Available online www.unicrossjournals.com

JOURNAL OF CONTEMPORARY RESEARCH (JOCRES)

RESEARCH ARTICLE VOL. 2 (1) ISSN:2814-2241

Date Accepted: 30th June, 2023

Pages 285 - 300

ECO-DIVERSITY, ABUNDANCE AND SEASONALITY OF INSECTS USED AS FOOD AND FEEDS IN CROSS RIVER STATE, NIGERIA.

Ogban[1], E, I, Oparaeke[2], A, M, and Akpe[1], T. E.

[1]University of Cross River State, Calabar - Nigeria.

[2]University of Calabar, Calabar.

Abstract

A survey of edible insects in Abi, Biase and Yala Local Government Areas of Cross River State was conducted within a period of 9 months. Five (5) communities in each of the LGA's and (14) fourteen respondents each, where selected using random sampling techniques. The study used questionnaire and oral interviews to obtain information on types of edible insects, abundance, seasonal availability, collection and processing methods, as well as preference for food and feeds. Out of a total of two hundred and ten (210) individuals' sampled, males were 55.71 % while females were 44.28 %. The result showed that seven (7) insect species belonging to six (6) orders were consumed. Majority of the insects showed seasonal availability and were harvested most of the year, some were abundant during the raining season and others dry seasons. Cooking and frying were the commonest processing methods found in the study area, although termites and caterpillars of oil and raphia palms were found to be eaten raw in some parts of Abi and Biase. Preference for insects by respondents as food and feed was due to the protein source. Proximate analysis showed that edible insects are excellent source of protein, lipids, carbohydrates and ash contents. Edible insect farming is therefore recommended in communities as means of increasing public awareness on entomophagy.

Keywords: Edible insects, Eco-diversity, Abundance, Acceptability, Seasonality, Insects as food and feeds.

1. Introduction

By 2050, the world's population is likely to swell to 9.7 billion (park and Yun, 2018); WPD, 2020). Current food production will need to double. Already, an estimated 1 billion people are chronically hungry (more than 13 percent of the entire population on earth). The oceans, rivers and other water bodies are overfished, and climate change is making fresh water and farmland scarcer (van Huis , 2016). A backup plan is needed! Is entomophay the answer? It is already well known that insects are good source of protein (Zielinska *et al.*, 2019). Commonly consumed insect species could be excellent sources of bioavailable iron and could provide the platform for an alternative strategy for increased mineral intake in the diets of humans (Durst and Shono, 2010). Many insects contain abundant stores of Iysine, amino acid deficient in the diets of many people who depend heavily on grain (Assielou *et al.*, 2015. Furthermore, insects generally have higher food conservation efficiency than most traditional meats and reproduce at a faster rate than beef protein. These creatures are generally considered as food for their novelty than their nutrient, for example embedded in chocolates or ice cream (Johnson, 2010), as a means of survival when wilderness adventures go wrong (Yoshimoto, 1999). In some rural communities, children hunt and gather insect for food and as a "game". As a "game" captured insect such as grasshoppers,

giant crickets, giant beetles and butterflies are tied between the region of the head and the thorax with a thin thread and allowed to fly around. This is to create fun and serve as a means of athletic exercise while in hot pursuit of the insects (Oparaeke, 2021). There are nearly 1700 species reported to be eaten deliberately by humans but cultures are highly variable, spanning the spectrum from active avoidance to occasional and substantial consumption (Raubenheimer and Rothman, 2012). In Nigeria and Cross River State in particular, the general attitude to entomophay is one of disgust; we tend to associate eating insects with "primitive" behavior. It is difficult to change human attitudes, but it is not impossible. According to Banjo *et al.*, (2006) the consumption of non-toxic insect should be encouraged. Therefore, there is a compelling need to collect data on the eco-diversity and conservation of edible insects in Cross River State with a view to making the information available to all interested parties through well designed insect pictorial charts and documentaries. The study will provide information on the list and distribution of these edible insects in Cross River State; their harvesting, processing and preservation techniques, their seasonality and most importantly their nutritional composition.

2. Materials and methods

2.1 Study area

The survey was carried out in three local government areas of Cross River State; Abi, Biase and Yala (Figure 1) selected, based on eco-diversity and knowledge of insect eating. The study area is characterized by a tropical climate with three distinct vegetation belts namely rainforest, monsoon and semi savanna. They are two seasons; the rainy season (April to October) in Biase and Abi and the dry season (November to March) which comes with harmattan from December to February and last longer in Yala than the other selected LGA's.

Majority of inhabitants in the study area are predominantly farmers relying on cassava, maize cocoyam, few cash crops and yam found to be the most celebrated agricultural produce. A significant number of youths work as traders, craftsmen and commercial motor cycle riders.

