing the socio-economic characteristics of fish processors in the study area; Section B focused on the fish smoking practices and types of smoking oven used; Section C focused on the awareness and adoption level of improved traditional fish smoking oven, and Section D looked into access to fishery extension service. A semi-structured interview guide was administered to the selected smoked fish processors in order to assess the awareness and adoption level of improved fish smoking oven. Level of awareness depicts the proportion of fish processors who knew that an innovation (improved fish smoking ovens) exists which has potential benefits and practical relevance to enhance fish smoking activities (Özçatalbaş, 2014). Meanwhile, adoption level refers to the degree of acceptance of such an innovation (Bolorunduro & Adesehinwa, 2007). Level of awareness and adoption were categorized as low or high if lower or higher than 50% of respondents, respectively. The interview schedule is structured in such a way to consist of both open and closed-ended questions. The open-ended questions allow the respondent to express their own opinions about specific

situations in order to fulfill the specific objectives of the study. The interview guide used for the data collection was found to be valid and reliable through face and content validity, as well as the test-retest method, respectively.

#### *Data analysis*

Data generated from the interview guide were coded appropriately in Microsoft Excel. They were analyzed using descriptive statistics such as frequency distribution, percentage, and meanwhile the tested hypotheses were analyzed with Pearson Product Moment Correlation and multiple linear regression analysis using Statistical Package for Social Sciences (SPSS 20.0 version; SPSS 2017).

### **Results and Discussion**

#### *Socio-economic characteristics of fish processors in Lagos Lagoon*

The distribution of fish processors surveyed in the four fishing communities along Lagos Lagoon with respect to their socio-economic characteristics is presented in Table 1. Almost all (99.4%) of the processors were female. This is in congruence with previous assertions that female are mostly involved in the processing and marketing of the fish caught in the artisanal fishery while male-dominated the fishing activities, particularly in Africa (Inoni & Oyaide, 2007; Okwu & Acheneje, 2011; Ake Assi *et al.* 2014; Shettima *et al.*, 2014; Sakyi *et al.*, 2019). In agreement, George *et al.* (2014) found that 97.9% of the fish processors in Ibeju-Lekki Local Government of Lagos State were women. Age is another important socioeconomic characteristic in the fisheries sector as it affects productivity, output and adoption of innovation (Olaoye *et al.*, 2016). Majority (77.8%) of the respondents are

able-bodied and agile young women who were below the age of 50 years (mean age =  $41 \pm 14$  years) thereby possess the physical strength to sustain rigorous and arduous tasks required in fish processing. Previous studies have also shown that most people that are engaged in fishery-related activities were in their youthful, productive and economic active age, usually between the ages of 20 and 50 years, simply because such activities require much energy (Ake Assi *et al.* 2014; George *et al.*, 2014; Ashley-Dejo *et al.* 2017; Odediran & Ojebiyi, 2017). This explains why Bolorunduro & Adesehinwa (2007) considered this age bracket as the economically active age group which would be more inclined to adoption of innovations that could enhance productivity and increase their income margin.

Majority (91.0%) of the respondents were married with dominant household size of six people per household. This implies that the fish processors were people of financial responsibility who may depend on the income from their business as a means of livelihood to cater for the family needs (Odediran & Ojebiyi, 2017). It is a common practice that family members also participate actively in fish processing and marketing activities thereby constituting the labour force, especially if they are adults and not dependents. Household size is often influenced by the educational status, locality, religion, mother's working status and family income level and/or wealth index. The mean household size in the study area is similar to the findings of Odediran and Ojebiyi (2017) who reported an averagely six members per household among fish processors in selected fishing communities of Lagos State. Bolorunduro and Adesehinwa (2007) and Ashley-Dejo *et al.* (2017) also reported an average of six persons per household among fisherfolks (fishermen, fish processors and fish

farmers) in Lagos and Rivers States as well as catfish farmers in Oyo State, respectively.

Respondents' educational status in this study revealed high level of illiteracy as nearly half of the respondents (49.7%) had no schooling (non-formal education) while 29.4% had primary school education, and 19.6% had post-primary school education. This aligns with the works of Odediran and Ojebiyi (2017) who found that close to half (48.2%) of the fish processors in Lagos State had no formal education. Kolawole *et al.* (2010) also reported that majority of the fish processors in Southwestern Nigeria had only primary-level education. A study by Ake Assi *et al.* (2014) noted that 59% of fish smokers in Abidjan, Cote d'Ivoire are illiterate. This probably would not only affect their living standards but could also have adverse effects on the ease of comprehension and adoption of introduced improved technologies and innovative practices. The fundamental role of education in every aspect of life and for successful business enterprise cannot be belittled as it provides a better chance for awareness, persuasiveness, reception and applicability of new or improved innovations for optimum productivity (Özçatalbaş, 2014). Adeyeye *et al.* (2015) had also noted that level of education is positively related to employment and income level which inescapably influences access to household amenities and facilities, including those related to biosecurity and hygienic measures together with environmental health during fish processing.

