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Nutritonal and Antinutritional Characteristics of Some Insects Foragaing in Akure Forest Reserve Ondo State, Nigeria

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Abstract: The levels of some nutrients, minerals and anti-nutrients of eight dominant insects herbivore distributed among six families from Akure forest reserve (Aponmu) located in Ondo State, Nigeria were determined in order to ascertain their suitability as a food and feed source. The insects contained g per kg dry matter crude protein 72.93 -1.13 g kg^{-1}, crude fiber 29.58 - 2.04 gkg^{-1}, ether extract 53.06 - 1.21 g kg^{-1}, Ash 7.72 - 0.69 g kg^{-1} and Carbohydrate 86.67 - 23.00 g kg^{-1}, (as nitrogen free extracts). Generally, there are significantly ($p \leq 0.05$) higher Nitrogen free extract and crude fiber in treehopper, ash in termite, crude protein in Ant and moisture in *Anaphe venata*. The protein and oil contents revealed that the entire insect analized as a good source of edible protein, which comparable to what is obtainable in chickens and beef suggest them as a potential protein supplement. The insects contained g kg^{-1}Dm calcium which ranges between 0.0126 and 0.0015 (g kg^{-1}Dm), magnesium between 0.0074 and 0.0025 g kg^{-1}Dm, phosphorus between 1224.67 and 425.00 ppm and iron ranges between 166.127 and 82.89 ppm. The calcium, magnesium and phosphorus in grasshopper were significantly ($p \leq 0.05$) higher, as well as iron in treehopper than any insect examined. The mineral composition was generally comparable with what is obtained in other insects. The insects contained tannin between 1050.00 and 250.00 $mgkg^{-1}$ and phytate between 3159.0169 and 1100.15 $mgkg^{-1}$ as the major anti-nutrient. The phytate and tannin recorded in this sturdy are generally lower than the lather level of 1% and 20-40 kg-Dm, respectively. The presence of lower tannin and phytate content are of nutritional significance as tannin form insoluble complexes with proteins. More work is needed to ascertain the impacts of processing on the levels of these anti-nutritional factors.

Key words: Nutrition, insect, dominant, antinutrient, herbivores

INTRODUCTION

Insects constitute more than half of the known species of animal[1]. About one million species have been named and classified and several thousand more are discovered each year Vines and Rees[2] and that about 70% of all known species of animal are insects.Although there is many land animals and are widely spread, they adapt to all types of environment. Their ubiquity, small size, amazing range of adaptation and their fecundity, all make them man's most serious rivals for the possession of the earth. Among the invertebrates, insects are the only group that can fly and feed on plant material, while some feed on animals' tissue and wastes[3] .

It is hardly possible to over emphasize the importance of insects. Some insect like butterflies, bees and some sap sucking once bring direct benefit to man as pollinator of flower; some are predators on pest and as objects of beauty. Others are destructive to cloths, furniture, book and buildings for example Ant and Termites.

The notable destructive group species to forestry are the larvae of Lepidoptera (caterpillars), grasshoppers, locusts and termites. They defoliate the leaves of wildling poles, seedling, herb and shrubs that are suppose to regenerate the logged over forest.

Although, man suffers and benefits from the insects legions Vines and Rees[2], noted that on the whole the suffering outweighs the benefits. It was further observed that pollination is by far the most useful activity that insects carryout from his contribution. The most important crop pollinators are bees, although visitors to flowers also include small beetles and a variety of flies. Indirectly, insects also help man in other ways, predator insects, such as a wasps and ladybugs, attack harmful pest although those pest are often insects themselves.

Insects have played an important role in the history of human nutrition. In Africa, Asia and Latin America[4] . Aletor,[5] noted that *Anaphae venata* is a good source of protein in humman diet since it averagely contains about 22.1 100 g of protein and Ashiru[6] reported a calorific value of 611k cal (2266 kj)100g for the caterpillar of *Anaphae venata.* Other beneficial insects live on organic remains, helping to recycle nutrients that plants can then use. These recycles include minute insects, such as

springtails and a variety of heavily built beetles. Some of these beetles bury the carcasses of small birds and mammals, slowly scraping away the ground until the corpse sinks - below the surface. It is, however, not strange that people travel 200-300 km to pick caterpillars and trader come from Lusaka and the copper belt (900km). He further noted that in several area of Zimbabwe, Some families make a fairly good living from selling caterpillars. Insect are not only sold widely in the village market of developing world but many make their way to urban markets and restaurants.

