PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 8 (7): 917-922, 2009
ISSN 1680-5194
© Asian Network for Scientific Information, 2009

Marketability and Nutritional Qualities of Some Edible Forest Insects in Benue State, Nigeria

F.S. Agbidye[1], T.I. Ofuya[2] and S.O. Akindele[3]
[1]Department of Forest Production and Products,
University of Agriculture, P.M.B. 2373, Makurdi, Nigeria
[2]Department of Crop, Soil and Pest Management,
Federal University of Technology, P.M.B. 704, Akure, Nigeria
[3]Department of Forestry and Wood Technology,
Federal University of Technology, P.M.B. 704, Akure, Nigeria

Abstract: This study investigated the marketability and nutritional qualities of four edible insect species in Benue State. Using market survey checklists, 10 out of the 23 Local Government Areas and three major towns of Benue State were covered for data collection. Proximate composition of the edible insects marketed in the study area was determined on dry weight basis. One-way ANOVA was used in analyzing the data collected. Results showed that *Cirina forda* Westwood had significantly the highest mean quantity per marketer of 13.2 kg. There was no significant difference in the mean quantity per marketer of *Bunaea alcinoe* Cram (3.5 kg), *Macrotermes natalensis* Haviland (1.6 kg) and *Brachytrupes membranaceus* Drury (0.2 kg). The proximate composition of the selected edible insects showed that the crude protein contents of the caterpillars of the emperor moths, *C. forda* (74.35±0.09), *B. alcinoe* (74.34±0.04) were significantly highest ($p<0.05$), followed by *M. natalensis* (65.62±0.07) and then *B. membranaceus* (35.06±0.12).

Key words: Marketability, nutritional qualities, edible forest insects, Benue State

INTRODUCTION

The forest and its by-products, in addition to timber, firewood and charcoal, are of vital importance to the rural population. These include various vegetables and fruits, mushrooms, edible insects, medicinal plants, honey, etc (Adeduntan and Bada, 2004; Akanbi and Ashiru, 2002; Latham, 2001). Non-timber forest products are important for food security, health, social and economic welfare of rural communities. They provide a significant nutritional contribution, especially crucial during times of drought and famine and create more varied, palatable and balanced diets (FAO, 1989; Ramos-Elorduy, 1997). Edible insects are a food resource that continues to be tapped extensively by populations in the Third World (De Foliart, 2002, 1990, 1989; Latham, 2001; Cherry, 1991). The pallid emperor moth, *Cirina forda*, which is a defoliator of shea butter tree, *Vitellaria paradoxa*, is a delicacy in many homes in Africa (Nongo, 2005; Akanbi and Ashiru, 2002; Odeyemi and Fasoranti, 2000; Fasoranti and Ajiboye, 1993). The larva of the moth, *Bunaea alcinoe*, is a defoliator of many forest trees including *Parkia biglobosa*, *Prosopis africana*, *Khaya senegalensis*, but the insect is cherished in many homes in Nigeria (Akanbi and Ashiru, 2002). The termite, *Macrotermes natalensis* is a delicacy in many homes in Nigeria and throughout Africa. However, termites form the most destructive group of insect pests of tree species in Nigeria (Akanbi and Ashiru, 2002; Appiah and Aisagbonhi, 2000; Fasoranti and Ajiboye, 1993; Ashiru, 1983; Agwu, 1981; Malaka, 1973). The large African cricket, *Brachytrupes membranaceus*, which is very much cherished in many homes in Nigeria is a pest of forest nurseries where severe defoliation may result (Akanbi and Ashiru, 2002; Hill, 1983). Where, careful studies have been conducted, the volume of insects consumed as a percentage of the total animal protein has been shown to be appreciable (Dufour, 1987).

Considering the popularity of the edible insects, it is not surprising that scores of species have been and are, prominent items of commerce in the town and village markets of Africa and tropical and semi-tropical regions of the world (De Foliart, 2002, 1989). In several areas of Zimbabwe, South Africa, Zambia and Nigeria, many families make fairly good living from selling insects (Adeduntan and Bada, 2004; Mbata and Chidumayo, 2003; Fasoranti and Ajiboye, 1993; Chavunduka, 1975). In South Africa for example, about 1600 tonnes of the emperor moth (mopane worm) *Gonimbrasia belina* (Westwood) are sold annually in the country (De Foliart, 1990; Vane-Wright, 1991). As many as 5000×50 kg bags of dry mopane worms, selling at the rate of South African Rand 120-150 per 50 kg bag were reported to have been purchased by one businessman in Botswana.