The study further revealed that 29.4% of the respondents had 11-20 years of fish smoking experience, 22.2% had 21 and 30 years of experience while few (8.5%) had more than 40 years of working experience. Fish smoking experience depicts the number of years that the fish processors had spent in

this business. Longer years of experience are usually correlated with better performance. In this present study, the mean fish smoking experience (22.6 years) which indicated that most of the sampled fish processors would have had sufficient mastery of fish processing skills, and could understand the business trends in terms of seasonal availability of harvested fish, shift in operation conditions, as well as price fluctuation of inputs and fish products which could inform their decision making. This result is in accordance with the report of Odediran and Ojebiyi (2017) who observed an average fish processing experience of 21.48 years and opined that they will be able to decide logically and rationally whether to adopt a technology or not based on their wealth of experience on the existing technologies vis-à-vis the newly introduced ones.

Almost all (98.0%) of the fish processors were members of fish processors association while only 3.3% belonged to Cooperative society. Social associations help their members to pool their resources thereby having access to credit facilities (Olaoye *et al.* 2012). It also provides a better platform to have insights into critical fish smoking issues such as price control, sharing of fish and/or smoking oven whenever there is abundance or scarcity. The welfare needs of registered members are also being attended to. One of the fundamental problems faced by fish processors is inadequate financial resources and/or unavailability of credits or loans to expand their business (Sayki *et al.*, 2019). Meanwhile, membership of social groups could facilitate the fish processors' access to credit facilities from the financial institutions as intervention agencies would prefer to assist groups than individuals (Olaoye *et al.* 2012). Information dissemination to raise awareness on improved technologies or innovations could be more



effective as extension workers could reach more people through their respective social organizations especially the fish processors' associations. Due to the influence of peer pressure, fish processors are likely to adopt new technologies because their colleagues adopted such technologies (Ashley-Dejo *et al.* 2017). Low subscription to cooperative society by fish processors in this study could be attributed to their low level of education as well as lack of awareness and interest.

#### *Fish processing characteristics of the fish processors in Lagos Lagoon*

Table 2 shows the fish processing characteristics of the fish processors in Lagos lagoon. The results revealed that majority (90.8%) of the fish processors were exclusively into fish processing on a full-time basis while 8.5% and 0.7% were part-time and occasional fish processors, respectively. This is an indication that fish processing is the major means of livelihood as well as the main source of income of the respondents. This is likely the major drive because the fishery-related enterprise had been reported to be profitable (Okeowo *et al.*, 2015; Ashley-Dejo *et al.*, 2017). Some respondents also combined fish processing with trading (2.6%), civil service (3.9%), fishing (0.7%) and vocational jobs like hairdressing and fashion designing (1.9%). This suggests that revenue generated from such occupations can serve as an additional source of income. However, fish processors who had no other occupation apart from fish smoking might be vulnerable to economic loss should there be a problem as a result of seasonality and natural disaster. Furthermore, almost all (97.4%) of the respondents went into fish processing primarily to make profit while others ventured into the business for household

consumption (15.0%) and increase in streams of income (5.8%).

Majority (88.2%) of respondents processed smoke fish every day while 11.1% processed fish between four and six times a week. Also, close to half (47.7%) of the respondents often process less than 100 kg of fish per time while 39.9% processed between 101 and 200 kg of fish. This implies that the fish processors are small-scale business owners. The scale of production, the commercial value of smoked fish products, and marketing channels (direct sales to final consumers or through middlemen) could influence the fish processors' revenue and gross margin. Respondents' income level shows that most (45.7%) of the respondents had monthly income of ₦31,000 - 60,000 while 32.0% earned at most ₦30,000 per month, 16.3% earned ₦61,000 - 90,000, and 5.9% earned more than ₦90,000. The average monthly income from fish processing activities was ₦48,274.51K. This could be an indication that the fish processors were earning relatively higher income than most civil servants in Nigeria where state governments are struggling to agree on a minimum wage of ₦30,000 for the workers. The amounts earned per month could be the major driving force that motivated even youths into the enterprise. This agrees with the findings of Olaoye *et al.* (2013) and Ashley-Dejo *et al.* (2017) who reported that artisanal fisher folks and fish farmers were motivated by the revenue generated from the enterprise. Undoubtedly, income level is positively linked with the financial status of individual and whoever earns higher income could have access to better living standards and health care than those who have lower revenue. Likewise, higher income could enhance the opportunity to adopt innovations due to higher purchasing power (Özçatalbaş, 2014).