Some of the selected dominant insect species are pests of some of economic timber tree species such as *Anaphe venata* which browses on the leaf of *Triplochiton scleroxylon,* Termites consume most of all available tree species as well as Tree hopper Meal bug is the pest of *Cola gigantia* fruit, Ant chew through most tree species for their shelter. Grasshopper and Cricket eat most of tree species mostly when they are in seedling state.

This study therefore, examined the nutrients, mineral and anti-nutrients of some selected insect species. The findings would further stress the understandings of populace for the consumption of these insect herbivores. The consumptions of these insects therefore will augment the diet of the rural dwellers thereby preventing malnutrition, and kwashiorkor in children. In addition, it will serve as biological control by reducing destructive activities of these herbivores in our forest ecosystem as swell serve as wealth generation through the commercial rearing of these edible insects.

MATERIALS AND METHODS

The insect sampling was carried out in Permanent Sample Plot (PSP) 29 in Akure Forest Reserve. The 23.52 ha PSP is located at the southern end of the forest reserve. Akure forest reserve covers an area of 69.93 km^2. The reserve is under the management of Department of Forestry of Ondo State Government of Nigeria. The PSP 29 lies within the forest reserve along Ondo-Akure road at about 20 km south of Akure Latitude 7^0 18'N and Longitude 5^o 02' E.

Laying of plot: One hectare of forest plot was mapped out (100 x 100 m). This plot was divided into sub- plots of 25 x 20m totaling 20 plots. Using fifty percent sampling intensity ten plots were randomLy selected. Thirty minutes were spent on each plot selected during which different species of insect were caught. All insects caught were mounted on a mounting board and were oven dried at temperature of 45°C for 4 days. Insects were identified in to order and species by consulting literatures and visiting Forestry Research Institute of Nigeria Ibadan (FRIN) museum. The frequencies of each species of insect from each plot were recorded and at the end of the exercise, the total frequencies of the insect were known. The insects with highest occurrence were selected as the dominant insect in the forest. Massive hunting for the most eight dominant insects were carried out by hand picking, sweep netting, and brushing and they were subjected to proximate, mineral and ant-nutrition analysis.

Proximate analysis: The samples were analyzed for proximate composition (crude protein, crude fiber, crude fat and crude ash) by the standard procedures of Association of Analytical Chemists[7]. However, crude protein values were subsequently obtained by using a factor of 6.25. Carbohydrate content (i.e. Nitrogen Free Extracts) of the insects were determined by subtracting the sum of the weights of crude protein, crude fiber, fat and crude ash from the total dry matter.

Mineral analysis: The concentrations of minerals (Ca, Fe, Mg and P) were determined after wet digestion with a mixture of perchloric and nitric acids using the Atomic Absorption spectrophotometer (AAS, model SP9, Pyechicam, Uk). Quantitative estimation of metal cat ions was done in determining the calcium and magnesium content of the samples.

Anti-nutrient determination: Phytate was determined according to the method of Wheeler and Ferrel[8] . Four gram of each of the sample was soaked in 100 mL 2% HCL for 5 h and filtered. Then, 25 mL of the filtrate was placed in conical flask and 5 mL of 0.3% Ammonium thriocynate solution was added. This was titerated with a standard $FeCl_3$ solution until a brownish-yellow colour pertsists for 5 min.

Tannin: Tannin was obtained by adopting the quantititative method of Markar and Goodchild, [9]. 0.2 g of each of the sample was soaked in 10 mL of 70% acetone and placed in ice water bag and soaked for 12 min to extract the tannin. This was filtered and 0.5 mL of the distilled water was added to the filtrate. 0.5 mL of lowery reagent and 2.5 mL at 20% Na_3CO were also added. The tube was vortexes and incubated for 40 minutes of room temperature and the result was read at wavelength 700 nm on corning colorimeter 253 against the blank. The value obtained was extrapolated from the standard tannic acid curve and then converted to mg TA/100g sample. .

