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Determinants of participation in edible maggot collection among rural households: Implication for alternative animal protein source

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Abstract

The study examined the determinants of edible maggot collection among rural households in Delta State Nigeria. A total of 206 respondents were randomly sampled for this study. Data was statistically treated using frequency counts, percentages and means from 4- point likert-type scale and binary logistic regression analysis. The result from the study showed that the mean age of the farmers were 30 years, with an average household size of six persons having an average monthly income of N43600. Majority (53.04%) of the edible maggot collectors, collects edible maggot very often, about 54% of the respondent sources of labour comes from family. The respondents were able to meet the protein needs of their family and better their standard of living through the income derived from participation in collecting edible maggot. some of the constraints identified were inadequate labour, long distance to collection site, low acceptability and consumption rate. The r^2 value of 0.78 shows that 78% of the respondents involved in edible maggot collection were significantly influenced by their socio-economic characteristics such as age, educational level, distance to collection site, household size, extension contact, rate of acceptability, rate of consumption, and cultural barriers. The major constraints identified were low level of consumption and acceptability, as well as bad roads to market, hence it was recommended that more awareness about the nutritional benefits of edible maggot should be created by extension agent and governments should create good road network in the rural areas to enable easy access to urban market.

Keywords: Alternative protein, consumption rate, collection, edible maggot, entomophagy, source

Introduction

Insect-based feed for livestock remains a largely untapped resource, offering a rich source of high-quality protein and energy (Müller *et al.*, 2013; Schiavone *et al.*, 2017) [28, 29]. Although insect-derived foods are not yet common in the diets of humans and animals in many countries, their consistent use presents significant environmental and economic advantages (van Huis *et al.* 2013; Pimentel *et al.* 2003; Halloran *et al.* 2017; Oonincx *et al.* 2010) [30, 31, 32, 33]. Growing evidence suggests that replacing traditional animal-based foods with insect-derived alternatives may provide notable health advantages (Payne *et al.* 2016; Latunde-Dada *et al.* 2016; Chesto *et al.* 2015; Cito *et al.* 2017) [34, 35, 36, 37]. Therefore, expanding the use of insect-based foods not only yields clear environmental and societal benefits but also holds significant promise for enhancing individual health. Moreover, the urgency to adopt such dietary changes is intensifying as the global population approaches nine billion, and concerns about resource scarcity and food sustainability become increasingly critical (Lerner *et al.* 2017; Barnosky *et al.* 2017) [38, 39]. Globally, insect consumption spans several major orders. In Orthoptera, examples include crickets like *Brachytrupes membranaceus* (Drury), grasshoppers such as *Zonocerus variegatus* (Linnaeus), and various locusts like *Locusta*

migratoria migratorioides (R. & F.), *Nomadacris septemfasciata* (Serville, the red locust), and *Schistocerca gregaria* (Forsskål, the desert locust). In the Hymenoptera order, species like *Apis mellifera* (Linnaeus, the honeybee) are consumed. Isoptera include termites such as *Macrotermes bellicosus* (Smeathman), while Lepidoptera feature caterpillars like the mopane worm (*Gonimbrasiabelina*, Westwood). Coleoptera examples include beetles such as *Zonocerus phoenicis* (Fabricius) and *Eretessticticus* (Linnaeus) (Halloran *et al.*, 2017) [32]. Despite the widespread presence of edible insects, insect farming remains largely undeveloped. Most insects consumed today are still harvested from the wild. For instance, the giant cricket *Brachytrupes membranaceus*, a common root crop pest, is typically dug out of the ground, roasted, and enjoyed as a delicacy. The larva and adult of the *Raphia* palm wine weevil (*Rhynchophorus phoenicis*) (F.) are cherished as food among the many communities in Nigeria and around the world, especially in those places where palms (oil, *raphia* and coconut) are cultivated on commercial basis (Renner *et al.* 2018) [24]. Insects are a nutrient-dense food source, rich in protein, essential vitamins, and minerals. They are particularly high in B-vitamins and iron. According to Van Huis (2003) [27], insects often contain greater amounts of protein, fats, and

carbohydrates than equivalent servings of beef or fish. Furthermore, research by Alamu *et al.* (2013) ^[40] indicates that insect protein content surpasses that of soybeans, maize, beef, fish, lentils, chicken, and other legumes.

