*Journal of Scientific Research & Reports*
*3(13): 1771-1779, 2014; Article no. JSRR.2014.13.005*

**SCIENCEDOMAIN** *international*
www.sciencedomain.org

# Nutritive and Anti-nutritive Composition of Locust Bean Tree Emperor Moth Larvae *Bunaea alcinoe* (Lepidoptera-saturniidae Stoll 1780) from Gurara Local Government Area, Niger State, Nigeria

**B. E. N. Dauda[1*], J. T. Mathew[1], Y. B. Paiko[1] and M. M. Ndamitso[1]**

*[1]Department of Chemistry Federal University of Technology PMB 65, Minna, Niger State, Nigeria.*

***Author's contributions***

*This work is carried out in collaboration between all authors. Author BEND designed the study, wrote the protocol, wrote the first draft of the manuscript and he carried out pretreatment of the sample. Author JTM managed the literature researches, analyses of the study performed the (GC/MS) spectroscopy analysis. Authors MMN and JTM managed the experimental process. Author YBP identified the species of insect and carried out mineral analysis.*

***Original Research Article***

***Received 26th October 2013***
***Accepted 29th April 2014***
***Published 27th May 2014***

## ABSTRACT

The analysis of proximate, mineral, fatty acids and anti-nutritional composition of *Bunaea alcinoe* were carried out. Results showed that *Bunaea alcinoe* had moisture 5.03±0.12, crude protein 44.23±0.62, crude lipids 10.85±0.65, crude fibre 11.80±0.27, carbohydrate 22.16±1.09 $g100g^{-1}$ and energy value of 1530.08±0.06 kJ/100 g. This insect contained reasonable amounts of sodium, potassium, calcium, phosphorus, magnesium, zinc and manganese. Anti-nutritional analysis revealed the presence of oxalate (15.47±1.88), phytate (18.21±2.14) and cyanide (1.68±0.20)mg/100g; which were within the permissible limits. The insect larvae could therefore serve as an additional promising sources of protein and mineral contents for Human and animal feeds formulations.

**Corresponding author: E-mail: daudaben@yahoo.co.uk;*

*Keywords: Anti-nutritional; fatty acid; mineral; proximate.*

## 1. INTRODUCTION

Insects are eaten as a delicacy in many parts of the world, particularly in the tropics. In contrast, people in most of the Western world tend to see human entomophagy as an aberration. They are very reluctant to even consider eating insects, often associating it with primitive or barbaric attitudes. This may be the reason that such traditional foods have received very little attention in assistance programmes on food security [1]. Due to their high nutrition value, in some regions, flour made from caterpillars is mixed to prepare pulp given to children to counter malnutrition. Termites are particularly high source of iron for those who are weak and anaemic while red ants are rich in bone building calcium. Insects are also believed to have a higher proportion of protein and fat than beef and fish with a high energy value. Depending on the species, caterpillars have high levels of minerals such as potassium, calcium, magnesium, zinc, phosphorus and iron, as well as various vitamins. Research shows that 100 grams of insects provide more than 100% of the daily requirements of minerals and vitamins [2].

*Bunaea alcinoe* or locust bean tree emperor moth belongs to the family *Saturniidae* and order Lepidoptera. The larvae are known by various names like *Katakpani* in Nupe, *Manimani* in Hausa, *Ikanni* in Yoruba and *Aruru* in Igbo. The larval stage of *Bunaea alcinoe* is about 70mm in length and 15mm in diameter. It has deep velvety black colour with eight yellow tubercular processes and red spiracles [3].

This work is aimed to determine the nutritive and anti-nutritive composition of *Bunaea alcinoe* and to achieve this, the proximate, mineral, fatty acid profile and anti-nutritional factors were carried out.

## 2. MATERIALS AND METHODS

### 2.1 Sample Collection

The locust bean tree emperor moth larvae (*Bunaea alcinoe*) were collected from locust beans trees between the months of July and August, 2012 around Diko in Gurara Local Government Area of Niger state, Nigeria. They were washed with distilled water, sun-dried for 48 hours, ground into powder and stored in air-tight containers for further analysis.

### 2.2 Moisture Content

2.00 g of the sample was put into the crucible, dried in an oven at 105ºC overnight. The dried samples were cooled in a dessicator for 30 minutes and weighed to a constant weight. The percentage loss in weight was expressed as percentage moisture content on dry weight basis [4].

This was repeated three times.

## 2.3 Ash Content

2.00g of the ground sample was placed in a crucible and ashed in a muffle furnace at 600ºC for 3 hours. The hot crucibles were cooled in a dessicator and weighted. The percentage residual weight was expressed as ash content [4].

