UNIZIK Journal of Agricultural Economics and Extension (UJAEE) Vol. 1 No.2 (2024): 351-360
A Journal of the Department of Agricultural Economics and Extension, Nnamdi Azikiwe University, Nigeria
Available at: https://journals.unizik.edu.ng/ujaee

Determinants of Choice of Energy in Bush Meat Smoking Preservation Method by Households in Ebonyi State, Nigeria

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KEYWORDS:
Bush Meat, Energy Sources, Households Smoking, Hunting

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ABSTRACT

Bush meat smoking preservation method and choice of energy source is a function amongst other factors. The study provided empirical evidence on the bush meat smoking preservation method and choice of energy sources among hunting households in Ebonyi State, Nigeria. Eighty households were selected using multistage random sampling techniques. Structured questionnaire and oral interview schedule were used to collect primary data. Percentage responses and multinomial legit models were used to address the objectives of the study. The socioeconomic characteristics of the hunting household result showed that most of the respondents were males, high processing experienced, had more formal education and moderate household size. More so, the types of biomass energy sources for meat smoking by the respondents were wood (90%), charcoal (77.5%), agricultural residues (66.5%) and dung (15%). As well, the determinant to choice of biomass energy was educational level, membership of business organization and years of farming experience in meat processing. The constraints to meat smoking in the study area were seasonality of bush meat (90%) zoonotic connection (85%), scarcity of firewood (67.3%), problem of attack of smoked meat by predators (61.25%) and environmental pollution (70%). There is need to increase households' access to educational programmers and experienced household members should be encouraged to remain in the business.

INTRODUCTION

The importance of smoking bush meat tends towards amongst increasing the palatability by adding flavor and imparting a rich brown color to the product. Despite the aforesaid odds, coupled with government regulations on hunting, yet the business continued to grow unabated in most rural areas in humid tropics of Africa, Asia and South America as source of animal protein, cash-earning for the hunting households and source of Gross Domestic Product to many countries (GDP) (Mohamed, 2018).

The hunters because of certain factors, such time of killing the animal, failure in price negotiation with customer (Adeyemi *et al.*, 2017) and among other reasons, could decides to preserve the meat. Among the most popular ways of preserve meats was through smoking (Tchereni, 2013). Basically, smoking is aimed to dehydrates the meat, changes the surface to be acidic and thereby it unreceptive to bacteria, and enhance the taste of the meat (Oyedepo, 2012). However, in many rural areas of the sub-Saharan Africa, access to modern, affordable and reliable energy services is a herculean task (Onyekuru *et al.*, 2021). In such society, most household, hunters inclusive,

biomass fuel is the major source of energy for cooking and heating, of which wood is most preferred, followed by charcoal, dung, agricultural residues and sometimes even leaves and grass in that order (Emagbetere *et al.*, 2016; Karakara *et al.,* 2019). In smoking according to Karakara *et al. (*2019), the containers usage may differ, but primarily the aim of the exercise is that meats are hung or placed on racks in an enclosed area so that the smoke does not escape and instead penetrates into the meat. Though, studies show that more than 70% of households in the rural areas of the developing countries use this biomass energy products for domestic cooking and in generating heat, but the undesirable aftermath of the use of the product to human health and the environment are well acknowledged (Oyedepo, 2012, Tchereni, 2013; Onyekurum, *et al;* 2020). The use of solid fuel as asserted by Ude *et al.* (2024), Efaisal *et al.* (2013) and Tolutope and Ayodele (2012), has some environmental implications (such as increase greenhouse gas emission, deforestation and desert encroachment) and adverse human health (including cardiovascular disease, respiratory diseases and lung cancer). Additionally, according to Daioglou *et al.* (2012) the cost involved in terms of human energy and time required to collect and process such fuel has serious implications for productivity and gender equity.