A report by FAO (2017) ^[10], highlights that many caterpillar species are especially abundant in minerals such as potassium, calcium, magnesium, zinc, and iron, in addition to B-vitamins. Also, in certain ethnic communities, insects contribute 5-10% of the annual protein intake, while also providing calories, fats, vitamins, and minerals. Moreover, insect consumption and harvesting can help alleviate unemployment by offering alternative livelihood opportunities.

In Nigeria, the larva and adult of the palm wine weevil (*Rhynchophorus phoenicis*) popularly known as edible maggot is consumed as staple food, it is consumed boiled, fried and even eaten raw as snacks by most people. It is sold in the market, along the road by hawkers, and on motor parks in South-East and South-South, Nigeria. It is common in Delta, Rivers, Edo and other Southern states of the country (Renner *et al.*, 2018.) ^[24] There is a growing demand for animal protein, and according to Ebenebe (2005) ^[41], the current rate of protein consumption is 7-10 g/person/day, falling short of the 34 g/person daily standard set by the Food and Agriculture Organization (FAO) of the United Nations. Given this knowledge, it is imperative to advance the usage and development of edible insects as a substitute for diets lacking in nutrients and to enhance the health of the world's rapidly expanding population (FAO, 2017) ^[10], according to Timbermont *et al.* (2010) ^[25].

Although various research has been carried out to ascertain the nutritional benefit of edible insect and types of edible insect in Nigeria, the determinants of participation in the collection of edible maggots in rural households have not been properly x-rayed. Thus, the study was thought out to examine the determinants of participation in edible maggot collection among rural households in the study area in order to fill the protein need gaps of the people as a substitute for conventional animal protein and provide a guide for extension practitioners in disseminating information. Hence the study is meant to determine the socio-economic characteristics of edible maggot collectors; examine the level of participation, ascertain the collectors' sources of labour; perceived benefits derived from edible maggot collections, determine the constraints to edible maggot collections and access the influence of socioeconomic characteristics on level of participation in edible maggot collection.

Materials and Methods

The study was carried out in Delta state Nigeria from May 2024 to December 2024. Delta state is located between longitude 5°00' and 6°45' East and latitude 5°00' and 6°30' North. The state is 7440 km² in size and is located in the mangrove swamp and rain forest, and fresh water forest in the south and central agricultural zones respectively. The north agricultural zone is under derived savannah vegetation cover. The state is bounded on the north by Edo State, on the South by Bayelsa State, on the east by Anambra state, on the west by Atlantic Ocean. It consists of twenty-five local government areas with a population of 6,037,667 (NPC, 2023) ^[18]. The state is divided into three agricultural zones

which include Delta North, Delta South and Delta Central agricultural zones. Having a lot of farming activities carried out in the state. Nigerian Population Commission (NPC, 2023) ^[18].

Sampling technique and sample size

The population for the study comprises edible maggot collectors in Delta state. A multi stage sampling procedure was employed in selecting respondents. Twenty percent (20%) of the local government areas in each agricultural zone were randomly selected. Delta North 2, Delta central 2 and Delta south 1 local government area giving a total of 5 local government areas selected in Delta State. Rural communities were identified and 30% known for trading in edible maggot was purposively selected giving a total of 10 rural communities selected from the chosen local Government areas. Rural households who were involved in the collection of edible maggots were identified by key informants and 10% were randomly selected giving a total of 206 respondents that were selected for this study

Data Collection

Data were collected for the study through primary source by the use of structured questionnaire and interviewed schedule administered to 206 respondents but only 198 questionnaires was retrieved and was used for the study.