### *Types of fish smoking oven used*

From this study, more than half (54.2%) of the processors used drum oven as smoker, 45.7% used box oven while 39.2% used mud oven (Fig. 2). This is an indication that drum and box ovens were the most commonly used smoking ovens in the study area. Previous studies also revealed that majority of fish processors used traditional smoking oven (Davies *et al.*, 2008; George *et al.*, 2014; Adeyeye *et al.*, 2015). A study by Davies *et al.* (2008) found that the use of drum and mud ovens were prevalent among fish processors in Rivers State, Nigeria. In the same vein, recent studies reported drum and mud ovens as the commonly used smoking ovens by fish processors in Abidjan, Côte d'Ivoire (Ake Assi *et al.*, 2014) and Lagos State, Nigeria (Adeyeye *et al.*, 2015; Odediran & Ojebiyi, 2017). On the contrary, George *et al.* (2014) reported galvanized iron sheet oven as the prevailing processing equipment in Ibeju-Lekki LGA, Nigeria. Meanwhile, Sakyi *et al.* (2019) reported that fish processors in Ghana employed improved types of conventional fish smoking ovens, chorker smokers, oil drums and upgraded smoking techniques.

### *Awareness and adoption levels of improved traditional smoking oven*

Findings presented in Table 3 indicate that the level of awareness among the fish processors was low with regards to the improved fish smoking ovens as more than two-thirds of the respondents were not aware of the improved fish smoking equipment. Only 34.0% of the fish processors were aware of improved mud oven while 15.7, 15.7 and 20.3% were aware of improved box oven, chorkor oven and smoking kiln, respectively. The low level of awareness of improved

processing equipment is worrisome and could be an indication of inadequate diffusion of improved fish processing technologies by the extension agents to the fish processors in the surveyed fishing communities. It is well known that having knowledge or information (awareness) is the foremost and critical stage in the five-step innovation adoption process followed by interest, evaluation, trial, and adoption (Özçatalbaş, 2014). In agreement, Odediran and Ojebiyi (2017) opined that high level of awareness is a key requirement for technologies to be adopted. Therefore, this situation requires that fish processors be reached with available innovations to enable them to utilize such for increased productivity and better living standards. We found that awareness of improved fish smoking oven was considerably higher among smoked fish processors in Epe (data not shown). This implies that Epe has received much attention of the extension agencies, research institutes and/or non-governmental bodies in terms of information dissemination through several channels when compared with other study locations. This assertion was confirmed through several reported studies on fishing activities and fish processing in Epe, Lagos State (Ajagbe *et al.*, 2012; Adeyeye *et al.*, 2015; Okeowo *et al.*, 2015; Odediran & Ojebiyi, 2017).

Table 3 shows the adoption level of each improved traditional smoking oven. More than 60% of the respondents who were aware of improved traditional smoking oven did not try to use it. Furthermore, 38.5% of the fish processors tried the usage of improved mud oven while 32.7% of them adopted but discontinued its usage with time. Meanwhile, 5.8% of them rejected the innovation after few moments of trial. Regarding chorkor oven, only 4.2% of respondents tried and adopted the innovation

but it was discontinued. Consequent to the low level of awareness of improved processing equipment, the adoption rate of the different improved fish smoking ovens was also low. This agrees with the findings of Bolorunduro *et al.* (2005) who reported low adoption level of improved smoking kilns (Altona, Chorkor, Burkinabe and Watanabe) among smoked fish processors in Northwestern Nigeria. Odediran and Ojebiyi (2017) also reported low adoption of charcoal fish smoking kiln among fish processors in Lagos State.

#### *Reasons for non-adoption and/or discontinuance of improved traditional smoking ovens*

The results on the reasons for non-adoption and/or discontinuance of improved traditional smoking oven are presented in Table 4. It reveals that fish processors indicated lack of awareness of the technologies (66.0%) and lack of access to the technologies (31.3%) were the major reasons for their non-adoption of improved traditional smoking ovens. This is because most of the technologies were presented to fish processors, especially their Union Leaders, during workshops without providing means for the fish processors to access the technologies for their use. This might suggest inadequate information dissemination and knowledge sharing by extension personnel and/or among fish processors. Other important reasons, based on the responses of significant proportion of the fish processors include low carrying capacity due to limited number of fixed wire mesh (18.9%), high cost of procuring modern smoking kiln (15.6%), difficulty in turning fish during smoking (11.1%), and low relative advantage (5.23%). This agrees with the established fact that innovation to be adopted should be of superior advantage and more economic-efficient compared to

the technology that will be replaced (Rogers, 2003; Wisdom *et al.*, 2014). Other constraints noted by the respondents are lack of repair and maintenance service (4.58%), and lack of interest in the technologies (1.96%).