It is important to note that insects are high in protein, energy and various vitamins and minerals (De Foliart, 2002, 1989). The nutritional qualities of edible insects have been studied by various authors including Ajayi and

Adedire (2007), Ogbalu (2005), Omotoso and Adedire (2005), Mbata and Chidumayo (2003), De Foliart (2002, 1991, 1989), Ashiru (1988), Taylor (1975) De Conconi *et al*. (1984). Insects contain a lot of protein, while others offer abundant fat calories (Taylor, 1975). In terms of dry matter, over 60% of an edible caterpillar is protein (Cunningham, 1996). It is further estimated that the consumption of 100 g of caterpillars by humans, provides about 76% of daily protein requirements and almost 100% of vitamins (Van Huis, 1996). The quantity and quality of proteins, lipids, vitamins, minerals and calories present in edible caterpillars are comparable to those of beef, fish, lamb, pork, chicken, milk and eggs (De Foliart, 1991). The amino acid composition of insects, although not ideal (tending to be low in methionine, cysteine and tryptophan), is easily balanced by the addition of suitable plant protein (Taylor, 1975). The indigenous people in Africa knowingly or unknowingly compensate for this amino acid deficiency by eating insects together with plant protein. Most indigenous diets of Africa are very rich in plant protein and carbohydrate (Mbata and Chidumayo, 2003). Insects contain calcium, iron, other minerals and some vitamins (notably riboflavin). Other analyses demonstrate that, while part of the protein in carcasses is unavailable, being bound in the indigestible cuticle, what remains is nutritious and readily utilized (Taylor, 1975). De Conconi *et al*. (1984) had reported above 50% crude protein content in 40 insect species on a dry matter basis and it ranged as high as 82%. Digestible protein ranged as high as 64%. De Foliart (2002, 1989) had reported that *Macrotermes subhyalinus* is high in magnesium and copper. Chavunduka (1975) in Zimbabwe had credited insect consumption as averting many potential cases of Kwashiorkor among the young in remote rural areas of Zimbabwe.

The specific objectives of this research are to determine the marketability and nutritional qualities of the edible insects in the study site. The determination of the nutritive values of these insects will encourage greater exploitation to meet protein needs in the rural communities. De Foliart (2002, 1989) had noted that the recognition and encouragement of the traditional foods and feeding habits of the rural communities could be the means of alleviating and perhaps even solving, the great problem of malnutrition and disease among these people.

MATERIALS AND METHODS

Study location: The research was conducted in Benue State which is located between latitudes 7°30´N and 8°10´N and between longitudes 7°30´E and 9°50´E. The State lies in the transition belt between the tropical rain forest of southern Nigeria and the open grassland savanna vegetation of northern Nigeria (Benue State Diary, 2007).

Marketability of edible insects in Benue State: A checklist was used to survey the marketability of edible insects in the study area. Three major markets were selected in each of the 10 LGAs under study and visited three times (on 3 different market days). Using purposive sampling, five insect marketers (where possible) were interviewed at random from each market (Osuala, 1986; Anonymous, 2003). The aim of this market survey was to identify the species of edible insects offered for sale, units of measurement, cost per unit measure and the quantities of the edible insects offered for sale in each market. Data analysis was by one-way ANOVA (Akindele, 1996).

Nutritional qualities of edible insects in Benue State: Proximate analyses were carried out to determine the nutritive value (dry matter, crude protein, ether extract, crude fibre, nitrogen free extract and ash of *C. forda, B. alcinoe, B. membranaceus* and *M. natalensis* (the marketed insect species). Insect samples were collected and oven-dried at 45°C according to the procedure described by Adedire and Aiyesanmi (1999). Dried samples were pulverized with pestle in a ceramic mortar and the resulting powder used. The proximate composition was determined on dry weight basis using the procedure given by AOAC (1990). Data obtained were subjected to arcsin transformation and then to one-way Analysis of Variance (ANOVA) with mean separation done using Duncan's Multiple Range Test (DMRT) (Akindele, 1996).