Data Analysis

Data were statistical treated using frequency counts, percentages and means from 4- point likert- type scale of strongly agree 4, agree 3, disagree 2, strongly disagree 1. Decisions on likert type scale mean were based on a cutoff point of 2.5 (4+3+2+1=10/4 =2.5) and logit regression analysis was used to ascertain the influence of demographic characteristics on participation of edible maggot collection. Model specification for influence of socio-economic characteristics on farmer's level of participation

- Y is Participation (yes=1, No=0)
- β_0 is intercept
- β_1 is regression coefficient
- X_1 is age (years, below 50=1, above 50=0)
- X_2 is gender (male=1, No = 0)
- X_3 is Marital status (= married 1, others 0)
- X_4 is educational level (numbers of years of schooling)
- X_5 is house hold size (below 6 =1, above 6 =0)
- X_6 is family income (N below 100,000=1, above 100,000 = 0)
- X_7 is farming experience (below 10 years = 1, above = 0)
- X_8 is (distance (below 10 km = 1, above = 0)
- X_9 is extension contact (twice=1, above=0)
- X_{10} is source of labour (family=1, others =0)

Result and Discussions

Demographic characteristics of edible worm collectors

In table 1, distribution of respondents according to age showed that 56.681% of the respondents are in the age bracket of 21-30 years, about 21.72% were in the age bracket of 31-40 years, 20.71% were above 40 years while 20.20% are in the age bracket of 15-20 years. The implication is that most of the respondents were within the

age range of 21-30years indicating that majority of them are in their youth and have the ability to engage in edible maggot collection and any form of farming activities this could be attributed to the fact that they want to get themselves engage due to the rate of unemployment in the country. Majority of the respondents are female (54.0%) while 45.9% are male. Indicating that women are more involved in edible maggot collection in order to cater for their families this finding is in consonant with Abushe *et al.* (2023) ^[1-2] who found that women empower themselves and are able to take care of their families through agriculture and its related activities. Majority (63.6%) of edible maggot collectors are married, 11.1% are divorced, about 10.6% were single while 9.59% were widows/widowers. This indicate that most of the respondents were married and thus has responsibilities as they had household members to take care of, hence once a person is married, she has commitment to make provision for her household and this commitment is expected to be the push factor for women to engage in edible maggot collection. This finding is in agreement with Omotayo (2018) ^[22] who reported an over 80% married respondents among rural households and they tend to be more responsible.

About 41.4% of the respondents had primary education, 25.8% had secondary, 23.7% had no formal education while 8.59% had tertiary education. This suggest that most of the respondents had basic education as they can read and write

and this is expected to help them acquire more knowledge, hence the awareness of the nutritional value of edible maggot.

The mean household size of the respondents was 6persons with 59.6% having 5-8 persons in the household, about 22.2% had 1-4 persons while 18.2% had above 8 persons in the households and this implies that the respondents relatively had a large household. This agrees with Ehinm (2012) ^[42] who reported that rural household sizes are between 5-8 persons larger than their urban counterparts and they are larger because of its dependence on family labour; 53% are into farming as their primary occupation, 30.81% are into farming while 16.2% are Artisan. This implies that majority of the respondents are farmers. This agrees with Ekong (2010) ^[9] that found the major occupations of the rural people is farming.

About 67.2% participated in edible maggot collection, while 32.8% of the respondent are not into collection of edible maggots. The respondents have an average farming experience of 8years. The respondent has an average monthly income of N43, 500. This implies they can earn even more than the approved government minimum wage. Hence, they can earn a living through getting involved in collections of edible maggots. Though the income is low, they can manage their households because they only procure few things that can make them live a simple life (Ofuoku &Ekorhi-Robinson, 2020) ^[21].