## 2.4 Crude Lipid Content

2.00g of the sample was used for determining crude lipid by extracting lipid from it for 5 hours with petroleum ether in a soxhlet extractor [4].

## 2.5 Protein Determination

Total protein was determined by the Kjedahl method as modified by Williams [5]. 0.5 g of the sample was weighed into a filter paper and put into a Kjedahl flask, 8-10 $cm^3$ of concentrated $H_2SO_4$ were added and then digested in a fume cupboard until the solution becomes colourless. Distillation was carried out with about 10 $cm^3$ of 40% of NaOH. The condenser tip was dipped into a conical flash containing 5 $cm^3$ of 4% boric acid in a mixed indicator till the boric acid solution turned green. Titration was done in the receiver flask with 0.01 M HCl until the solution turned red [4].

## 2.6 Crude Fibre Content

2.00 g of each sample were used for estimating crude fibre by acid and alkaline digestion methods with 20% $H_2SO_4$ and 20% NaOH solution [4].

## 2.7 Metabolisable Energy

The metabolisable energy was calculated in Kilojoules per 100 g (kJ/100g) by multiplying the crude fat, protein and carbohydrate values by Atwater factors of 37, 17 and 17 respectively.

## 2.8 Carbohydrate Determination

The carbohydrate content was calculated using following:

available carbohydrate (%), = 100 – [protein (%) + Moisture (%) + Ash (%) + Fibre (%) + Crude Fat (%)].

## 2.9 Mineral Analysis

Sodium (Na) and potassium (K) were determined using Gallenkamp Flame analyzer, while calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) were determined using Buch Model 205 Atomic Absorption Spectrophotometer. Phosphorus (P) level was determined using the phosphovanado molybdate colorimetric techniques on JENWAY 6100 Spectrophotometer Pearson [6].

## 2.10 Anti-nutritional Properties

Oxalate and cyanide contents were determined using the method of Day and Underwood, [7]. Phytate content was determined by the method described by Wheeler and Ferrel, [8].

## 2.11 Fatty Acid Composition

The fatty acid analysis was carried out by injecting the clear supernatant of the fatty acid methyl esters (FAMEs) in to a Hewlett-Packard 5890 gas liquid chromatograph equipped with a detector. The fatty acids were observed as peaks whose retention times were measured by the spectrometer detector and compared with those of known standards of the Wiley library.

## 3. RESULTS AND DISCUSSION

The results of the proximate composition of emperor moth (*Bunaea alcinoe*) were as shown in Table 1. The moisture content of *B. alcinoe,* was 5.03±0.12%. This value was lower than the 48.45±0.90% moisture content reported for termites (*Macrotermes bellicosus*) by Agomuo [9]. The low moisture contents of the insect in this work indicated that it can be preserved for a reasonable period of time without the risk of microbial deterioration and spoilage. The physiological role of crude fibre in the body is to maintain an internal distension for proper peristaltic movement of the intestinal tract [10]. The crude fibre content obtained in this study was 11.80±0.27% for *B. alcinoe*. This was appreciably high and could be attributed to the chitin found generally in insects [10]. This result was lower than the respective 26.40±1.40 and 28.12±0.20% reported for edible black ants and dung beetle by Subhachai et al. [11] and Paiko et al. [12]. Diets with high fibre contents have been used for weight control and fat reduction as they give a sense of satiety even when small food is eaten [13]. Therefore, this insect can be conveniently used to control human weight in nutrition. The crude protein value recorded for *B. alcinoe,* was higher than the 22.42±0.10 $g100^{-1}$ reported for edible larva of dung beetle by Paiko et al. [12]. The high levels of protein in this sample indicated that it can contribute significantly to the daily protein requirements from 23-56g for humans as stipulated by the NRC [14]. Fats are vital in the structural and biological functioning of the cells and help in the transport of nutritionally essential fat soluble vitamins. The fat contents of the *B. alcinoe* was 10.85±0.65 $g100^{-1}$. This value was lower than crude fat content observed in *Z. variegatus* (17.65±3.24 $g100^{-1}$) by Subhachai et al. [11]. In general, however, this insect can provide supplementary dietary fat needed in feeds formulation for animal husbandry. A human adult needs about 400-500 g carbohydrate intake as starch [14]. The amounts of carbohydrate obtained from the insect in this work were 22.16±1.09 $g100^{-1}$. Similar carbohydrate contents were reported by Onyeike et al. [15] for *O. rhinoceros* (27.7*0*±0.50 $g100^{-1}$) but smaller than *R. pheoniccis* (35.60±0.90 $g100^{-1}$). Present value of carbohydrate was however, much higher than the value reported by Dunkel [16] for cricket (5.10 $g100^{-1}$), grasshopper (2.20), red ant (2.90 $g100^{-1}$) and giant water beetle (2.10 $g100^{-1}$). The ash content of a sample is a reflection of the minerals it contains. The ash content of *B. alcinoe* was 5.*92*±0.17 $g100^{-1}$ higher than the 2.74±0.01 $g100^{-1}$ reported for the dung beetle by Paiko et al. [12]. The insect in this study could serve as a fair source of mineral elements which will be useful particularly for children and pregnant and lactating women. The calculated energy value of 1530.08±0.06 kJ/100g for *B. alcinoe* was lower than the 2172-2600 kJ/100g reported for the larva of edible stink-bug by Teffo et al. [17], but similar to the value 1731.83 kJ/100g reported by Paiko et al. [12] for edible larva of dung beetle.