However, literatures (Karakara *et al.* 2019; Daioglou *et al*., 2012; Tolutope & Ayodele, 2012; Oyedepo, 2012) have shown that several socioeconomic factors included age of household, income, education, and household size, ownership of the house and type of home, influence the households' choice of energy to be used. Presently, there is no data documented in the study area on the types of biomass energy sources and choice of the energy sources among bush meat hunting households to the best knowledge of the researcher. Therefore, producing data relating to hunting household objectives (smoking energy sources and choice of the energy sources) could facilitate in filling the existing knowledge gap. Specifically, the study identified the traditional methods of bush meat smoking based on biomass energy sources use by the respondents, determined factors affecting respondents' choice of traditional methods of bush meat smoking based on biomass energy sources and constraints to bush meat smoking.

METHODOLOGY

The study was carried out in Ebonyi State of Nigeria. The State is located between latitude $5^0$41' and $6^0$50'N of Equator and Longitude $5^0$25' and $7^0$30E of Greenwich Meridian. Its rainfall ranges from 1500 mm-2500 mm per annum, temperature of 28-48^{0}C and average relative humidity of 75%. It is bounded in the North by Benue State, South by Abia State, in the East by Cross River State and in the West by Enugu State. Ebonyi State is made up of 13 local government areas and three Agricultural zones namely North, Central and South. The North agricultural zone consists of four local government areas: Abakaliki, Ebonyi, Izzi and Ohaukwu. The Central Agricultural zone has four Local Government Areas: Ezza North, Ezza South, Ikwo and Ishielu, while the South agricultural zone has five local government areas: Afikpo North, Afikpo South, Ivo, Ohaozara and Onicha. Among the crops planted there are cassava, yam, sweet potato, rice, maize and tomato. Also, among the domestic animals reared are goat, sheep, local cow, poultry, rabbit, piggery and others. .The inhabitants also engaged on off-farm income activities such as hunting, saloon, petty trading, auto-mechanics, civil servants and brick layers (Wikipedia, 2012).

The study employed multi-stage purposive and random sampling. In the first stage, two (2) Agricultural zones out of three (3) were purposively selected. The choice was made based on high number of people involved in hunting there. The selected zones were Ebonyi Central and South agricultural zones. In the second stage, two (2) Local Government Areas were purposively selected randomly each of the Agricultural Zones. These brought to a total of four (4) Local Government Areas (LGAs). The selected LGAs from Ebonyi State were Izzi and Ohaukwu, while Afikpo North and South from Ebonyi South Agricultural zone. In the third stage, two (2) communities were

randomly selected from each of the LGAs, totaling eight (8) communities. Finally, from the lists provided by local leaders in each of the communities, ten (10) hunting households randomly selected and this this brought to a total of eighty (80) respondents for the study.

Primary data were collected through structured questionnaire and oral interview that were administered to the households. The study used descriptive statistics (such as percentage responses and Frequency Distribution Table) to identify the traditional methods of bush meat smoking based on biomass energy sources use, constraints to bush meat smoking by the respondents, while multinomial legit model was used to analyse factors affecting respondents' choice of traditional methods of bush meat smoking based on biomass energy sources.

Model Specification

The Multinomial Logit (MNLM) model was employed to analyze the factors influencing households' choice of energy sources in wild meat smoking. The model was favoured by literatures as it allows making choice across more than two groups in the dependent variable, thus making possible the tendency to choose energy sources. The MNL is likened by researchers than multinomial probit model due to its simplicity in computation (Oscar *et al.*, 2012).