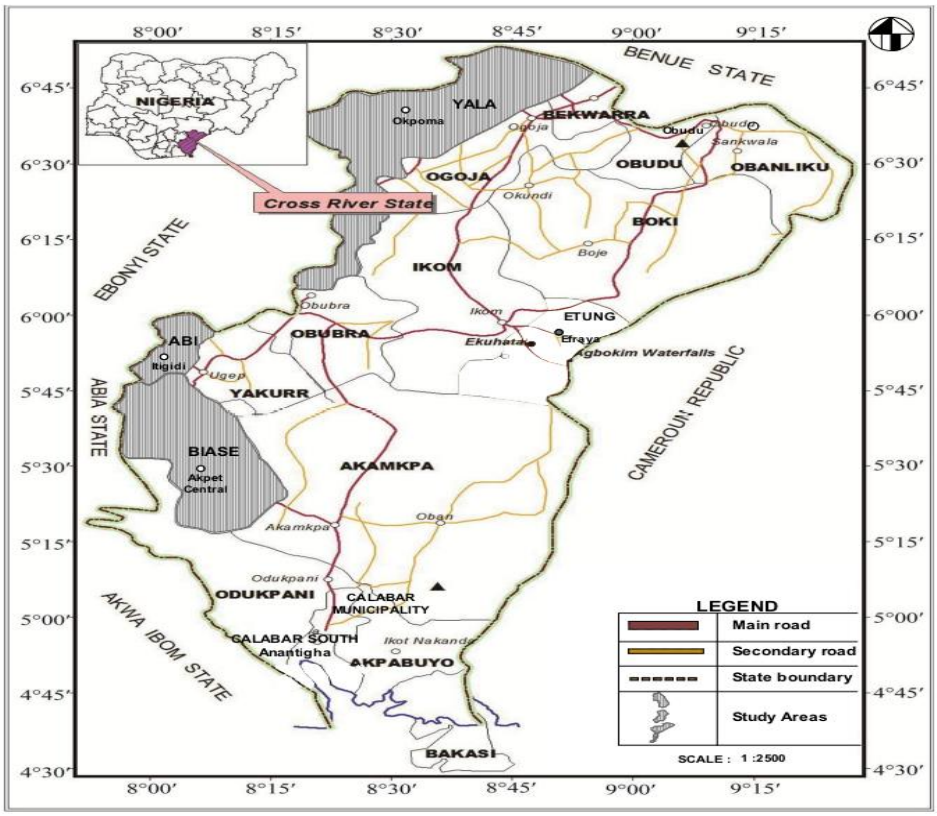


Figure 1: Map of Cross River State Showing Study Area.

2.2 Sampling techniques

Multistage sampling techniques was adopted to select samples. Five (5) communities in each of the three (3) selected LGA's and fourteen (14) respondents each were selected using stratified random sampling techniques. A total of two hundred and ten (210) copies of structured questionnaire were designed and administered to respondents in the study area. The questionnaire was pre-tested and revised before final administration. Information validation was by personal observation, insects' collection and identification. In each community, forest area measuring 100 X 100 m was surveyed for edible insects using collection materials such as sweep and butterfly nets, beating trays, pitfall traps and some artificial pheromones. Untargeted insects not meant for the survey but accidentally captured were released immediately while targeted ones were sorted out and preliminary identification carried out, and thereafter preserved.

2.3 Population of the study

The estimated population of these selected local government areas in Abi, Biase and Yala are 169,183, 1310 and 144, 317 respectively (NPC, 2006). Seventy (70) respondents made up of farmers, traders, artisans, civil servants and students were purposively selected from each of the LGA constituting the study area. The respondent ages were determined using a range of 15-24, 25-34, 35-44, 45-54 and 55 and above. These age brackets cut across males and females with variable educational and occupational backgrounds (Table 1, 2 3 and 4) and Figure 2

Table 1: Age distribution and marital status of the respondents

Age group	Abi	Biase	Yala
15-24	14 (20%)	09 (12.9%)	12 (17.1%)
25-34	19 (27.1%)	12 (17.1%)	17 (24. 3%)
35-44	11 (15.7%)	14 (20%)	13 (18.6%)
45-54	16 (22.9%)	17 (24.3%)	22 (31.4%)
Above 55	10 (14.3%)	18 (25.7%)	6 (8.6%)
Total	**70**	**70**	**70**

Table 2: Gender distribution

Categories	Abi	Biase	Yala
Male	37(52.9%)	39(55.7%)	41(58.6%)
Female	33(47.1%)	31(44.3%)	29(41.4%)

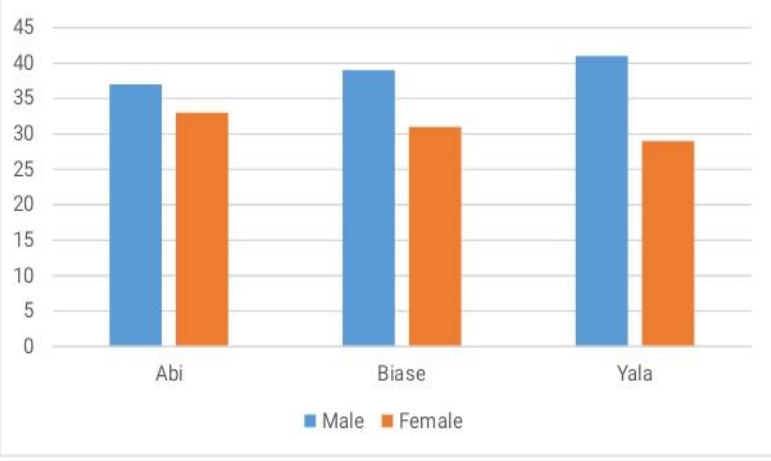


Figure: 2. Gender distribution of the respondents

Table 3: Educational qualification of respondents

Educational	Abi	Biase	Yala
Primary school	11(15.7%)	18(14%)	14(19.9%)
Secondary school	19(27.1%)	22(31.4%)	16(22.9%)
Tertiary	23(32.9%)	19(27.1%)	31(44.3%)
No formal education	17(24.3%)	11(15.7%)	09(12.9%)