Symbolic rejectors, who based their decision on the dissatisfaction expressed by their peers, confirmed the impact of social influence from interpersonal sources (family, friends, peers and colleagues) as a major determinant in the adoption of innovative technology, primarily in stages of trial and final adoption. This implies that socio-economic, political, cultural and technological factors play significant role in the adoption of innovations. Meanwhile, for the adoption of fish processing technologies to take place, it is expected that innovations or improved technologies that do not receive high awareness should be re-introduced and popularized and that the strengths and possible opportunities of adopting such technologies should be duly demonstrated (Olaoye *et al.*, 2016). Therefore, proper dissemination which ensures that the innovations developed on improved fish processing equipment and techniques reach the active fish processors in Lagos State should be done by extension agents.

#### *Fisheries extension variables associated with fish processing in Lagos Lagoon*

Table 5 shows the fisheries extension variables associated with fish processing in the study area. Almost all (99.4%) of the fish processors were aware of fisheries extension services within the study area. More than half (53.9%) of the fish processors became aware of extension services through extension visits while 46.1% became aware through fellow fish processors. More than half (53.5%) of the respondents have been visited at one time or the other. To worsen the situation, most (84.2%)



of the visited fish processors were visited on irregular basis. This implies inadequate and untimely access to information. This confirms the reason for low level of awareness and adoption of improved technologies by the fish processors. It is generally believed that adoption of innovation begins with awareness which occurs when an individual knows that such an idea exists (Wisdom *et al.*, 2014). Beyond this, however, the time required to complete innovation adoption process varies according to the characteristic of innovation, the way it is presented, and the characteristics of individuals (Özçatalbaş, 2014). Therefore, extension workers are expected to be consistent and persistent in the dissemination and demonstration activities in order to hasten the adoption of technologies being introduced.

Regarding the period of fish processors' contact with extension agents, most of them were visited for the first time (45.1%) and the last time (59.8%) between the years 2010-2018. Noteworthy is the fact that extension agents in Nigeria are very dutiful owing to the high intensity of their extension services as evident in higher level of awareness by stakeholders in fishery sectors (Ogunremi *et al.*, 2016; Olaoye *et al.*, 2016). However, the likely reasons for differences in the period of visit by extension workers could include proximity of fish processing centres or communities to extension offices, inadequate number of extension workers, inadequate funding and other logistics.

#### *Perceived effectiveness of extension services by fish processors in Lagos Lagoon*

Perceived effectiveness of extension services among fish processors is presented in Table 6. Most (75.1%) of the respondents had not received any form of training on fish processing by the extension workers. Various aspects of

fish processing covered during the training attended include the use of improved mud oven (63.2%), modern smoking kiln (23.7%), and improved smoking techniques (13.2%). Some (27.5%) of the respondents asserted that the training programmes were organized by extension workers through organizations such as FADAMA, Advancing Capacity to support Climate Change Adaptation (ACCCA), and All Farmers Association (AFAN). There is high degree of variation in respondents' participation in each of the training programmes organized. Results show that 17.7% of the respondents usually participate in the training programmes on a regular basis while about 19.0% attend occasionally. Effectiveness and efficiency of the extension services provided by extension workers on information sharing and demonstration of improved fish processing technologies were assessed by fish processors majorly as poor (42.5%), fair (30.1%) and good (15.0%).

#### *Correlation analysis of the socio-economic characteristics, fish smoking activities and adoption of improved smoking ovens*

In this study, certain socio-economic factors of respondents (variables) were tested on the fish processing activities and adoption of improved traditional smoking oven. For all significant variables, the correlation coefficients ' $r$ ' was very weak ( $r < 0.4$ ) showing a weak relationship among variables. Results of Pearson Product Moment Correlation (PPMC) analysis as presented in Table 7 showed that significant association exist between mode of fish smoking operations and gender ( $r = 0.23$ ,  $P < 0.01$ ), educational level ( $r = 0.25$ ,  $P < 0.01$ ), and household size ( $r = 0.21$ ,  $P < 0.05$ ). The implication is that women with higher literacy and family size are more likely to smoke fish on a full-time basis. The significant inverse

correlation of frequency of fish smoking to the age of respondents ( $r = -0.27$ ,  $P < 0.01$ ) indicates that productivity and output would diminish as age impresses due to the reduction in physical strength and energy required to carry out tedious tasks in fish processing (Olaoye *et al.*, 2012).