Table 1: Demographic characteristics of Respondents

Variables	Frequency	Percentages	Mean
Age(years)			
15-20	40	20.2	30years
21-30	74	37.4	
31-40	43	21.7	
Above 40	41	20.7	
Sex			
Male	91	45.9	
Female	107	54.0	
Marital status			
Single	21	10.6	
Married	126	63.6	
Widow/widower	19	9.59	
Divorced	22	11.1	
Level of education			
No formal education	47	23.7	
Primary	82	41.4	
Secondary	51	25.8	
Tertiary	17	8.59	
Household size			
1-4	44	22.2	6
5-8	118	59.6	
Above 8	36	8.59	
Primary occupation			
Farming	165	53.0	
Artisan	32	32.8	
Trading	61	30.8	
Participate in collection			
Yes	133	67.2	
No	65	32.8	
Farming experience(years)			
1-5	98	49.5	6years
6-10	65	32.6	
Above 10	35	17.7	
Extension contact			

Once a month	31	15.7	
once in 2 months	15	7.60	
Once in 6months	31	15.7	
None at all	121	61.1	
Income derived from collection			
1000-14000	15	7.60	N43,500
15000-30000	40	20.2	
35000-65000	118	59.6	
Above 65000	25	12.6	
Source: field survey 2024			

Level of Participation in Edible Maggot Collection

Table 2 shows the level of participation of the respondents. Majority (53.1%) of the edible maggot collectors collects edible maggot very often, 27.3% often participates in the collection, 13.6% seldom or rarely participate, while 6.60% do not participate in edible maggot collection at all. The implication is that majority of the rural household are into the business of collecting edible maggot which could be attributed to the fact that they can be used for traditional medicine worldwide (Denisha and Rokozena, 2016; Jideani, 2017) [6, 13]. And also, many rural households depend on traditional medicine to make good living from the enterprise and could be as a result of the soaring unemployment rate. This agrees with (Ibitoye *et al.*, 2019) [12]. Also, they

participate in the collection in a bid to meet up with the food and protein needs of their households. Hunger and malnutrition are emerging as serious problems in communities that are highly vulnerable, especially poverty-stricken regions (FAO, 2017) [10]. According to Ali Emre and Nese (2023) [43], it is estimated that over 2 billion people currently consume insects, making them a more widely eaten source of protein compared to many other animals. The practice of eating insects, known as entomophagy, has the potential to help meet the increasing global demand for protein. In recent times, insect consumption has been a traditional practice in many countries around the world Ebenebe *et al.* (2017) [7].

Table 2: Participation in edible maggot collection

Statement	Frequency	Percentage
I collect very often	105	53.1
I often go to collect	54	27.3
I rarely collect	27	13.6
I do not participate at all	12	6.06
<i>Source: field survey 2024</i>		

Edible Maggot Collectors Source of Labour

Table 3 shows that 54% of the respondents' sources of labour comes from family members about 23.7% uses paid casual labourers and 22.2% of respondent personally collects edible maggots without employing labour or assistant from family members. The implication of this is that majority of the edible maggot collectors' sources of labour comes from family members. This agrees with Ehirim, 2012 [42] who reported that the rural household is relatively large due to their dependence on family members as source of labour.

Table 3: Labour source of edible maggot collectors

Sources of labour	Frequency	Percentages
Family members	107	54.0
Paid casual labourers	47	23.7
Personal effort	44	22.2
<i>Source: field survey 2024</i>		

Benefits Derived from Edible Maggot Collection

Majority of the respondent (table 3) are able to meet the protein needs of their household through collection of edible maggots (mean = 2.87), have the ability to send their children to school through the earning and collection of edible maggots (mean = 3.04). This implies that majority of the respondent benefited from collection of edible maggots because they were able to send their children to school and

meet the protein needs of their family through collections and the earning gotten from the collections of edible maggots. I have been able to acquire household utilities from the money gotten from the collection of edible maggot (mean= 2.92) greater than the mean cut off point of 2.5 indicating that the respondent have the ability to acquire more household utensils from the money derived from the collections and sales of edible maggot; I have used the money gotten to build myself a house (Mean = 1.86) lesser than the mean cut off point of 2.5 implying that the respondent do not earn enough to build a house but can afford other household properties. I have been able to feed my family (Mean = 3.03) > Mean cutoff point of 2.5. The implication is that the respondent can better feed his family with the proceeds derived from the collections and sales of edible maggot. I have been able to cloth my children (mean= 3.05) indicating that the respondents are able to cloth their children through getting engaged with edible maggot collection business.