Method of data analysis: Data obtained for proximate, minerals and anti-nutrition properties were subjected to

Table 1: ANOVA table for proximate composition gkg $^{-1}$ Dm of dominant insects herbivore foraging in Akure Forest reserve Aponmu

Proximate content	Source of variation	Sum of squares	df	Mean square	F-value	Sig.
Moisture content	Insect	673.4098705	7	96.20141008	131945.2	7.18487E-37
	Error	0.011665624	16	0.000729101		
	Total	673.4215362	23			
Crude protein	Insect	5143.038481	7	734.719783	47293.8	2.6363E-33
	Error	0.248563592	16	0.015535224		
	Total	5143.287045	23			
Ether extract	Insect	3342.744795	7	477.5349707	898392.8	1.55544E-43
	Error	0.008504699	16	0.000531544		
	Total	3342.7533	23			
Ash	Insect	15.72587295	7	2.246553279	36370.8	2.15447E-32
	Error	0.000988289	16	6.1768E-05		
	Total	15.72686124	23			
Crude fibre	Insect	1447.855	7	206.8364	3536.998	2.67729E-24
	Error	0.935647	16	0.058478		
	Total	1448.791	23			
Nitrogen free extract	Insect	2352.646	7	336.0923	4506.11	3.86346E-25
	Error	1.193375	16	0.074586		
	Total	2353.84	23			

Table 2: Result of Duncan MultipleRange test of proximate composition of dominant insect herbivore foraging in Akure forest reserve Aponmu)

Insect	Moisture content	Crude Protein	Ether Extract	Ash	Crude Fiber	Nitrogen
Ant	16.357± 0.012^{c}	72.933± 0.348^{h}	1.533± 0.009^{b}	0.697± 0.003^{a}	2.040±0.01^{a}	23.000± 0.540^{a}
Termite	15.533± 0.024^{b}	2.400± 0.029^{b}	1.580± 0.010^{c}	9.887±0.009^{h}	2.880± 0.07^{b}	24.670± 0.100^{b}
Cricket	19.477± 0.009^{e}	7.410± 0.015^{d}	2.133± 0.003^{d}	0.910± 0.006^{b}	5.160±0.02^{c}	33.110± 0.020^{c}
Meal bug	7.333± 0.033^{a}	25.347± 0.029^{f}	15.867± 0.009^{g}	1.007± 0.003^{c}	9.450± 0.13^{d}	52.620± 0.090^{d}
Grasshopper	17.733± 0.018^{d}	22.120± 0.060^{e}	1.213± 0.003^{a}	4.307± 0.007^{f}	12.780±0.15^{e}	56.550± 0.130^{e}
Anaphe venata	36.337± 0.019^{h}	2.840± 0.025^{c}	14.137± 0.009^{f}	2.037± 0.032^{d}	17.540± 0.030f	59.590 ± 0.030^{f}
Tree hopper	20.257± 0.007^{f}	34.000± 0.058^{g}	11.940± 0.010^{e}	7.717± 0.012^{g}	21.670± 0.480^{g}	63.450± 0.460^{g}
Winged termite	27.247± 0.009^{g}	1.133± 0.033^{a}	53.063± 0.032^{h}	3.227± 0.015^{e}	29.580± 0.140^{h}	86.670± 0.180^{h}

All values are Mean ± SE Means followed with the same alphabet in the same column is not significantly different ($P \leq 0.05$)

Table 3: ANOVA for mineral composition in gkg^{-1}Dm and antinutrient in mg/100g of dominant insects herbivore foraging in Akure Forest Reserve