The negative relationship between frequency of fish smoking and gender of respondents ( $r = -0.30$ ,  $P < 0.01$ ) confirms the assertion that fish smoking in artisanal fishery is the exclusive responsibility of women, and that frequency of fish smoking would decrease if more men are involved in fish smoking in this study area. More so, an inverse correlation of frequency of fish smoking to marital status ( $r = -0.17$ ,  $P < 0.05$ ) and household size ( $r = -0.18$ ,  $P < 0.05$ ) implies that married women with large family size would require more time to discharge the family responsibilities. Olaoye *et al.* (2016) and Odediran and Ojebiyi, (2017) reported that marriage was highly cherished by fisher folks in Southwest Nigeria, thereby always express their commitment to the obligations conferred on them by marriage. The study also found that the frequency of fish smoking was inversely correlated with years of experience in fish smoking ( $r = -0.29$ ,  $P < 0.01$ ). This implies that older smoked fish processors would employ their expertise to ensure a known quantity of fish is smoked in fewer batches.

There was statistically significant inverse correlation between adoption of improved smoking oven and age ( $r = -0.32$ ,  $P < 0.01$ ), marital status ( $r = -0.22$ ,  $P < 0.01$ ), as well as fish smoking experience ( $r = -0.20$ ,  $P < 0.05$ ). This points out that there is the likelihood that adoption level would decrease among older, married smoked fish processors who might not be able to procure or construct the improved ovens. This probably could be

due to their financial responsibility as a larger share of their income might be used to cater for the family needs. In agreement, Odediran and Ojebiyi (2017) had noted that fish processors who are breadwinners of their households expend more of their income to meet the household needs.

#### *Regression analysis for the determinant of adoption of improved fish smoking oven*

Table 8 revealed that adoption of improved smoking oven by smoked fish processors is significantly predicted by their age ( $\beta = -0.658$ ,  $P < 0.001$ ), years of fish smoking experience ( $\beta = 0.444$ ,  $P < 0.01$ ), frequency of fish smoking ( $\beta = -0.163$ ,  $P < 0.05$ ), extension agent visit ( $\beta = 0.338$ ,  $P < 0.001$ ), training on fish smoking ( $\beta = 0.285$ ,  $P < 0.01$ ) and effectiveness of extension services ( $\beta = -0.232$ ,  $P < 0.05$ ). The  $R^2$  of 0.366 for the regression analysis model with F-value of 6.638 and 0.1% significant level implies that 36.6% of the variability in the smoked fish processors' adoption of improved smoking oven is explained by their age, fish processing activities, and effectiveness of extension services. The negative relationship between age and adoption of improved smoking oven implies that as age increases the smoked fish processors become less productive as per *a priori* expectation. Thus, they might not be enticed to adopt any improved technologies. Therefore, educated young people should be encouraged to be involved in fish processing so as to promote the adoption of improved technologies.

Fish smoking experience had a positive influence on the adoption of improved smoking oven which could be due to sufficient mastery of fish processing skills and better resource-use efficiency as years of experience increase. This is in congruence with the finding of Bolorunduro

*et al.* (2005) and Odediran and Ojebiyi (2017) who stated that the more the fish smoking experience, the higher the tendency for the adoption of fish processing technologies. The positive coefficient of improved smoking oven adoption and extension visits, training on fish smoking as well as effectiveness of extension services was the *a priori* expectation which indicates that with more visits and effective information dissemination on modern fish smoking technologies, there is a higher prospect for the adoption of improved techniques or innovations among smoked fish processors. This is strongly supported by Bolorunduro *et al.* (2005) who reported a significant correlation between extension contacts and adoption of improved smoking oven. Summarily, this study found that respondents' age, marital status, years of experience in the fish processing business, extension visits, training on fish smoking and effectiveness of extension services would influence the adoption of improved traditional fish smoking oven among fish processors in Lagos State. Based on the findings of this study, the null hypotheses tested were rejected. This implies that adoption of improved traditional fish smoking oven depends on the socio-economic characteristics of fish processors and the effectiveness of fisheries extension services.

### Conclusions and Recommendations

The study revealed that smoked fish processors were mostly women within the economically active age with nearly half of them having no formal education and majority of them being married. All the processors used traditional smoking oven such as drum oven, box oven and mud oven. Most of the fish processors were not aware of improved fish smoking equipment. The adoption level of improved fish smoking ovens was low with its usage

being discontinued over time. Irregular visits of extension agents to the study area had negative impact on the adoption of improved traditional smoking ovens. The null hypotheses tested were rejected because socio-economic characteristics and access to extension services influenced the adoption of improved smoking oven.

Extension agents should ensure proper dissemination of innovations developed on improved fish processing equipment and techniques to the active fish processors in Lagos State. More so, all concerned stakeholders, particularly Lagos State Agricultural Development Authority (LASADA), should endeavor to extend their coverage area to other locations, especially Agbowo-Ikosi, Bayeku and Ejinrin using as many channels as possible. Fish processors should be empowered financially by the government and other funding bodies so that they can procure (or acquire) the improved smoking oven such as chorkor oven, smoking kiln or FAO-Thiaroye Oven. Also, modern fish processing centres should be constructed in fishing communities along Lagos Lagoon to facilitate processors' access to the technologies. Educated youths should be encouraged to be involved in fish processing so as to promote the adoption of improved technologies.