The MNL model is expressed as follows;

$$P(y = j/x) = \exp(x\beta_j)/\left[1 + \sum_{h=1}^{J} \exp(x\beta_h), \; j = 12, \ldots . J\right]$$

Where, y indicates a random variable assuming the values {1, 2, …, J} for a positive integer J and x connotes a set of habituation variables. X is a 1xK vector with first factor unity and βj is a K×1 vector with j = 2, …, J. In this is situation, y signifies energy sources while x connotes wildmeat hunters' socioeconomic characteristics. The effects of the factors to their responses could be represented by the probabilities P(y = j/x), j = 1, 2, …,J . Since the chances should be totaled to unity, P(y = j/x) is resolute once the likelihood for j = 1, 2, …,J are identified. In the course of this study, hunting households' choice of energy in wild or bush meat smoking in order to ensure food security. These management practices of the choice group for the multinomial Logit model. To achieve unprejudiced and reliable parameter estimates of the MNL model in Eq. (1), the Independence of Irrelevant Alternatives (IIA) is believed to embrace (Oyedepo, 2012). The Irrelevant Alternatives (IIA)assumption requires that the odds of adopting wood source of energy by hunter household must be autonomous of the odds of opting another wood source of energy (that is, Pj/Pkis autonomous of the residual odds).The basis of this assumption is the autonomous and homoscedastic disturbance terms of the basic model in Eq. (1).The parameter estimates of the MNL model merely give the course of the outcome of the self-governing variables on the dependent (option) variable; hence the approximation does not symbolizes the real degree of change and the prospect, but can be best done with the marginal effects. Marginal effect according to Oscar, et al; (2014) estimates the anticipated variation in the chances of a specific system being selected with revere to a unit change in an autonomous variable from the mean. The model's marginal effect could be achieved through differentiating, Eq. (1) with revere to the descriptive variables as revealed in equation (2):

$$\frac{\partial P_j}{\partial X_k} = P_j\left(\beta_{jk} - \sum_{j=1}^{J-1} P_j \beta_{jk}\right)$$

It has also been noted that the signs of the marginal effects and respective coefficients may be different (Hassan & Nhemachena, 2008), since the former depends on the sign and magnitude of all other coefficients. Implicit expression of the model is ;

Y_i= In (P_i, P_1) = β_0 +β_1X_1 +β_2X_2 +β_3X_3 + β_4X_4 + β_5X_5 + β_6X_6 + β_7X_7 + β_8X_8 + β_9X_9+ $\beta_{10}X_{10}$ +ei…….(2)

Where; Y_i= Choice of energy (wood, charcoal, dung, agricultural residues such as leaves and grass).X_i, where I = 1,2,….10 are explanatory variables,X_1 = Age of the farmers (years), X_2 = Educational attainment (years), X_3 = Household size (in number), X_4 = Smoking experience (years), X_5=Member of meat smoking organization (yes=1 and 0 otherwise), X_6 = Extension services(Access; 1 and otherwise; 0).

RESULTS AND DISCUSSIONS

Socioeconomic Characteristics of the Respondents

The results of socioeconomic characteristics of the respondents are presented and discussed in Table 1. The study showed that 32.5% of the respondents were below 40 years of age, while 67.5% were above 39 years of age. Aged people could imply many years of observations and experimenting in smoking of meat, hence could efficiently accomplish the tasks of smoking of meat. However, the finding of Karakara *et al*. (2019) contradicted the above assertion. They argued that smoking of meat exercise is often labourious, especially in gathering of firewood and could be best accomplished by energetic youths. Majority (68.75%) of the respondents had household of size of 6-10 persons, the least (12.5%) had 11 and above persons. The size of household is a good indicator of labour available for implementing of activities in meat smoking such as cutting of the meats in desired sizes, washing, salting of the meat and fetching of firewood especially during top of farming season, when labour is expensive (Magbetere, 2016). As well, 25% of the respondents had years of smoking meat experience of less than 11years, whereas 75% had above 11 years. Long years of meat smoking experience enhances efficient use of scarce resources and setting of target in meat smoking preservation (Chausson *et al*., 2019). The finding of Akan *et al*. (2015) is synonymous with the result. Further, 87.5% of the respondents had no access to extension services, while 12.5% had access. This result is in line with the findings of Mohamed (2018) and Onyekuru *et al*. (2020) who reported that poor extension outreach in many developing countries. Nuno *et al*. (2012) noted that this could be as result of high extension- farmers' ratio. Extension services facilitate information dissemination to farmers, giving technical assistants about the technology and aiding farming households in sourcing meat smoking inputs.