**Table 1. Proximate composition (g/100g) of *Bunaea alcinoe***

| Parameters (g/100g) | Mean±SD |
|---|---|
| Moisture | 5.03±0.12 |
| Ash | 5.92±0.17 |
| Crude protein | 44.23±0.62 |
| Crude lipids | 10.85±0.65 |
| Crude fibre | 11.80±0.27 |
| Total carbohydrate | 22.16±1.09 |
| Energy value (kJ/100g) | 1530.08±0.06 |

The mineral concentration of present insect under study was presented in Table 2. The concentrations of Fe in *B. alcinoe,* was 38.67±1.0 2 mg/100g higher than the 5.34±0.11 mg/100g reported for *C. forda* larvae by Omotoso [18]. This implies that, *B. alcinoe* will serve as blood building foods and should be desired for human and animal feeds formulations. The P concentration in *B. alcinoe* was 128.50±0.32 mg/100g, similar to 131.20±0.01 mg/100g reported for edible larva of dung beetle [12].The intake of P helps in bone growth, proper kidney function and cell growth. It also plays a role in maintaining the body's acid-alkaline balance [19]. The K concentration of *B. alcinoe* was 91.25±2.18 mg/100g. This value was higher than the 38.40 mg/100g reported for *O. monoceros* by Ifie and Emeruwa [20], but lower than the 2130 mg/100g reported for edible larva of *C. forda* by Akinnawo and Ketiku, [21]. The Zn concentration in *B. alcinoe* was 24.73±0.90 mg/100g, higher than the value reported for the red ant (3.81±0.01 mg/100g) by Dunkel [16]. Regular consumption of this insect may assist in preventing the adverse effects of Zn deficiency which results in retarded growth and delayed sexual menstruation because of its role in nucleic acid metabolism and protein synthesis [22]. The Na concentration of *B. alcinoe* was 125.90±1.25 mg/100g, is higher than the value (55.30 mg/100g) for *E. delegorguei* reported by Teffo et al.; [17], but much lower than value of *O. monoceros larva* (440.0 mg/100g) reported by Ifie and Emeruwa, [20]. Calcium is an essential mineral for bone development. The Ca concentration of B. alcinoe was 27.00±0.12 mg/100g, higher than the value 11.72±0.02 mg/100g reported for edible larva of dung beetle by Paiko et al. [12]. The Mg concentration of *B. alcinoe* was 19.53±2.10 mg/100g, much lower than the value175.00 mg/100g reported by Ifie and Emeruwa, [20] for *O. monoceros*. However, present value was higher than 11.72±0.02 mg/100g reported by Paiko et al. [12] for the larva of dung beetle. Dietary deficiency of Mg which is linked with ischemic heart disease could be prevented by regular consumption of this insect in the indigenous diet. Copper stimulates the immune system to fight infections to repair injured tissues as well as to promote healing. Severe deficiency of Cu in pregnant women increases the risk of health problems in their foetuses and infants [23]. The Cu content of the *B. alcinoe* was 1.13±0.50mg/100g, lower than the 4.4 mg/100g reported for *E. delegorguei* by Teffo, et al. [17]. The Mn concentration of *B. alcinoe* was 16.93±2.01 mg/100g, higher than values reported by Teffo et al. [17] for *E. delegorguei* (0.8 mg/100g) and 1.21 mg/100g reported by Ifie and Emeruwa [20] for *O. monceros*. Lead was not detected in this insect which indicated that the investigated sample was free from the toxic metal. Results of anti-nutritional concentration of the insect were presented in Table 3. Phytates limit the availability of some notable minerals like Zn, Mg, Fe and Ca by forming complexes that are indigestible, thereby decreasing their bioavailability [24,25]. The phytate concentration of value18.21±2.14 mg/100g was recorded for *B. alcinoe*. This value was ten times lower than the 178 mg/100g reported by Ifie and Emeruwa [20]for larva of *O. monoceros*. However that value was higher than the 0.311 mg/100g reported for *H. meles* by Adesina [26]. Based on the phytate value obtained from this work this insect could be consumed without much fear of harm to Humans and his animals in respect of phytic acid