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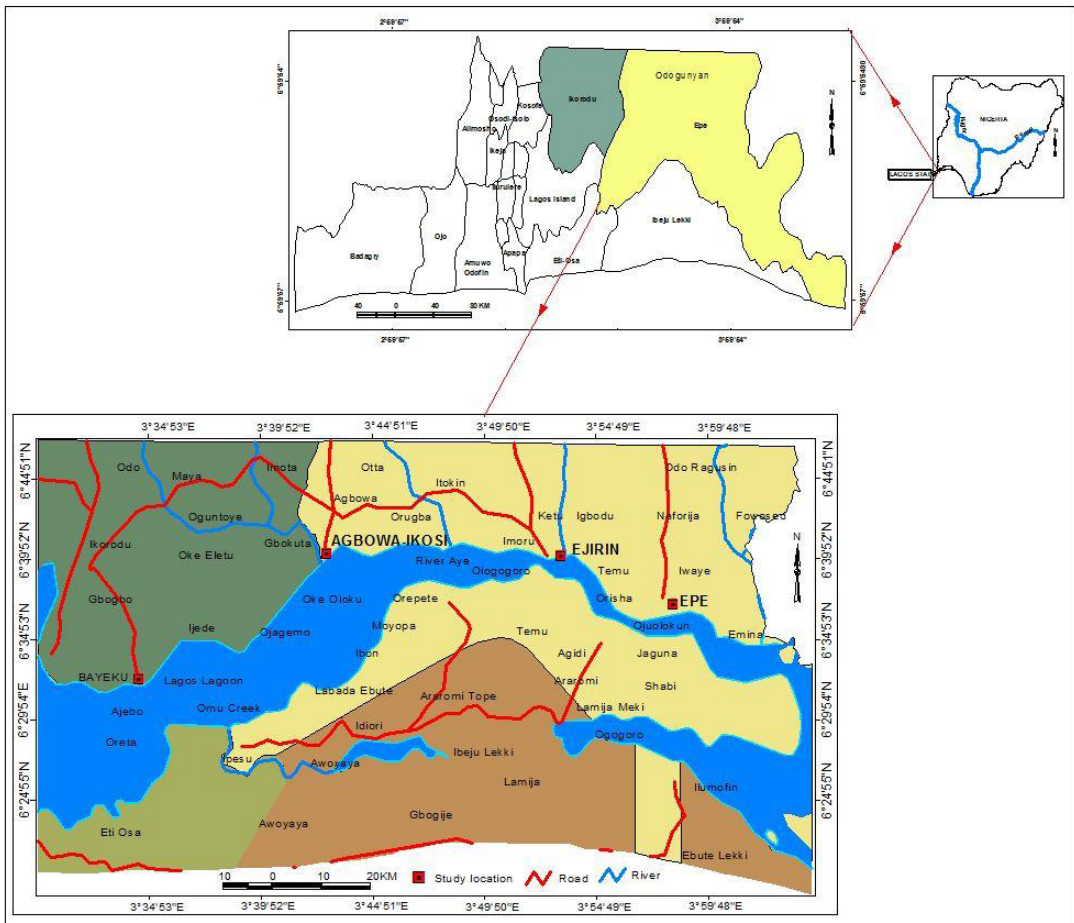


Fig. 1: Map of Lagos Lagoon showing Study Area  
Source: Field survey, 2018

TABLE 1  
*Socio-economic Characteristics of Fish Processors in Lagos Lagoon, Nigeria*

<i>Characteristics</i>	<i>Frequency</i>	<i>Percentage (%)</i>	<i>Mean</i>
<b>Gender</b>			
Female	152	99.4	
Male	1	0.7	
<b>Age</b>			
< 30	44	28.8	
31 – 40	39	25.5	41.7 years
41 – 50	36	23.5	
51 – 60	22	14.4	
> 60	12	7.8	
<b>Marital status</b>			
Single	1	0.7	
Married	140	91.5	
Separated	3	2.0	
Widow	9	5.9	
<b>Highest Education</b>			
Non formal	76	49.7	
Primary	45	29.4	
Secondary	30	19.6	
Tertiary	2	1.3	
<b>Total household size (Persons)</b>			
1 – 5	66	43.1	6.2 per- sons
6 – 10	78	51.0	
11 – 15	9	5.9	
<b>Years of experience in fish smoking</b>			
1–10	40	26.1	
11–20	45	29.4	22.6 years
21–30	34	22.2	
31–40	21	13.7	
> 40	13	8.5	
<b>Membership of Social Organizations*</b>			
Fish Processors' Association	150	98.0	
Cooperative Society	5	3.3	
None	2	1.3	