Minerals	Source of variation	Sum of Squares	df	Mean square	F-value	Sig.
Calcium	Insect	0.000308706	7	4.41009E-05	3024.061	9.36618E-24
	Error	2.33333E-07	16	1.45833E-08		
	Total	0.00030894	23			
Magnesium	Insect	5.82096E-05	7	8.31565E-06	739.1693	7.17757E-19
	Error	0.00000018	16	1.125E-08		
	Total	5.83896E-05	23			
Phosphorus	Insect	1437365.958	7	205337.994	1627.514	1.32194E-21
	Error	2018.666667	16	126.1666667		
	Total	1439384.625	23			
Iron	Insect	15968.78086	7	2281.254409	32205945	0
	Error	0.001133333	16	7.08333E-05		
	Total	15968.782	23			
Antinutrient						
Phytate	Insect	9654274.398	6	1609045.733	1.15E+11	0
	Error	0.000195333	14	1.39524E-05		
	Total	9654274.399	20			
Tannin	Insect	2164040.625	7	309148.6607	59356.54	4.28276E-34
	Error	83.33333333	16	5.208333333		
	Total	2164123.958	23			

one-way analysis of variance where significant differences were discovered, means separation was done by Duncan Multiple Range Test[10].

RESULT

Five thousand eight hundred and eighty four (5,884) insect herbivores were encountered per hectare distributed among fifty insect species. These species belong to eleven Orders. It was observed that *Anaphe venata* have the highest relative frequency 51.37%, followed by cricket with relative frequency of 5.44%. Other insect speacies used for nutritional analysis have their relative frequency above 1.00%.

The result from the Table shows that there were significant differences among the proximate composition of the insects ($p \leq 0.05$).

The proximate chemical composition in gkg $^{-1}$ Dm of the eight dominant insects herbivore foraging in Akure forest reserve (Aponmu) is as presented in Table 2. The moisture content of the insects ranges between 36.34 and 7.33 gkg $^{-1}$ with the *Anaphae venate* recording the

Table 4: Result of Duncan Multiple Range Test of mineral composition of dominant insect herbivore foraging in Akure forest reserve (Aponmu)

	Mean			
Insect	Calcium (mg/100g)	Magnesium (mg/100g)	Phosphorus (ppm)	iron (ppm)
Tree hopper	0.0012±0.0001^{a}	0.0074±0.0000^{h}	1224.67±0.333^{g}	96.083± 0.003^{b}
Anaphe venata	0.0013±0.0001^{ab}	0.0056±0.0001^{d}	500.000±0.000^{e}	130.71±0.006^{e}
Cricket	0.0015±0.0001^{bc}	0.0040±0.0001^{b}	850.33±0.333^{c}	112.373±0.007^{c}
Winged termite	0.0016± 0.0001^{c}	0.0067±0.0001^{f}	425.00±0.000^{a}	82.89± 0.000^{a}
Meal bug	0.0023±0.0001^{d}	0.0068±0.0001^{g}	650.00±0.000^{d}	123.507± 0.0033^{d}
Termite	0.0024±0.0000^{d}	0.0043±0.0000^{e}	631.67±18.333^{g}	150.743± 0.003^{g}
Ant	0.0037±0.0001^{e}	0.0025±0.0001^{a}	450.00±0.000^{f}	137.85± 0.006^{f}
Grasshopper	0.0126±0.0001^{f}	0.0060±0.0001^{e}	675.33± 0.333^{h}	166.127± 0.007^{h}

All values are Mean ± SE Means followed with the same alphabet in the same Column is not significantly different ($P \leq 0.05$)

Table 5: Duncan result of Antinutrient composition in mg/100g of Dominant Insect Herbivore foraging in Akure forest reserve (Aponmu)

	Mean	
Insect	Phytate	Tannin
Ant	2030.797± 0. 007^{d}	400.000± 0.000^{b}
Termite	2482.084± 0.000^{f}	948.333± 1.667^{e}
Cricket	3159.017± 0.001^{g}	900.000± 0.000^{d}
Meal bug	2256.437± 0.003^{e}	1150.000± 0.000^{h}
Grasshopper	1100.146± 0.001^{a}	1050.000± 0.000^{g}
Anaphe venata	1917.971± 0.003^{c}	753.333± 3.333^{c}
Winged termite	1128.227± 0.003^{b}	250.000± 0.000^{a}
Tree hopper	ND	1000.000± 0.000^{f}