Table 4: Occupational distribution of respondents

Categories	Abi	Biase	Yala
Farming	39(55.7%)	46(65.7%)	42(60%)
Teaching	08(11.4%)	03(4.3%)	6(8.6%)
Trading	11(15.7%)	12(17.1%)	09(12.9%)
Civil service	06(8.6%)	07(10%)	05(7.1%)
Others	06(8.6%)	02(2.9%)	05(11.4)

2.4 Data collection instrument

Questionnaire administration was majorly relied upon to collect primary data. Structured questionnaire containing 28 questions which allowed respondents to make personal decisions, based on individual degree of rating personal observations, was employed to authenticate the information collected. The questionnaires were collected and coded to aid statistical analysis of the data. Reports, journals, bulletins and relevant materials and documentaries constituted the sources of secondary information for the research. Based on the responses, a list of the insects consumed as food in the communities sampled were documented. Percentages were calculated to show the differences in preference.

3. Data analysis

Descriptive statistics such as frequency, tables, charts, simple means and percentages were used to describe and present data generated from the questionnaire. Nutrient composition was determined through proximate analysis.

4. Results

4.1 Eco-diversity of study area

There are three major vegetation belts that characterize the study area (Table 5).These are tropical rainforest / mangrove, tropical monsoon and derived savanna. There are also two distinct climate seasons; rainy (wet) and dry season.

Table 5: Eco-diversity of study area.

Ecological zones	Locations in Cross River State	Land area	Latitude and longitude	Annual average temp.	Annual average rainfall	Altitude above sea level
Tropical rainforest and mangrove swamp	Abi	1552 km^2	Lat.6.83^0 6.02^{1}N Long.7.93^0 8.71^{1}E	15-35 ^{0}C	1300-3000mm	208 m(682ft)
Topical Monsoon	Biase	1310 km^2	Lat. 5·00^0 5·47^{1}N	15-33 ^{0}C	1963-3,143mm	113 m(371ft)

			Long. $8^{\cdot}06^{0}$ $8^{\cdot}11^{1}$'E			
Derived savanna	Yala	1739 km^2	Lat. $6^{\cdot}35^{0}$ 20.99^{1}N Long. $8^{\cdot}38^{0}$ 0.59^{1}E	27-37 ^{0}C	1200-2000mm	55 m(180ft)

4.2 Abundance of edible insects consumed in study area.

Table 6 shows the different insects consumed in the study area. Seven (7) major and different insects are consumed in the various communities that constitute the study area. Amongst the insects highly valued and consumed are oil and raphia palm caterpillars, termites, crickets (bush and mole) and beetles of different species. In Yala local government area, the oil and raphia palm caterepillars and termites are abundant and serves as a source of revenue for some families. Among the Abi communities, the termites and crickets are highly abundant and consumed. Biase communities from the results also have abundant number of raphia palm caterpillars, termites, beetles and crickets.

Table 6: Abundance of edible insects in study area

Insect	Abi	Biase	Yala
Oil/Raphia maggots	66.75^{b}±0.58	98.67^{a}±7.45	95.85^{a}±2.53
Temites	68.25^{b}±5.00	92.41^{a}±2.35	90.33^{a}±2.00
Grasshoppers	15.67^{e}±2.00	55.33^{c}±8.45	36.26^{d}±1.53
Mole crickets	50.24^{c}±6.67	65.25^{b}±4.51	85.67^{a}±2.50
Bush cricket	85.33^{a}±4.16	89.56^{a}±0.57	99.45^{a}±0.58
Yam beetles	62.85^{b}±1.25	85.21^{a}±7.02	75.33^{b}±4.18
Others	38.25^{d}±3.45	45.67^{c}±3.79	26.25^{e}±0.46

Means within a column followed by the same letter do not differ significantly by LSD test at 5 % of probability

4.3 Seasonal availability of edible insects in study area

The result in Table 7 shows that some species of edible insects are available all year round and can be collected in forested areas and the wild; some others are obtained for a short season. Oil and raphia palm caterpillars were collected mostly at the end of the rainy season (September – October in decaying oil and raphia palms. Termites were more abundant during the rains in dead trees and ant hills. Crickets were found most of the year in forest trees, around homes and underground tunnels. Grasshoppers (green and brown) were collected abundantly between November to April in open fields and grass lands. Also found most of the year breeding in rotting vegetation, decaying trees, were oil palm caterpillars (*Oryctes boas*). Bees were collected all-round the year from their hives and container traps. Because many insects are seasonally available, they are frequently conserved for later consumption (Plate 1, 2, 3, 4, 5,6 7)