RESULTS

Marketing of edible insects in Benue State, Nigeria: Four edible insect species were offered for sale within the study period (Table 1). These were larvae of the pallid emperor moth, *Cirina forda* Westwood (Plate 1); larvae of the spiny emperor moth, *Bunaea alcinoe* Cram (Plate 2); alate forms of the termite, *Macrotermes natalensis* Haviland (Plate 3) and *adults* of the cricket, *Brachytrupes membranaceus* Drury (Plate 4) with *Cirina forda* having significantly the highest mean quantity per marketer ($p<0.05$). There was no significant difference in the mean quantity per marketer of *Bunaea alcinoe, Macrotermes natalensis* and *Brachytrupes membranaceus*. Edible insects were sold using spoons, milk tins and local mudus or just placed in heaps with prices depending on the unit measure, the

Table 1: Mean quantities in kilograms (Kg) of edible insects offered for sale in Benue State markets

Type of insect	[a]Mean quantity (kg) per marketer
Cirina forda	13.2±1.1[a]
Bunaea alcinoe	3.5±0.5[b]
Macrotermes natalensis	1.6±0.2[b]
Brachytrupes membranaceus	0.2±0.3[b]

[a]Values are mean quantity + SEM of edible insects offered for sale in Benue State markets. Means with the same superscripts are not significantly ($p>0.05$) different

Plate 1: Dried *Cirina forda* larvae displayed for sale in North bank Market, Makurdi Benue State

Plate 2: Dried *Bunaea alcinoe* larvae displayed for sale in Wurukum market in Makurdi, Benue State

Plate 3: Dried alate form of *Macrotermes natalensis* (termites) on sale in Gboko main market, Benue State

insect species in question and market in consideration (Plate 1-3). For example, a mudu of dried *C. forda* and *B. alcinoe* which weighed 0.8Kg was sold for N350.00 while, a milk tin (0.1 kg) of the same product was sold for N50.00 in North Bank market in Makurdi. The same product was sold for N300.00 and N50.00, respectively in Zaki-Biam market in Ukum LGA. In many rural markets, there was no particular unit of measurement as edible insects were sold in various containers with the prices depending on the quantity in the container. In

Plate 4: Adults of *Brachytrupes membranaceus* (crickets) displayed on sticks for sale at Emere near Okaba in Benue State

Plate 5: Termite and *Cirina forda* snacks for sale alongside native pear, poultry eggs and pork at 'Mban u Injaa' night market in Gboko, Benue State

some cases edible insects were prepared in the form of snacks and displayed for sale alongside other meat products like poultry eggs, pork and even fruits of native pear, *Dacryodes edulis* (Plate 5).

Proximate composition of edible forest insect species in Benue State, Nigeria: Analysis of variance performed for the proximate composition of various edible insect species showed significant difference among the insect species ($p<0.05$) (Table 2). The dry matter of the adult cricket, *Brachytrupes membranaceus*, was significantly higher than that of the caterpillars of the emperor moths, *Cirina forda*, *Bunaea alcinoe* and the alate caste of the termite, *Macrotermes natalensis*. Ether extract was significantly more in cricket than in termite and the emperor moths-*Cirina forda* and *Bunaea alcinoe*. There was significantly higher level of ash in the termite compared to cricket, *C. forda* and *B. alcinoe*. The crude fibre content of the termite was significantly highest

Table 2: Mean + SEM values of proximate composition of selected edible forest insect species in Benue State

Insect species	Dry matter	Ether extract	Ash	Crude fibre	Crude protein	Nitrogen free extract
C. forda	67.85±0.10^{b}	14.30±0.12^{c}	3.10±0.20^{b}	6.01±0.36^{b}	74.35±0.09^{a}	2.36±0.65^{b}
M. natalensis	68.44±0.11^{b}	21.35±0.10^{b}	4.05±0.10^{a}	7.85±0.20^{a}	65.62±0.07^{b}	1.13±0.36^{c}
B. membranaceus	88.40±1.45^{a}	53.05±0.44^{a}	3.25±0.07^{b}	6.30±0.14^{b}	35.06±0.12^{c}	2.33±0.58^{b}
B. alcinoe	68.17±0.48^{b}	14.10±0.15^{c}	2.85±0.04^{c}	5.55±0.08^{c}	74.34±0.04^{a}	3.16±0.09^{a}