Source: Field survey, 2018; \*Multiple Responses

TABLE 2  
*Fish Processing Activities and Income Level of Fish Processors in Lagos Lagoon*

<i>Variables</i>	<i>Frequency</i>	<i>Percentage (%)</i>	<i>Mean</i>
<b>Mode of fish processing operations</b>			
Full time	139	90.8	
Part time	13	8.5	
Occasionally	1	0.7	
<b>Other Occupations</b>			
Civil service	4	2.6	
Trading	6	3.9	
Vocational Job (Hair dressing, tailoring)	3	2.0	
Fishing	1	0.7	
None	139	90.8	
<b>Reason for going into Fish Smoking*</b>			
To make profit	149	97.4	
To meet subsistence need (household consumption)	23	15.0	
To augment income from other sources	9	5.8	
As hobby	3	2.0	
<b>Frequency of fish smoking (number of times per week)</b>			
1 – 3	1	0.7	6.8 times
4 – 6	17	11.1	
7	135	88.2	
<b>Quantity of fish usually smoked per time (kg)</b>			
≤ 100	73	47.7	132.1 kg
101 - 200	61	39.9	
201 - 300	15	9.8	
≥ 301	4	2.6	
<b>Estimated Monthly Income (₦)</b>			
≤ 30,000	49	32.0	₦48,274.51K
31,000 – 60,000	70	45.8	
61,000 – 90,000	25	16.3	
≥ 91,000	9	5.9	

Source: Field survey, 2018; \*Multiple Responses

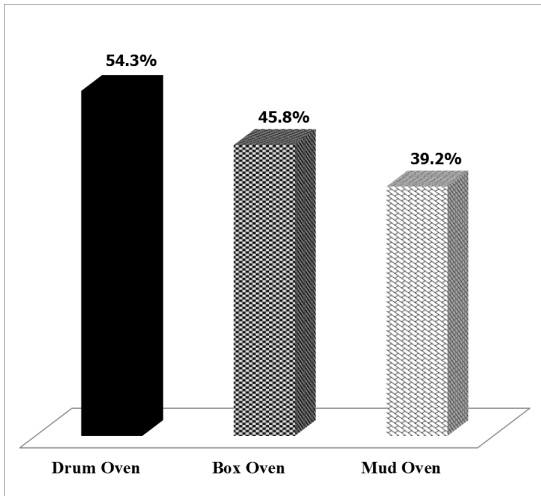


Fig. 2: Types of smoking oven used by the respondents

TABLE 3

Adoption levels of improved traditional smoking oven

Improved Smoking Oven	Decision <sup>#</sup>				
	Aware	Trial	Reject	Adopted	Discontinued
Improved mud oven	52 (34.0)	20 (38.5)	3 (5.8)	17(32.7)	17 (32.7)
Improved box oven	24 (15.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Chorkor oven	24 (15.7)	1 (4.2)	0 (0.0)	1 (4.2)	1 (4.2)
Smoking kiln	31 (20.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Source: Field survey, 2018; <sup>#</sup>Percentage (%) in Parentheses; n = 153 for “Aware” while for others, n = “Aware”.

TABLE 4

Reasons for non-adoption of improved traditional smoking oven (n=153)

Constraints	Frequency	Percentage (%)
Lack of awareness of the technologies	101	66.0
Lack of access to the improved technologies	48	31.4
Low carrying capacity due to limited number of fixed wire mesh	29	19.0
Difficulty in turning fish during smoking	17	11.1
Low relative advantage over traditional smoking oven (Longer smoking duration)	8	5.2
Lack of repair and maintenance service	7	4.6
High cost of procuring the improved technologies (Smoking kiln)	24	15.7
Lack of interest in the technologies	3	2.0

Source: Field survey, 2018; \*Multiple Responses

TABLE 5  
*Awareness of extension services by Fish Processors in Lagos Lagoon*

<i>Extension service variables</i>	<i>Frequency</i>	<i>Percentage (%)</i>
<b>Awareness of fisheries extension services</b>		
Yes	152	99.4
No	1	0.7
<b>Sources of awareness</b>		
Extension Visits	82	53.9
Fellow fish processors	70	46.1
<b>Visitation by fisheries extension agents</b>		
Yes	82	53.6
No	71	46.4
<b>Frequency of fishery extension visit*</b>		
Fortnightly	3	3.6
Monthly	1	1.2
Quarterly	2	2.4
Twice a year	7	8.5
Not regularly	69	84.2
<b>First contact with extension agents (Year)*</b>		
1990 – 1999	3	3.7
2000 – 2009	8	9.8
2010 – 2018 (Present)	37	45.1
Not Certain (Forgotten)	34	41.5
<b>Last contact / visit by extension agents (Year)*</b>		
1990 – 1999	1	1.2
2000 – 2009	0	0.0
2010 – 2018 (Present)	49	59.8
Not Certain (Forgotten)	32	39.0

Source: Field survey, 2018; \*Sample size = 82 (visited fish processors).