The grand mean of 2.78 indicates that majority of the respondent engaged in edible maggot collection have been able to improve their standard of living and enhanced the protein needs of their family through getting involve in collection of edible maggots. Insects can also contribute to a circular economy through the biotransformation of organic waste streams into feed for monogastric animals and human food Cappellozza *et al.* (2019) [5], Nava *et al.* (2020) [17].

Table 4: Edible maggots Collectors Benefit

Statement	Mean	Standard deviation	Remark
I have been able to send my children to school through collection of edible maggot	3.04	1.57	Benefit
I have been able to acquire household utilities and furniture from money gotten from collecting edible maggot	2.92	1.45	Benefit
I build a house from the money gotten from collecting edible maggot	1.86	6.08	No benefit
It is my major source of livelihood	3.05	2.01	Benefit
I have been able to feed my family with collection of edible maggot	3.03	1.44	Benefit
I am able to meet up the protein needs of my family	2.87	1.56	Benefit
Mean ≥ 2.50 =benefit, mean<2.50 no benefit. Source: field survey 2024			

Constraints to Edible Maggot Collection

table 5 shows that (18.7%) do not have adequate labour, about 26.26% work long distance to collection site, 54.6% do not have accessible roads to market, about 55.1% have problem of low rate of consumption, while 75.8% have the problem of low acceptability of edible maggot, and (55.6%) have a problem of cultural barrier, This suggests that the major constraints are cultural barrier, low rate of consumption and acceptability and no accessible roads to market.

This is in consonance with Francesco *et al.* 2017; Ali Emre and Nese 2023) ^[43, 44] who reported that although in Africa insect eating had been culturally accepted but in the western world it is still a new idea with low acceptability and willingness to consume it. In general, people in the tropics are increasingly rejecting insects as food, as traditional habits are disappearing due to a changing education and Western dietary acculturation Niassy *et al.* (2016) ^[20]. Also, due to urbanization, level of education and the issue of perception acceptability are low in the urban areas of Nigeria (Ibitoye *et al.*, 2019) ^[12]. However, most people refused to consume this insect because of cultural barriers Kekeunou *et al.* (2021) ^[15]. *Oxytanta* may constitute a new food source easily acceptable given its good taste, but its consumption is hindered by wrong idea people have about it, because they never experienced it as food. People need to overcome these barriers and change their paradigm to fully appreciate this food source Kekeunou *et al.* (2021) ^[15].

Table 5: Edible maggot collector's constraints

Constraints	Frequency	Percentage
Low rate of consumption	109	55.1
Low rate of acceptability	150	75.8
Long distance to collection site	109	26.3
Not enough workers	37	18.7
poor accessible road to market	108	54.6
Cultural barriers	109	54.6
Source: field survey 2024		

Influence of Socio-Economic Characteristics on level of Participation in Edible Maggot Collection

The influence of socioeconomic characteristics of edible maggot collectors on level of participation was achieved using binary logistic regression. The model summary suggest that logistic regression model (table 6) is significant (chi-square = 75.2, df 12, $p < 0.01$) showing that the variables had an influence in level of participation in edible maggot collection in the study area. The Nagelkerke R square value of 0.78 showed that the model variables was able to profound explanation for approximately 78% of the variation in participation in edible maggot collection. The coefficient of age is -0.90 and is statistically significant

($p < 0.05$). The odd ratio (Exp B) is 2.60, which means for each year younger in age, the individual is 2.60 times more likely to participate in the collection of edible maggots. In inverse exp (B) (calculated as $1/2.60 = 0.38$) shows that an older individual is 0.38 times likelihood of being involved in collection. The implication is that younger individuals had more strength to engage themselves in the collection and also uses it as a medium to engage themselves due to the high rate of unemployment in the country and as such most workers around 88.0% were in self-employment according to National bureau of statistics (NBS 2023) ^[19].