Values with different superscripts within the same column are significantly different ($p<0.05$)

followed by that of cricket, *Cirina forda* and that of *Bunaea alcinoe*. The crude protein contents of the caterpillars of the emperor moths, *C. forda*, *B. alcinoe* were significantly highest followed by termite and cricket. Nitrogen free extract was significantly highest in *Bunaea alcinoe* and least in *Macrotermes natalensis*.

DISCUSSION

The results of this study have shown that edible insects are prominent items of commerce in Benue State contributing to the socio-economic well-being of the people in both rural and urban communities alike. It also shows that edible insects compete favourably with other meat products in Benue state which explains why they are displayed for sale alongside other meat products like pork and poultry eggs. It is also indicative of the fact that the edible insect species are abundant in Benue State since the quantities are enough to meet household consumption and also for sale. The results of this study tally with those obtained by Mbata and Chidumayo (2003); Fasoranti and Ajiboye (1993) and Agbidye and Tyokever (1999) who have reported that edible insects are notable items of commerce in many communities in developing countries playing important roles in poverty alleviation and meeting the protein needs of the people. De Foliart (2002, 1989) had also reported that edible insects contribute heavily in the incomes of the rural populace in many Third World countries.

The dry matter of the adult cricket, *B. membranaceus*, was significantly highest, which means that weight for weight, *C. forda*, *B. alcinoe* and *M. natalensis* have more water content than *B. membranaceus*. This could be explained on account of the more sclerotised exoskeleton present in cricket than in the emperor moths and termite. The cuticle in termite and the caterpillars of the emperor moths is thin and flexible compared to the cricket (Borror *et al*., 1976). Ether extract is more in cricket than in termite and the emperor moths. This also explains the lesser water content in the cricket mentioned above. This also, shows that the fat content of cricket is more than that of *C. forda*, *B. alcinoe* and *M. natalensis*. The implication of fat content on comparative feeding value is that *C. forda* and *Bunaea alcinoe* would attract more value by virtue of their lower fat content. This result agrees with Taylor (1975) and De Foliart (1991) that some insect species have high fat content compared to others. The significantly higher level of ash in the termite compared to cricket, *C. forda* and *B. alcinoe* could be explained on account of the fact that the termite feeds principally on humus, grass and fungi while *C. forda*, *B. alcinoe* and *B. membranaceus* feed principally on tender foliage.

The higher content of crude fibre in termites could be explained on account of its feeding behavior (preferring woody plants to grasses). Components of crude fibre are mainly structural carbohydrates which are celluloses and hemicelluloses. Nutritionally the caterpillars of the emperor moths are of higher value followed by the termite based on the crude protein value. The crude protein value of the caterpillars of the emperor moths is comparable to fish (61.1%) in human diet (Ande, 1991; De Foliart, 1991; Cullison and Lowrey, 1987). This result agrees with Cunningham (1996) that over 60% of the dry matter of edible caterpillars is protein. Cricket has the least amount of crude protein. This could be as a result of the high proportion of fat. Fat content is known to be inversely related to crude protein (Cullison and Lowrey, 1987). Nitrogen free extract is normally determined by difference and it is generally low in animal products. Its variability between insect types as observed in this study could be explained on account of other proportions of the different variables analyzed.

Conclusion and recommendations: This study sought to investigate the marketability and nutritional qualities of the edible forest insects in Benue State. The study has revealed that edible forest insects are marketed in Benue State with the most marketed being *C. forda and B. alcinoe, M. natalensis, B. membranaceus*. The study showed that edible forest insects are of high nutritive value having as high as 74% crude protein in the pre-pupae of *C. forda* and *B. alcinoe*. Information on the marketability and nutritive value of these insect species in Benue State would reveal their economic value to consumers. In the light of the economic significance of edible insects in Benue State, the following recommendations are made:

The State government should enforce the legislation against bush burning and illegal tree felling to preserve the habitats of these insects. Recently there has been massive exploitation of *Prosopis africana* and *Vitellaria paradoxa* trees for firewood, burnt bricks, bakery etc in the State.