TABLE 6  
*Perceived effectiveness of extension services by Fish Processors in Lagos Lagoon*

<i>Extension service variables</i>	<i>Frequency</i>	<i>Percentage (%)</i>
<b>Training on fish processing /smoking</b>		
Yes	38	24.9
No	115	75.1
<b>Aspect of fish processing covered by the training (n=38)</b>		
Use of Improved mud oven	24	63.2
Modern smoking kiln	9	23.7
Improved smoking techniques	5	13.2
<b>Training programmes organized by extension agents (n=153)</b>		
Yes	42	27.5
No	2	1.3
I don't know	109	71.2
<b>Extension agency (n=153)</b>		
FADAMA	38	24.8
ACCA	4	2.6
AFAN	1	0.7
I don't know	110	71.9
<b>Frequency of Participation (n=153)</b>		
Regularly	27	17.7
Sometimes	11	7.2
Occasionally	29	19.0
Not at all	86	56.2
<b>Effectiveness of fisheries extension services (n=153)</b>		
Excellent	6	3.9
Good	23	15.0
Fair	46	30.1
Poor	65	42.5
Very Poor	13	8.5

Source: Field survey, 2018.



TABLE 7  
*Correlation analysis of the socio-economic characteristics, fish smoking activities and adoption of improved smoking ovens*

<i>Variables</i>	<i>Mode of fish processing operations</i>	<i>Frequency of fish smoking</i>	<i>Quantity of fish smoked</i>	<i>Income level</i>	<i>Smoking oven used</i>	<i>Adoption of improved smoking oven</i>
Age	0.081	-0.274**	-0.037	-0.083	-0.059	-0.322**
Gender	0.230**	-0.303**	-0.008	0.175*	0.011	0.030
Marital status	0.051	-0.173*	-0.049	-0.079	0.059	-0.221**
Education level	0.254**	-0.025	-0.166*	-0.161*	0.052	0.125
Household size	0.206*	-0.184*	-0.148	-0.069	0.142	-0.148
Fish smoking experience	0.079	-0.292**	0.032	-0.002	-0.040	-0.204*

Source: Field survey, 2018; Correlation level of significance at 2-tailed: \* =  $P < 0.05$ ; \*\*  $P < 0.01$ ; \*\*\*  $P < 0.001$

TABLE 8  
*Estimates of regression analysis for the determinant of adoption of improved fish smoking oven*

	Parameters	Unstandardized Coefficients		Standardized Coefficients	t-ratio
		$\beta$	Std. Error	$\beta$	
Constant	$\beta_0$	2.578	0.491		5.250***
Age ( $X_1$ )	$\beta_1$	-0.015	0.004	-0.658	-3.847***
Gender ( $X_2$ )	$\beta_2$	-0.212	0.293	-0.053	-0.724
Marital status ( $X_3$ )	$\beta_3$	-0.032	0.035	-0.076	-0.911
Education level ( $X_4$ )	$\beta_4$	0.017	0.030	0.042	0.552
Household size ( $X_5$ )	$\beta_5$	-0.001	0.010	-0.008	-0.112
Fish smoking experience ( $X_6$ )	$\beta_6$	0.010	0.004	0.444	2.621**
Frequency of fish smoking ( $X_7$ )	$\beta_7$	-0.071	0.034	-0.163	-2.076*
Quantity of fish smoked ( $X_8$ )	$\beta_8$	0.000	0.000	0.099	1.360
Smoking oven used ( $X_9$ )	$\beta_9$	-0.001	0.029	-0.002	-0.029
Extension agent visit ( $X_{10}$ )	$\beta_{10}$	0.220	0.068	0.338	3.250***
Training on fish smoking ( $X_{11}$ )	$\beta_{11}$	0.182	0.051	0.285	3.586***
Perceived effectiveness of extension services ( $X_{12}$ )	$\beta_{12}$	-0.077	0.036	-0.232	-2.163*

Source: Field survey, 2018; R = 0.605; R Square ( $R^2$ ) = 0.366; Adjusted  $R^2$  = 0.311; F-value = 6.638 @  $P < 0.001$ ; \* =  $P < 0.05$ ; \*\*  $P < 0.01$ ; \*\*\*  $P < 0.001$