Plate 1: Fresh oil palm maggots, *Rhynchophorus phoenicis*

Plate 2: Fresh raphia palm maggots, *Rhynchophorus phoenicis*

Plate 3: Fresh mole crickets, *Gryllotalpa africana*

Plate 4: Fresh bush crickets, *Brachytrupes membranaceus*

Plate 5: Fresh termites, *Macrotermes natalensis*

Plate 6: Fresh grasshopper, *G. rufus* and ***Z. variegatus***

Plate 7: Fresh yam beetle, *Heteroligus meles*

Plate 8: Freshly collected *Apis melifera*

Table 7: Seasonal availability and habitats of some of the edible insects in the study area

Scientific name	Common name	Season available	Habitat
Rhynchophorus phoenicis	Oil palm weail (white grub)	End of the rainy season (September – October	Decaying palm
Brachytrupes membranaceus *Gryllotalpa africana*	Bush cricket Mole cricket	Most of the year	Bush, soil, forest trees and underground tunnels
Macrotermes bellicosus	Termites	Abundant during the rain	Dead trees, decaying wood and ant hills
Zonocerus variegatus *Gomhocerippus rufus*	Green grasshopper	November – April (mainly dry seasons)	Fields and grassy areas

	Brown grasshopper		
Heterolygus meles	Yam beetle	Mainly yam sowing season	Yam heaps and underground
Apis melifera	Honey bee	Most of the year	Trees
Oryctes boas		Most of the year	Breeds in rotting vegetation, decaying trees, e.g. coconut raffia palm

4.4 Stages of consumption, and processing methods

Most of the edible insects in the study area are consumed at the adult stage (Table 8.) These include crickets, termites, grasshoppers, yam beetle and bees. Their processing methods generally involve washing, removing the gut and roasting or frying the insects. *R. phoenicis* are consumed at the caterpillar and adult stages. As larvae, they are washed and their guts disposed before either frying or roasting or even cooking with various condiments. In some parts of Abi and Biase, the maggots are eaten fresh.

Table 8: Stage of consumption, collection and processing methods

Insect	Stage of consumption	Collection method	Processing method
Oil and raffia palm grub	Larva or maggot Adults	Hand picking directly from dead oil or raphia palm	Guts are emptied, lavae washed and fried using different condiments
Crickets	Adults	Collected from tunnels in the bush and around houses	roasting or frying
Termites	Adults	Collected from ant hills or during nuptial flights	Wings are detached, then the body is washed and fried or sun dried
Grasshoppers	Adults	Use of sweep nets and hand picking/traps	Gut is removed after which the insect is washed thoroughly and roasted. In some areas they are fried with condiments
Palm weevil	Larvae	Collection by hand	Lavae are thoroughly washed, gut removed and then body fried
Yam beetle	Adult	Hand picking	Adult is washed, appendages detached and then fried
Bees	Adult	Use of traps in the bee hive	Washed and fried

Table 9 and Figure 3 show the different reasons advanced by respondents for eating insects. As a source of protein, the percentage responses from respondent in Abi, Biase and Yala, revealed 22.9 %, 20 % and 12 % respectively. Cultural practices triggered the following responses 18.6

%, 25.7 % and 14.4 % respectively, while as medicinal food, the percentage responses showed 17.1, 8.6 and 18.6% respectively. Biase and Yala with responses of 4.3 and 11 % respectively showed the least response in terms of aphrodisiac preference (Fig. 3)

Table 9: preference of insect consumption LGA's

Reason	Abi	Biase	Yala
Source of protein	22.9 %	20 %	17.1 %
Cultural practices	18.6 %	25.7%	14.5 %
Religion	12.9 %	24.3%	22.9 %
Medicinal purpose	17.1 %	8.6 %	18.6 %
Recreational purpose	11.4 %	17.1%	20.0 %
Aphrodisiac	17.1 %	4.3 %	11.0 %