There is need to establish plantations of *V. paradoxa, P. africana, P. biglobosa and Khaya senegalensis* to promote the production of *C. forda* and *B. alcinoe*, which are heavily marketed in Benue State.

REFERENCES

Adedire, C.O. and A.F. Aiyesanmi, 1999. Proximate and mineral composition of the adult and immature forms of the variegated grasshopper, *Zonocerus variegates* (L) (Acridoidea; Pygomorphidae). Biosci. Res. Commun., 11: 121-126.

Adeduntan, S.A. and F.A. Bada, 2004. Socio-Economic Importance of Local Silkworm (*Anaphe venata*) to the Rural Dwellers in Ondo State, Nigeria. Abstracts of Papers presented at the 35th Ann. Conf. Entomol. Soc. Nigeria held at the Federal University of Akure, 3 -7, October, 2004, pp: 7.

Agbidye, F.S. and J. Tyokever, 1999. Insects in the Diet of the Tiv people of Benue State: A Preliminary Survey of Kwande LGA of Benue State. Being a paper presented at the 30th Annual Scientific Conference of the Nutrition Society of Nigeria held at Hotel Presidential Enugu, 17-20, November.

Agwu, S.I., 1981. A checklist of insects injurious to oil palm in Nigeria. J. Nig. Institute for Oil Palm Res., pp: 59-64.

Akanbi, M.O. and M.O. Ashiru, 2002. A Handbook of Forest and Wood Insects of Nigeria. Agbo Areo Publishers, Ibadan, pp: 66.

Ajayi, O.E. and C.O. Adedire, 2007. Nutrient Characteristics of the Subterranean Termite, *Macrotermes subhyalinus* (Rambur) (Isoptera: Termitidae). Nig. J. Entomol., 24: 42-47.

Akindele, S.O., 1996. Basic Experimental Designs in Agricultural Research. Montem Paperbacks, Akure, Nigeria, pp: 122.

Ande, A.T., 1991. Some Aspects of the Biology of *Cirina forda* Westwood (Lepidoptera: Saturniidae). Ph.D. Thesis, Department of Biological Sciences, University of Ilorin, Ilorin, Nigeria, pp: 327.

Anonymous, 2003. Guidelines for Planning Effective Surveys. Statistical Services Centre, University of Reading, http://www.rdg.ac.uk/ssc/develop/dfid/booklets/toppes.html.

AOAC, 1990. Association of Official Analytical Chemists: Official Methods of Analysis. 15th Edn. Helrich, K. (Ed.). Vol.1 Arlington, Virginia, pp: 1298.

Appiah, F.O. and C.I. Aisagbonhi, 2000. Termite Damage Assessment in a Five-Year Old date Palm Plantation in Dutse, Jigawa State. Nig. J. Ent., 17: 31-38.

Ashiru, M.O., 1983. A Review of the problems of Tree Protection in Nigeria with Special Reference to Insect Pests. Nig. J. Ent., 4: 39-46.

Ashiru, M.O., 1988. The food value of the larvae of *Anaphe venata* Butler (Lepidoptera: Notodontidae). Ecol. Food Nutr., 22: 313-320.

Benue State Diary, 2007. Benue State of Nigeria Diary, produced by the Ministry of Information and Culture, Makurdi.

Borror, D.J., D.M. Delong and C.A. Triplehorn, 1976. An Introduction to the Study of Insects. 4th Edn. Holt Reinhert and Winston, pp: 852.

Chavunduka, D.M., 1975. Insects as a source of food to the African. Rhod Sci. News, 9: 217-220.

Cherry, R.H., 1991. Use of insects by Australian Aborigines. Am. Entomologist, 32: 8-13. http://www.insects.org/ced1/aust_abor.htm.

Cullison, A. and R.S. Lowrey, 1987. Feeds and Feeding. 4th Edn. Prentice-hall. Inc. New Jersey, pp: 645.

Cunningham, T., 1996. Saturniid Subsidy: Cash and Protein from Edible Caterpillars of Zambesian Woodlands and Welfare in Africa. In: Campbell, B. (Ed.). Centre for International Forestry Research, Bangor, Indonesia.