toxicity. Oxalate can bind to Ca present in the food thereby rendering Ca unavailable for normal physiological and biochemical role such as the maintenance of strong bone, teeth, nerve impulse transmission and cofactors in enzymatic reactions as well as clotting factors in the blood [27]. The lethal dose of oxalates is around 105 mg/100g [28]. The value of oxalate concentration of 15.47±1.88 mg/100g recorded for *B. alcinoe* was lower than the 29.00 mg/100g reported by Adesina [26] for yam beetle and 19.32 mg/100g for palm weevil. High level of cyanide in foods has been implicated with cerebral damage and lethargy in Human and animals [29]. The cyanide concentration of *B. alcinoe* was 1.68±0.20mg/100g, was lower than the value 2.65 mg/100g reported by Adesina [26] for *H. meles* and 2.53mg/100g for *R. phoenicis*. The cyanide concentration obtained in this study showed that the insect consumption is safe as far as its cyanide content is concerned.

**Table 2. Mineral composition of *Bunaea alcinoe***

| Parameters | Concentration (mg/100g) |
|---|---|
| Na | 125.90±1.25 |
| K | 91.25±2.18 |
| P | 128.50±0.32 |
| Ca | 27.00±0.12 |
| Zn | 24.73±0.90 |
| Mg | 19.53±2.10 |
| Cu | 1.13±0.50 |
| Fe | 38.67±1.02 |
| Mn | 16.93±2.01 |

*Values are means ± SD of three determinations*

**Table 3. Anti-nutritional composition of *Bunaea alcinoe***

| Parameters | Concentration (mg/100g) |
|---|---|
| Cyanide | 1.68±0.20 |
| Phytate | 18.21±2.14 |
| Oxalate | 15.47±1.88 |

*Values are means ± SD of three determinations*

Table 4 shows fatty acids composition of the lipids extracted from *Bunaea alcinoe.* The abundance of unsaturated fatty acids in the oils were desirable from the nutritional and health point of view as unsaturated fatty acids consumption will not lead to heart related diseases while the consumption of foods rich in saturated fatty acids is implicated with certain cardiovascular disorders like atherosclerosis, cancer and aging [30,31]. The unsaturated acids accounted for 19.51% of the total fatty acids, the saturated fatty acids accounted for 33.66%. The presence of both saturated and unsaturated fatty acids in this insect could be an advantage since it may complement the functions of one another. The ratio of the total unsaturated fatty acids to the total saturated fatty acids (TUFA/TSFA) of *B. alcinoe* was 0.58% which was lower than TUFA/TSFA ratio recorded for edible dung beetle (0.86%) by Paiko et al. [12].Therefore this oil is expected to have a potential use for dietetic management of certain coronary heart diseases.

**Table 4. Fatty acid composition of the lipids extracted from *Bunaea alcinoe***

| S/N | Fatty acid | Current | Composition ($g100g^{-1}$) | Retention time |
|---|---|---|---|---|
| 1 | Dodecanoic acid | Lauric acid | 2.11 | 13.268 |
| 2 | Nonanedioic acid | Azelaic acid | 2.36 | 13.727 |
| 3 | Decanal dimethyl acetal | | 2.19 | 14.346 |
| 4 | Methyl tetradecanoate | Myristic acid | 2.27 | 15.876 |
| 5 | Pentadecanoic acid | | 2.79 | 16.764 |
| 6 | Pentadecanoic acid | | 2.80 | 17.347 |
| 7 | 11-Hexadecenoic acid | | 4.18 | 18.856 |
| 8 | Hexadecanoic acid | Palmitic acid | 8.35 | 19.470 |
| 9 | Heptadecanoic acid | Margaric acid | 3.46 | 21.230 |
| 10 | 6-Octadecenoic acid | | 7.73 | 22.500 |
| 11 | Octadecanoic acid | Stearic acid | 2.49 | 23.024 |
| 12 | 9,12,15-Octadecatrienoic acid | Linolenic acid | 3.35 | 23.240 |
| 13 | 9,12-Octadecadienoic acid | Linoleic acid | 4.25 | 23.759 |
| 14 | Nonadecanoic acid | | 2.52 | 24.128 |
| 15 | Eicosanoic acid | Arachidic acid | 2.32 | 25.276 |
| 16 | TUFA | | 19.51 | |
| 17 | TSFA | | 33.66 | |
| 18 | TUFA/TSFA | | 0.58 | |