Moreover, 37.50% of the sampled households had no formal education and 62.50% had formal education Educational status of the household could enhance his/her information seeking behaviour in improving meat smoking skills and knowledge. The finding of Hoffiman *et al*. (2011) was in consistent with the above statement. They opted that educated people are very receptive to new technology in order to increase their efficiency and effectiveness in carry out certain activities, meat smoking inclusive. Besides, 85% of the respondents were members of meat smoking organization, whilst 15% were not. This finding gave credibility to Subramanian (2012), who reported that meat smoking households that belong to organization have greater odds of improving their meat smoking efficiency through cross breeding of ideas among members

Table 1: Distribution of Respondents According to Socioeconomic Characteristics

Variable	Frequency (N=80)	Percentage (100 %)
Age		
20 – 29	6	7.5
30 – 39	20	25
40 – 49	32	40
50 – 59	14	17.5
60 and above	8	10
Household Size		
1 – 5	15	18.75
6 – 10	55	68.75
11 and above	10	12.5
Years of Meat Smoking Experience		
1 -5	8	10
6 – 10	12	15
11 – 15	30	37.5
16 – 20	20	25
21 and above	10	12.5
Extension contact		
Access	10	12.5
No access	70	87.5
Educational Level		
No Formal	45	37.50
Primary	20	25
Secondary	10	12.5
Tertiary	5	6.
Organization.		
Yes	68	85
No	12	15

Source: Field Survey, 2023

Types of biomass used in Meat Smoking

The results in Table 2 shows that the most important source of biomass source heat for smoking of the bush meat was use of firewood (90%). The use of fire wood is associated to two types of heat transfer: a transfer of heat by radiance and a transfer of heat by convection, which could give best smoked meat the desired brown, and/or add flavor in order to increase palatability of the meat compare to other method. This was followed by use of charcoal (77.5 %).

Table 2: Types of Biomass Used in Meat Smoking

Source	Frequency*	Percentage (%)
Wood	72	90.00
Charcoal	62	77.50
Dung	12	15.00
Agricultural residues	53	66.25

Source: Field Survey, 2023; *Multiple Responses Recorded

The findings agree with Kumlachew *et al.* (2014) who reported that smoking with charcoal has more convenience, less problem of fire disaster and produces meat of cleanest versions possible. The findings also agree with that of Rochlitz and Brown (2008) and Adeyemi *et al.* (2017) who reported that charcoal is pressed from saw into banquettes, a natural and sugar bases binding agents that burns clear. Also, literatures show that charcoal has a cooking time of about 30-45 minutes and once it reaches its peak temperature, it starts to cool quickly. Also, the least of the variables considered was use of animal dung, (15%). Again, the findings agree with the report of Schipper (2008) and Akan et al. (2015) who stated that animal dung contain arsenic in which the fumes when inhaled through respiratory tract could lead to diseases such persistent cough and chronic bronchitis. Combustion of dung is cumbersome and produces high emissions of carbon monoxide, hydrocarbons and particulate matter.

Choice of Traditional Methods of Bush Meat Smoking

To argue the interpretation of the estimated results of multinomial Logit regression, the marginal effects of each variable on the predicted probability of respondents' choice of traditional methods of bush meat smoking based on biomass energy sources were evaluated at the means of the explanatory variables, are presented in Table 3. The marginal effects report of the multinomial Logit regression provides the probability that households will make choice of traditional methods of bush meat smoking based on biomass energy sources available. The results provide the probability estimation for the likelihood of choice of traditional methods of bush meat smoking among households given the statistically significant variables as; age, educational level, household size, and hunting experience.