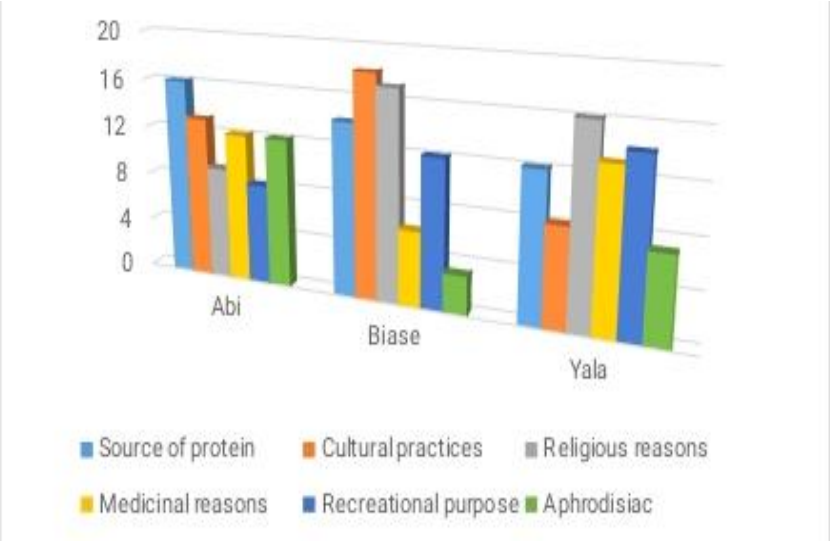


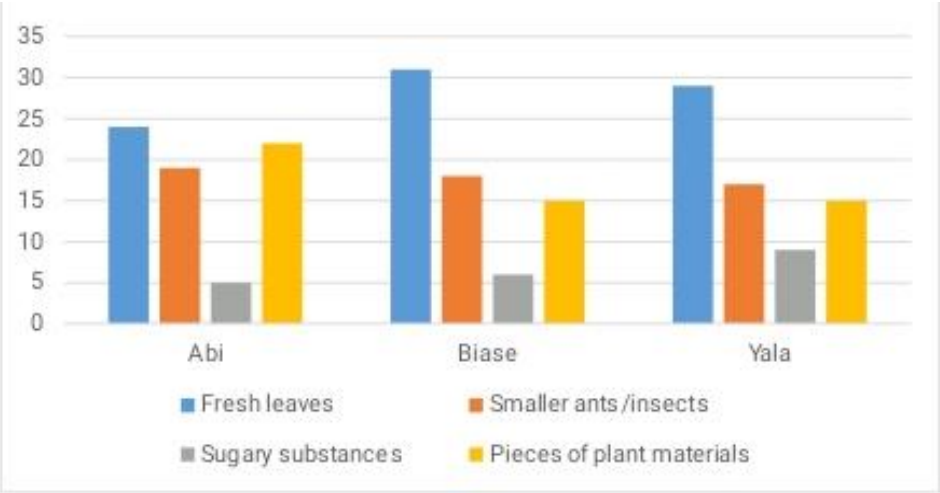
Figure 3: Preferences of insect consumption

4.5 Types of feeds used for animal husbandry in study area

Table 10 and Figure 4 show the varieties of feeds which some of the respondents admitted they use in keeping their animals. In Abi, Biase and Yala percentage respondent that use smaller ants/insects were 27.1 %, 25.7 % and 24.2 % respectively. The result also revealed that the percentage of respondents that use pieces of plant material as animal feeds were higher than those that use insects in all the local government areas. The consciousness of using insects in feeding domestic animals appeared to be higher among respondents in Abi (27.1 %) than in other LGA's.

Table 10: Feeds used for animal husbandry

Categories	**Abi**	**Biase**	**Yala**
Fresh leaves	24(34.3%)	3.2(44.3%)	29(41.4%)
Smaller ants/insects	19(27.1%)	18(25.7%)	17(24.2%)
Sugary substances	05(7.1%)	06(8.6%)	09(12.9%)
Pieces of plant mater	22(31.4%)	15(21.4%)	15(12.4%)



4.6 Nutritional composition of edible insect in study area

The result reveals that insect food resource is very rich in nutrient (Tables 11, 12, 13). Generally, the protein content of insects in Biase was among the highest (19.47 ± 0.68, 19.22 ± 0.01, 19.88 ± 0.01, 19.01 ± 0.05, 19.75 ± 0.50, 17.82 ± 0.01). Termites recorded the highest nutritional content (19.88 ± 0.01). The least termite protein content was found in Abi (18. 62 ± 1.34, 8.21 ± 2.23, 18.26 ± 0.85, 19.20 ± 3.11, 19.10 ± 0.15 and 18.44 ± 1.25). The result also revealed that carbohydrate content was relatively high which could be indicative of abundant energy presence. Ash content which is a reflection of the mineral content of food substances was equally high, with the white larva of *R. phoenicis* recording 19.55 ± 0.11, 19.75 ± 2.25 19.35 ± 1.20 in Abi, Biase and Yala respectively. Similarly, the lipid content of *R. phoenicis* recorded 19.50 ± 2.05, 18.76 ± 2.50, 19.50 + 0.25 in Abi, Biase and Yala respectively. However, moisture content was low in all the insects across the study area. Yala recorded the least 9.25 ± 0.85 among mole crickets, followed by 10.25 ± 0.10 in brown grasshoppers.

NUTRITIONAL COMPOSITION OF DIFFERENT SPECIES OF INSECTS IN ABI LOCAL GOVERNMENT AREA

TABLE 11: PROXIMATE ANALYSIS, 100% COMPOSITION (DRY WEIGHT)