ND- Not Determined All values are Mean ± SE Means followed with the same alphabet in the same column is not significantly different ($p \leq 0.05$)

highest while Meal bug having the least value. It was also reveal that these were higher crude protein content in Ant, Mealbug. Gosshoper and Tree hopper as 72.93, 25.35, 22.12 and 34.00 gkg^{-1}, respectively, while termite, Cricket, *Anaphae Venata* and winged termite have significantly lower protein of 2.40, 7.41, 2.84 and 1.13 gkg^{-1}, respectively. Winged termite has an outstanding value of ether extract of 53.06 gkg^{-1} to lead the table while the values of other insects are relatively low to the value obtained in winged termite. The table further revealed that the Ash content ranges from 9.89 gkg^{-1} to 0.697gkg^{-1} with grasshopper having the highest value and Ant has the least. Likewise higher crude fiber value, in Termite as 29.58 gkg^{-1} and Treehopper as 21.67 gkg^{-1}. Generally the entire insects have a very high value of carbohydrate as Nitrogen Free Extract (NFE)

Means followed with the same alphabet vertically is not significantly different ($p \leq 0.05$)

The Minerals Composition of the eight dominant insect herbivores is presented in Table 3. Grasshopper with 0.126 mg/100g representing the highest value obtained in this sturdy and Treehopper has the least value of 0.0012 mg/100g. From the result Treehopper has the highest magnesium composition of 0.0074 mg/100g and also the highest value of phosphorus as 1224.67 ppm. Grasshopper has the greatest value of iron of 166.13mg/100g while *Anaphae Venata* , Meal bug, tree hopper and winged termite with value of 130.7100, 123.5067, 96.0833 and 82.8900 respectively in gkg^{-1}Dm.

Result from the Table 3 shows that there were significant ($p \leq 0.05$) differences in calcium, magnesium and phosphorus as among the insects while there is higher significant ($p \leq 0.05$) difference in iron among the eight dominant insects herbivore. The Table 5 also revealed that there was no significant ($p \leq 0.05$) difference in phytate level and there was significant difference ($p \leq 0.05$) in Tannin among the eight dominant insect herbivores. Table 4 Shows the Duncan multiple range tests comparing the pair of means of each element among the insets. While Table 5 Show the mean comparison of the pair of mean if phytate and tannin among the insects. There is significant in all the pairs compared in phytate and Tannin.

DISCUSSION

The high crude protein content of Ant (72.93gkg^{-1}) which is much greater than the value contained in water bottle (21.0 gkg^{-1}) as reported by Florence[3] and the crude protein content of meal bug, Grasshopper and Tee hopper. It is however, is comparable to the value obtained in beef (27.4 gkg^{-1}Dm) and fish 28.5 gkg^{-1}Dm[3] . The high crude protein content is an indication that the insects can be of value in man and animal ration and can equally replace higher animal protein usually absent in the diet of rural dwellers in developing countries. The ether extract (oil) of Winged termite of 53.06 gkg^{-1}Dm is quite high which is a characteristics of good source of oil and can provide high calories of energy to both and animal if feed with it. The ash content, which ranged from 9.88 to 0.70 gkg^{-1}Dm is lower than the 20.8 gkg^{-1} Dm present in oil bean (*Penfaclethra macrophylla* Benth)[11]. The insects cannot be adjudged a good source of mineral food as evident in Table 3. Among the element determined, Grasshoppers has the highest calcium value and Treehopper has high Phosphorus values and as a result of this they could be used to feed or compound the feed of young once that are still developing in bone and teeth. Though these food elements are in the insects, the insects could be consumed along with other food and animals rich in these minerals to enhance healthy and strong bone

formation in man and animals.

Barry,[12] reported that Phytate could interfere with mineral bioavailability when it is 1% or more in the diet but the one recorded in the entire insect in this sturdy is much lower.

Barry,[12] reported that condensed tannin (20-40 kg^{-1}Dm) has some beneficial effect in protein metabolism and the good palatability generally associated with low - tanning diets. However, Aletor,[8] reported that high levels of tannins (76-90 g kg Dm^{-1}) could be detrimental if consumed. It was noted that tannins usually form insoluble complexes with protein, thereby interfering with their bioavailability and high tannin in diets is ascribed to its astringent property, which is a consequence of its ability to bind with proteins of saliva and mucosal membranes[14]. The tannin content of the insects examine ranges between 1150.00 mg/100g and 250.00 mg/100g which is much lower than the 3.36 gkg^{-1} Dm as contained in oil bean as reported by Enujiugha and Agbede[11].

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