The results of the marginal effect of the multinomial Logit regression indicates that there is a probability of 0.80% that the household head will choose dung as source of energy in meat smoking than their counterparts who are older if their age decreases, at mean value by one year. This implied that the younger households will prefer to use dung as source of energy in meat smoking than their counterparts. This result is in agreement with Nuno *et al.* (2013). They stated that aged farmers are conservative and did not easily accept innovation such as meat smoking innovations with dung. However, the use of dung has proven to yield high quality smoked meats. Nevertheless, Zhou et al. (2014) found positive relationship between age and meat preservation. This relationship was borne out of the situation where the household population is predominantly youths. In this situation, there is likelihood that this class of household would had some formal education and therefore might be more successful in gathering information and understanding improved meat smoking practices, which in turn improve their efficiencies in meat perseveration.

More so, the marginal effect shows that there is probability of 0.62%, 0.23%, 0.01%, and 0.47% that the household heads will use firewood, charcoal, dung and agricultural residues respectively if their level of education increases by 1 year. High educational attainment by the respondents is a desirable condition for high meat preservation methods, smoking to be précised development, since it facilitates for ease of extension services in transferring improved research results in meat smoking for sustainable meat preservation (WildAIDS, 2021). Onyekuru *et al.* (2020) reported that the level of educational attainment by households would not only increase his or her meat smoking efficiency but also enhanced his/her ability to understand and evaluate improved meat smoking technologies. The study also showed that the probability that the household head to use firewood as source of energy in meat smoking will increase by 0.74% if there is additional one active member in the household, and also decrease by one active member will increase the use of dung by 0.38%. The number of years a household had spent in the smoking meat business, as asserted by Oyedapo, (2012) could give a clue of the practical knowledge he/she had gained on how he/she can overwhelm certain intrinsic meat smoking problems. Similarly, there is a probability of a 0.34%

and 0.32% that household will choose firewood and charcoal respectively as source of energy in meat smoking if there is increase in processing experience. The implication is that a year increase in meat smoking experience increased the household's prospect of adopting firewood and charcoal energy uses by approximately 0.34% and 0.32% respectively, relative to no adaptation. Duoglou *et al*. (2012) was of the view that as the number of years of experience of household in meat smoking experience increases, the more he/she gains more knowledge and information about meat preservation using smoking method in order to avoid possible spoilage of their meat. The findings of Onyekuru *et al.* (2020) concurred with the above result. The marginal effect shows that there is probability of 0.32%, 0.40%, 0.39% and 0.17% that the household head will select firewood, charcoal, dung and agricultural residue as source of energy in meat smoking respectively if there is additional active one member in the cooperative society. This result is in synchronization with Oyedapo, (2012) and Zafar, (2015), who was of the view that membership of meat organization enables members to have access to information as regards improved meat smoking technologies, material inputs of the technology (biomass energy sources, salt, smoking screen, and water), credit for payment of labour, capacity building and training. Kumlachew *et al*. (2014) made similar findings. They reported that through interaction among members, information on the subject under discuss could be harnessed for improvement of quality of meat smoked.

Table 3: Marginal Effects for Continuous Determinants of MNL Regression on Choice of Traditional Methods of Smoking Bush Meat

Variable	Firewood	Charcoal	Dung	Agricultural residues	No Adaptation
	Dy/dx	Dy/dx	Dy/dx	Dy/dx	Dy/dx
Age	0.0032	0.0035	-0.008*	0.0044	0.0675
Educational level	0.0062*	0.0023*	0.0001*	0.0047*	0.0055
Household size	0.0074*	0.0056	-0.0038*	0.0089	0.0012
Processing Experience	0.0034*	0.0032*	0.0032	0.0032	0.0022
Membership of cooperative organization	0.0032*	0.0040*	0.0039*	0.0017*	0.0033
Number of Extension contact	0.0042	0.0055	0.0052	0.0044	0.0077