Components	***R. phoenicis*** **(white larva)**	***R. phoenicis*** **(Yellow larvae)**	Termites ***M.natalensis***	Bush cricket ***B.membranaceus***	Brown Grasshopper ***G.rufus***	Green Grasshopper ***Z.variegatus***
Moisture content	13.85 ± 1.15	13.05 ± 0.50	11.56 ± 1.25	11.80 ± 4.11	11.24 ± 0.23	10.42 ± 0.50
Ash content	19.55 ± 0.11	18.25 ± 0.75	16.12 ± 3.25	17.14 ± 2.19	16.31 ± 2.33	18.79 ± 0.06
Lipid content	19.14 ± 2.05	17.86 ± 0.20	17.38 ± 1.66	16.12 ± 0.61	17.19 ± 0.25	17.48 ± 0.21
Fibre content	16.35 ± 0.75	15.38 ± 0.35	15.89 ± 2.10	14.24 ± 2.71	18.23 ± 1.27	16.20 ± 0.41
Protein content	18.62 ± 1.34	18.21 ± 2.23	18.26 ± 0.85	19.20 ± 3.11	19.10 ± 0.15	18.44 ± 1.25
Carbohydrate content	18.02± 0.77	15.47 ± 0.88	14.25 ± 1.29	17.31 ± 1.85	16.25 ± 1.51	17.45 ± 0.55

Result presented in Mean Standard Deviation of Triple Determinations

NUTRITIONAL COMPOSITION OF DIFFERENT SPECIES OF INSECTS IN BIASE LOCAL GOVERNMENT AREA

TABLE 12: PROXIMATE ANALYSIS, 100% COMPOSITION (DRY WEIGHT)

Components	***R.phoenicis* (white larva)**	***R. phoenicis* (Yellow larvae)**	Termites ***M.natalensis***	Bush cricket ***B.membranaceus***	Brown Grasshopper ***G.rufus***	Green Grasshopper ***Z.variegatus***
Moisture content	13.23 ± 0.125	13.50 ± 2.50	10.50 ± 2.50	11.70 ± 5.25	12.55 ± 5.25	11.48 ± 0.211
Assh content	19.75 ± 2.25	18.25 ± 1.75	16.58 ± 0.50	18.25 ± 0.25	16.38 ± 0.55	16.38 ± 0.25
Lipid content	18.76 ± 2.50	18.05 ± 0.51	17.41 ± 1.22	17.10 ± 5.25	16.23 ± 0.11	16.34 ± 0.50
Fibre content	17.55 ± 3.25	15.25 ± 0.25	16.50 ± 1.75	17.33 ± 1.75	17.85 ± 0.05	18.64 ± 0.01
Protein content	19.47 ± 0.68	18.22 ± 0.01	19.88 ± 0.01	19.01 ± 0.51	19.75 ± 0.50	17.82 ± 0.01
Carbohydrate content	18.49± 0.01	15.88 ± 0.01	13.32 ± 0.01	17.54 ± 0.50	17.12 ± 0.01	16.34 ± 0.55

Result presented in Mean Standard Deviation of Triple Determinations

NUTRITIONAL COMPOSITION OF DIFFERENT SPECIES OF INSECTS IN YALA LOCAL GOVERNMENT AREA

TABLE 12: PROXIMATE ANALYSIS, 100% COMPOSITION (DRY WEIGHT)

Components	***R.Phoenicis*** (White larvae)	***R.Phoenicis*** (Yellow larvae)	Adult Yam beetle ***H. meles***	Brown Grasshopper ***G.rufus***	Bush Cricket ***B.membranaceus***	Mole cricket ***G.africana***
Moisture content	13.75 ± 1.15	11.05 ± 1.50	9.50 ± 1.50	10.25 ± 0.11	11.85 ± 3.25	9.25 ± 0.85
Ash content	19.35 ± 1.20	18.00 ± 0.50	17.50 ± 1.25	16.21 ± 0.25	15.75 ± 0.11	17.15 ± 1.11
Lipid content	19.50 ± 0.25	18.12 ± 0.56	16.81 ± 1.50	16.85 ± 0.50	18.23 ± 0.5	16.80 ± 0.50
Fibre content	17.05 ± 0.25	15.56 ± 1.24	16.01 ± 0.50	16.25 ± 1.75	16.25 ± 2.50	15.14 ± 0.20
Protein content	18.47 ± 0.65	19.25 ± 1.22	18.05 ± 0.01	19.20 ± 0.50	19.75 ± 1.25	18.05 ± 2.11
Carbohydrate content	19.41 ± 1.75	15.85 ± 0.13	15.31 ± 1.22	16.15 ± 0.25	18.13 ± 1.22	17.35 ± 0.21

Result presented in Mean Standard Deviation of Triple Determinations

5. Discussion

The present study reveals that insect eating practice is welcomed among communities in the study area made up of Abi, Biase and Yala LGA's. Seven (7) species of edible insects from six (6) orders and 7 families were found present, although the list of these insects is not exhaustive, given that not all the edible insects were encountered during the survey. This finding indicates the acceptance of entomophagy in the study area and could suggest that insect consumption is widespread in the State. The findings of this study agree with the results obtained by Ajayi and Adedire (2007) and Kelemu *et al*., (2015) who reported that Nigeria is known for widespread consumption of insects such as *Macrotermes bellicosus, Bunacea alcinoe, Anaphe panda, Cirina fonda, Cirina butyrospermi, Anapha venata Nomadacris septemfasciata, Zonocerus variegatus* etc. Similarly Alamu *et al*., (2013) in the study of edible forests insect species in Nigeria, stated that twenty-two (22) insect species from six different orders have been reported with potential for consumption among the three major ethnic groups (Yoruba, Hausa, Igbo). This present results are in congruent with the findings of DeFoliart, (2002) that about ten (10) species of edible insects used as food were identified in Cross River State. This development could be indicative of evidence of age long existence and wide spread knowledge of entomophagy across the State, as it is the case in many parts of Nigeria. It could also imply that consumption of insects cuts across some major ethnic groups in the State. This study also reveals that amongst the insects consumed in the study area, the oil and raphia palm caterpillars, crickets and termites constituted the most abundant and consumed insect species (Table 6). This result however may not imply that the less abundant insect species are not greatly cherished or demanded by the locals. Agbidye *et al*., (2009), however asserted that available insects have decreased in both quantity and in the number of species due to increased demand and decreased insect habitats.