Educational level had a coefficient of 0.86, $p < 0.01$, having an odd ratio of 1.71 this indicates that an educated individual in the rural area is 1.71 times probability of participation. Inverse odd ratio shows that a less educated person is 0.59 times likelihood of participation. The implication is that the more education one acquires the more knowledge and exposure he gets thus having good knowledge on the nutritional benefits will spur up interest in participation. This finding agrees with Lawal and Okeowo, (2014) ^[16].

Household size has a coefficient of 0.57, ($p = 0.01$). An odd ratio of 2.88 implies that a person with larger household size is 2.88 times probability of participation than a person with smaller household size. The implication is that the larger the household size, the more likely members will want to participate in order to satisfy the protein needs of his family and also be able to earn more income for better and more comfortable life. Family income had a coefficient of 0.855, ($p < 0.05$) with an odd ratio of 1.97. This indicates that the probability of participation for a family whose income is small is 1.97 times inversely the probability of participation for a family whose income is large is 0.51 times. The implication is that when a family can no longer meet up with family needs, there is always drive to participate more in collection in order to source for more income to be able to meet up with his family needs.

Distance to collection site $p < 0.05$ having a coefficient of 0.81 with an odd ratio of 2.56 implying that the probability of participation is high if the distance to collection site is short inversely the probability of participation if the distance is long is 0.39 times. Extension contacts had a coefficient of -0.76, $p < 0.01$, with an odd ratio of 2.61 implying that the odd not to participate in collection of edible maggots without regular extension contact is high compare to those with extension contact.

Extension contact is needed to create awareness and education to farmers on innovations and profitable ventures Abushe *et al.* (2023) ^[1-2]. Rate of consumption $p < 0.01$, with a coefficient of -0.92 and an odd ratio of 1.66 implying that the probability of no participation is 1.66 when the consumption rate is low, inversely it becomes high when the consumption rate is high.

Rate of acceptability influences participation having a coefficient of 0.64, $p = 0.05$ with an odd ratio of 1.61 implying that the probability to participate in collection of edible maggots is 1.61 times with high rate of acceptability

compare to when acceptability is low. This is in agreement with Ibitoye (2019) ^[12] who reported that the rate of acceptability affects edible insect entrepreneurs in Nigeria.

Table 6: Estimation of the influence of Socio-Economic Characteristics on Participation in Edible Maggot Collection

variables	B	S.E	Wald	Df	P	ExpB
Age	-0.90	0.03	6.79	1	0.04	2.60
Sex	-0.02	0.05	0.07	1	0.71	1.16
marital status	0.01	0.03	0.33	1	0.76	1.01
education level	0.86	0.03	6.86	1	0.001	1.71
household size	0.57	0.02	0.54	1	0.01	2.87
family income	0.86	0.41	9.81	1	0.02	1.95
distance to site	0.81	0.04	0.32	1	0.01	2.56
extension contact	-0.76	0.05	5.73	1	0.01	2.61
source of labour	0.57	0.03	3.82	1	0.01	1.98
rate of consumption	-0.92	0.28	5.42	1	0.001	1.66
rate of acceptability	0.64	0.03	5.83	1	0.05	1.61
farming experience	-0.01	0.01	0.63	1	0.22	0.58
Constant	1.12	0.28	6.31	1	0	0.04
Model summary						
Nagelkerke R Square	0.78					
Ominibus Test of model Coefficient						
Chi-Square	Df	Sig				
75.2	12	0.001				

Source: Field survey 2024

Conclusion

The study concluded that participation in edible maggot collection brought about improvement in the standard of living of the rural households in delta state, also age, household size, extension contact, educational level, rate of consumption and acceptability, distance to collection site were the major factors that determined respondent participation in the edible maggot collection. The major constraints identified were bad roads network to market, inadequate source of labour and low acceptability rates hence it is recommended that more awareness about the nutritional benefits of edible maggot should be created an implication for extension service delivery, and good road network should be created by the government.

Conflict of interest

The authors declare no competing interests

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