*, ** and *** Statistical significance at 10%, 5% and 1% respectively
Source; Field Survey, 2023

Constraints to Meat Smoking

Seasonality of bush meat was reported by 90% of the sampled farmers. Literatures show that bush meats are very much available during dry season. In this season, grass and many shrubs are fast drying up thus exposing animal habitats for ease of hunting. Also, many streams and ponds are fast drying up, hence exposing the animals to hunters as they (animals) travel long distances for life sustenance compare to during rainy season (Wilkie *et al.*, 2014). As well, 85% of respondents were deterred from bush meat smoking business due to zoonotic connection. Literature show connection of bush meat consumption to Ebola and COVID 19 transmission through consumption of bush meat, since the diseases are zoonosis (Baselers *et al.*, 2017). Also, scarcity of firewood especially during rainy season for smoking of meat was reported by 67.3% of the respondents. During rainy season, firewood is not only scarce but very expensive (Fox *et al.*, 2003).

Besides, the problem of attack of smoked meat by predators (61.25%) was reported by the respondents. Literatures revealed that smoked meat can be attacked or eaten while in the smoked house or chamber by dog and cat, hence leading to losses to the owners (Hoffimann *et al.*, 2011).

Table 4: Constraints to Meat Smoking

Problems	Frequency	Percentage (%)
Seasonality of bush meat	72	90
Campaign of Ebola and COVID 19	68	85
Scarcity of biomss resources(firewood)	54	67.5
Time consuming	23	28.75
Storage problem	21	26.25
Attack of smoked meat by predators	49	61.25
Source of air Pollution	56	70
Fire burns	18	22.5

Source: Field Survey, 2023; *Multiple Responses Recorded

More so, 70% of the sampled farmers complained of environmental pollution often related to meat smoking. Batesson and Bradshaw, (2012) reported the oozing of odour and flies proliferation around the vicinity of meat smoking is a common place. This is capable being source of annoyance to the people living around in the surrounding (Ume, *et al*; 2021). As well, 70% of respondents complain of disease infection. The use of biomass as source of energy in smoking is capable of causing chronic obstructive pulmonary disease (COPD). This disease can be thought of as the physical manifestation of the pulmonary response to chronic inhalation of noxious particles (Rivera, Cosio, Ghezzo, Salazar, and Perez-Padilla, 2008). This finding was in harmony with Perez-Padilla, Schilmann, and Riojas-Rodriguez, (2010), who was of the view that airway inflammation, oxidative stress and protease/antiprotease imbalance are interlinked and all contribute to the development of COPD.

CONCLUSION AND RECOMMENDATIONS

The types of biomass energy sources used for meat smoking by the respondents were wood, charcoal and agricultural residues. Also, educational level, years of farming experience in meat smoking and household size were the determinant to choice of biomass energy source for meat smoking. Besides, the constraints to meat smoking in the study area were seasonality of bush meat, zoonotic connection, scarcity of firewood, problem of attack of smoked meat by predators and environmental pollution.

The study based on the finding proffered the following recommendations: The positive influence of education on the respondents' choice of energy sources for meat smoking, in this direction, there is need to strengthen the current policies on education such as basic education, adult education and nomadic education. Furthermore, the coefficient of the household smoking experience was positive therefore, the need to encourage new entrant, especially young and educated into meat smoking to absorb the available labour in order to reduce poverty should be advocated. Policies aimed at encouraging farmers to form cooperative/association should be advocated. Cooperative helps in capacity building, acquisition of credit, training and provision of production inputs to the members at reduced cost, hence enhancing their choice of adaptation. Policies aimed at employing more extension agents to guide smokers on choice of energy sources in order to achieve optimum meat preservation with desiring quality. In addition, smoked meat should be well guided with wire mesh to curtail attack by dog and mice, and also there is need to collect firewood during the dry season, when it is plenty compare to dry season.

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