The seasonal availability of insects obtained in the survey (Table 7) shows that a number of these insect species are available most of the year, though some could only be obtained for a short season. This observation is in agreement with the findings of Adeduntan and Bada (2004) that attributed the trend to weather or other natural circumstances as well as the findings of van Huis (2015) and Tobih (2013) who attributed it to availability of their host plant. Most of the insects breeding all through the seasons appear to be more available to harvesters than others, who collect them easily from habitats already known to them. This all year round availability of the insects makes them more popular and accessible. Oil and raphia palm caterpillars, crickets and honey bee were very popular and abundant in Biase and Yala. According to Fasoranti and Ajiboye (1993), some kinds of Nigeria edible insects are available all year round and can be collected in the forested areas and the wild. The responses obtained in this study also revealed that insects are consumed at different stages after being processed (Table 8). Some are cooked, fried and sun dried. This agrees with the report of Chavunduka (1975) that a wide range of insects are consumed at various stages of their life cycles. Banjo, *et al*., (2006) reported that crickets, termites and grasshoppers are eaten at both larval and pupae stages. Similarly Ifie and Emeruwa (2011) in their study found that *O. monocerus* is commonly consumed raw, boiled, smoked, or fried.

Using insects as food is an efficient means of providing adequate energy, protein, vitamins and minerals (Oparaeke, 2021). In the same vein, insect used as feed ingredient have good palatability and can be served as meal for poultry, fish, monogastrics and ruminants, and could replace 25-100 % of soymeal or fishmeal depending on the animal species (Schlup and Brunner, 2017). Despite the advantages of insect feed over other alternative sources, evidence from respondents in the study shows that most families preferred fresh leaves as feeds for their animal up keep. The greatest awareness of the

use of small ants/insects as feeds was demonstrated in Abi (27.1%) and closely followed by Biase and Yala with 25.7 and 24.2 % respectively (Table 9). This preference of leaves may be as a result of lack of awareness of the importance of insect feeds as well as the availability of the fresh leaves. Table 10 shows the preference of insect consumption. The percentage responses show that preference was based on different reasons in each community. Respondents who demonstrated knowledge of the importance of proteins for food and feeds were more in Abi and followed by Biase. while still on religious ground the reason for this is not known. However, educational, cultural, and religious backgrounds could be critical to preferences. Tables 10, 11 and 12 which shows the proximate analysis of collected insects, reveals that they are very rich in nutrients. These present findings are corroborated by the report of Ajayi and Adedire (2007) who observed that nutritionally, most edible insects are very rich. The relatively low percentage moisture content of insects collected is the reason they can be stored for a long time compared to red meat (*Ahmad et al*., 2003). There is a consensus among researchers that ash content of a given sample correlates with the mineral content of the sample. It stands to reason that insect gives a fair source of mineral element as earlier reported by Ene (1963). It was also observed that the insects across the study area contain high level of carbohydrate. This is not surprising given that insects source of food revolve around plant/humous materials. Timothy (2016) reported that termites supply the body with more energy and iron than beef. The protein content of the crickets in this study is within the range of the reported protein for other edible insects, including other orthopterans (Ogban *et al*., 2018). This variation in protein content observed amongst crickets could be due to the influence of the species diet, habitat and the stage of development of the cricket.

Conclusion

This study has identified some of the edible insects consumed by the people of Abi, Biase and Yala in Cross River State, Nigeria. Since not all the edible insects were identified, more research should be done to identify others, and also there is need to research into anti nutritional qualities of these edible insects so as to protect consumers. Again, there is need for proper education of the people on the increase consumption of insects in view of the nutritional benefits and also its use as feeds for domestic animals and pets. The indiscriminate hunting of these insects brings about ecological deterioration in such forms as deforestation, water pollution and bush burning which brings about a reduction in the availability of insects.

Reference

Adeduntan, S. A and Bula, A. (2004). Socio economic importance of local silkworm, (*Anaphe veneta*) to the rural dwellers in Ondo state, Nigeria. Abstract of papers presented at the 35th annual conference of the Entomological Society of Nigeria held at the federal University of Akure, 3-7 October, 2004, pp7.