De Conconi, J.R.E., J.M. Pino Moreno, C. Marquez, Mayaudon, F. Rincon Vadde, M. Alvarado Perez and H. Bourges Rodriguez, 1984. Protein content of some edible insects in Mexico Ethnobiol., 4: 61-72.

De Foliart, G.R., 1989. The human use of insects as food and as animal feed. Bull. Ent. Soc. Am., 35: 22-35.

De Foliart, G.R., 1990. Insects as food in indigenous populations. Ethno-biology: Implications and applications. Proceedings of 1st Int. Conf. Ethno-biol. Belem, 1: 145-150.

De Foliart, G.R., 1991. Insect fatty acids: similar to those of poultry and fish in their degree of unsaturation, but higher in the polyunsaturables. The Food Insects Newsletter, 4: 1-4.

De Foliart, G.R., 2002. The Human Use of Insects as a Food Resource: A Bibliographic Account in Progress. http://www.food-insects.com/book.

Dufour, D.L., 1987. Insects as food. A case study from the Northwest Amazon. Am. Anthropol., 89: 383-397.

Fasoranti, J.O. and D.O. Ajiboye, 1993. Some edible insects of Kwara State, Nigeria. Am. Entomolog., 39: 113-116.

FAO, 1989. Forestry and food security. FAO Forestry Paper 90. FAO, Rome, pp: 128.

Hill, D.S., 1983. Agricultural Insect Pests of the Tropics and their Control. Cambridge University Press, Cambridge, pp: 746.

Latham, P., 2001. Edible Caterpillars and their Food Plants in Bas Congo, D.R. Congo. Forneth (U.K.), pp: 41.

Mbata, K.J. and E.N. Chidumayo, 2003. Traditional Value of Caterpillars (Insecta: Lepidoptera) among the Bisa people of Zambia. Insect Sci. Applic., 23: 341-354.

Malaka, Omo, S.L., 1973. Some measures applied in the control of Termites in parts of Nigeria. Nigeria Entomologists' Magazine, pp: 137-141.

Nongo, N.N., 2005. Conversion of Pestiferous Caterpillars to Food in Benue State. In: Obinne, C.P.O. (Ed.). Readings on Indigenous Processing, Storage and Marketing for Poverty Reductionin Nigeria. CEKARD Associates Publishers, pp: 264-271.

Odeyemi, M.O. and J.O. Fasoranti, 2000. Distribution of the Emperor moth Caterpillar, *Cirina forda* (Lepidoptera: Saturniidae) on sheanut tree Canopy at Ilorin, Nigeria. Nig. J. Entomol., 17: 59-67.

Ogbalu, O.K., 2005. The Domestication of the Edible Monarch Moth, *Bunaea alcinoe* Stoll (Lepidoptera: Saturniidae)-A Source of Protein in Animal Diets. Abstracts of papers presented at the 36th Annual Conference of the Entomological Society of Nigeria held at the University of Port-Harcourt, 9-12 October 2005, pp: 19.

Osuala, E.C., 1986. Introduction to Research Methodology. 2nd Edn. Africana-FEP Publishers, Onitsha, Nigeria, pp: 228.

Omotoso, O.T. and C.O. Adedire, 2005. Nutrient Composition, Functional Properties and Potential Commercial Uses of the Palm Weevil *Rhynchophorus phoenicis* F. (Coleoptera: Curculionidae). Abstracts of papers presented at the 36th Annual Conference of the Entomological Society of Nigeria held at the University of Port-Harcourt, 9-12 October 2005, pp: 14.

Ramos-Elorduy, J., 1997. Insects: A sustainable source of food? Ecol. Food and Nutr., 36: 247-276.

Taylor, R.L., 1975. Butterflies in my stomach. Santa Barbara, Woodbridge Press, pp: 224.

Vane-Wright, R.I., 1991. Why not eat insects. Guest Editorial, Bull. Ent. Res., 81: 1-4.

Van Huis, A., 1996. The traditional use of Arthropods in sub-Saharan Africa. Proceed. Section Experim. Applied Entomol. Netherlands Entomolog. Soc., 7: 3-20.