Aghidye F. S., Ofuya, T. I. and Akindele S. O (2009). Marketability and Nutritional Qualities of some edible insects in Benue State, Nigeria. *Pakistan Journal of Nutrition*, 8: 917-922

Ahmad, S. M., Birnin-Yauri, U. A., Bagudo, B. U. and Sahabi, D. M. (2013). Comparative Analysis on the Nutritional values of Crayfish and some insects. *African Journal of Food science and Technology*, 4(1):9-12.

Ajayi, O. E and Adedire, C. O. (2007). Nutrient characteristics of the subterranean termites, *Macrotermes subhyalinus* (Rambur) (Isoptera) : Termitidae). *Nigeria Journal of Entomology*, 24:42-47.

Alamu, O. T., Amao A. O., Nwokedi, C. I Oke, O. A., and Lawa, I. O (2013). Diversity and Nutritional status of edible insects in Nigeria. *A review International Journal of Biodiversity and Conservation,* (5(4): 215-222.

Assielou, B., Due E. A, Koffi, M. D., Dabonne, S. and Kouame, P. I. (2015). *Oryctes owariensis* larvae as good alternative protein source; nutritional and functional properties. *Annual Research Review of |Biology*, 8:1-9.

Banjo, A. D., Lawal, O. A & Songonuga, E. A. (2006). The nutritional value of fourteen species of edible in southwestern Nigeria. *African Journal of Biotechnology*, 5(3): 298-301.

Benny, F. E. (2021). "Eating insects could be the future of food agriculture, food, and insects" Mongatay series: Environment explained. Article published on 3 may, 2022, by Aditi Tandon.

Chavunduka, D. M. (1975). Insect as a source of food to the African. *Rhodesia Science News*, 9:217-220.

Defoliart, G. (1992): Insects as human food. *Crop protection*, 5(11): 395 399.

Defoliart, G. R. (2002). The Human use of insects as a food resource: A bibliography account in progress. http//www.food-insects.com/book.

Ene, J. J. (1963). Insects as food: a case study from the Northwest Amazon Am. Anthropological.

Fromme, A. (2005). *Edible insect Zoogoer*, 34(4): 1-3.

Guine, R. P. F., Correia, P., Coelho, C and Costa, C. A. (2020). "The role of edible insects to mitigate challenges for sustainability" *Open Agriculture,* 6(1): 24-36.

House, J. (2016). Consumer acceptance of insect-based foods in the Netherlands: academic and commercial implications. *Appetite*, 107: 47-58.

Ifie, L. and Emeruwa, C. H. (2011). Nutritional and anti-nutritional characteristics of larva of *Oryctes monoceros*. Agriculture and Biology Journal of Nigeria, 2(1):42-46.

Kelemu, S., Niassy, S., Torto, B., Fiaboe K., Affognon H, Tonnang H., Maniania, N. K and Ekesi, S. (2015). African edible insects for food and feed; inventory, diversity commonalities and contribution to food security. *Journal of insects, food and feed*, 1:103-119.

Murefu, T. R., Macheka, L., Musundire, R, and Manditsera, F. A (2019). Safety of would harvested and reared edible insects. *A review food control*, 101:209-224

National population commission (NPC) 2006. Nigerian national population census Federal Republic of Nigeria official Gazettle, 94(24) :182-183.

Nyangena, D. N., Mutungi, C., Inathiu, S., Kinyuru, J., Afforgnon, H., Ekesi, S. Nakimbugwe, D. and Fiaboe, K. K. M., (2020). Effects of traditional processing techniques on the nutritional and microbiological quality of four edible insect species used for food and feed in East African, *Foods*, 9:574.

Ogban, E. I., Omagu T., O. and Ukpong, I. G. (2018) Evaluation of Nutritional value of the termite, *Macrotermes bellicosus* (Smeathman) and Beef. Haya: *The Saudi Journal of life Science*: 3(10): 645-649.

Oparaeke, A. M. (2021). The potential of insects as food and feeds in food security. A paper presented at the 51st Annual Conference of the Entomological Society of Nigeria held on the 4- 8 th October at University of Uyo, Akwa Ibom State.

Park, S. and Yun, E. (2018). Edible insect food; Current scenario and future perspectives; Food Science and Animal Resource industry, 7: 12-20.

Schlup, Y.and Brunner, T.(2018). Prospects for insects as food in Switzerland, a tobit regression *Food Quality and Preference*, 646:37-46.

Timothy, J. B. (2016). Survival of the creepiest. Washington press, Washington, U. S. A.

Tobih, F. O. (2013). Occurrence and Seasonal variation of Heterologous males Billb (Coleoptera: Dynastidae) in Upper Niger Delta, *Nigeria Agricultural Journal.*

Tzompa-Sosa, D. Y., Valenberg, H. J. F and Lakemond, C. (2019). Four insect oils as food ingredient; Physical and Chemical Characterization of insect oils obtained by an aqueous oil extraction" *Journal of insects as food and feed*, 5:1-14.

Van Huis, A. (2013). Potentials of insets as food and feed in assuring food security. *Annual Review of Entomology*, 58(1):56-58.

World Data Population Sheet (2020).

Zielinska, E., Karas, M, and Baraniak, B. (2018). Comparisons of functional properties of edible insect and protein preparations thereof. *LWT-Food Science Technology*, 91:168-174.