*TUFA= total unsaturated fatty acid, TSFA = total saturated fatty acid*

## 4. CONCLUSION

The result obtained from this work reveals that the locust bean emperor moth (*B. alcinoe*) is a good source of protein and minerals. It contains low amount of anti-nutrition factors with reasonable level of fatty acids. It may be recommended for consumption by Human and animals.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Van HA. Insect as Food in Sub-Saharan Africa. Insect Science Application. 2003;3(3):163-185.
2. Hema P, Srivastava SK, Naresh B. Traditional insect bioprospecting-As human food and medicine. Indian Journal of Traditional Knowledge. 2007;8(4):485-490.
3. Latham P. Edible caterpillars and their food plants in Bas-Congo province, Democratic Republic of Congo (Mystole Publication Canterbury 2003) ISBN 0-9543012-7-7.
4. AOAC. Methods of the Association of Official Chemists. Official Methods of Analysis, 15th ed., Virginia Association. Official Analytical Chemists, USA. 1999;1141.
5. Williams CL, Bollella M, Wynder EL. A new recommendation for dietary fiber in childhood. Pediatrics. 1964;96:985-988.
6. Pearson D. Laboratory Techniques in Food Analysis. Butter-worths, London. 1976;33-52.

7. Day RA, Underwood AL. Qualitative Analysis. 5th Ed. New Delhi, India: Prentice Hall Publications. 1986;701.
8. Wheeler EI, Ferrel RE. Methods for phytic acid determination in wheat and wheat fractions. Jour Cereal Chem. 1971;48:312-320.
9. Agomuo EN. Proximate and fatty acid compositions of termites (*Macrotermes bellicosus*). International Science Research Journal. 2011;4(2):93-96.
10. Oduor PM, Struszczyk MH, Peter MG. characterization of chitosan from blowfly larvae and some crustacean species from Kenyan marine waters prepared under different conditions. Discovery and Innovation. 2008;20(2):129-142.
11. Subhachai B, Oranut S, Lirong S, Duo L. Nutritional and fatty acid profiles of sun-dried edible black ants (*Polyrhachis vicina* Roger). Maejo International Journal of Science and Technology. 2010;4(1):101-112.
12. Paiko YB, Dauda BEN, Salau RB, Jacob JO. Preliminary data on the nutritional potentials of the larvae of edible dung beetle consumed in Paikoro Local Government Area of Niger state, Nigeria. Continental Journal of Food Science and Technology. 2012;6(2):38-42.
13. Ekpo KE, Onigbinde AO. Pharmaceutical potentials of *Rhynchophorus phoenicis* larval oil. Nig Annals of Natural Sci. 2004;5:28-36.
14. NRC (National Research Council) Recommended Dietary Allowances. 9th edn. Nat Acad Sci Washington DC; 1980.
15. Onyeike EN, Anyalogu EO, Okaronye CC. Nutritive value of the larvae of raphia palm beetle (*Orycetes rhinoceros*) and weevil (*Rhyncophorus pheonicis*). Journal Sci Food Agric. 2005;17:1822-1828.
16. Dunkel D. Nutritional values of various insects per 100 grams. The Food Insect News letter. 1996;(9):1-8.
17. Teffo LS, Toms RB, Eloff JN. Preliminary data on the nutritional composition of the edible stink-bug, *Encosternum delegorguei* Spinola, consumed in Limpopo province, South Africa. South African Journal of Science. 2007;103:434-438.
18. Omotoso OT. Nutritional quality, functional properties and antinutrients compositions of larva of *Cirina forda* (Westwood) (Lepidoptera: Satuniidae). Journal Zhejiang Univ Sci B. 2006;7:51-55.
19. Fallon S, Enig MG. Nourishing Traditions. The Cookbook that Challenges Policitally Correct Nutrition and the Diet Dictocrats. 2001;40-45.
20. Ifie I, Emeruwa CH. Nutritional and anti-nutritional characteristics of the larva of *Oryctes monoceros*. Agriculture and Biology Journal of North America. 2011;2(1):42-46.
21. Akinnawo O, Ketiku AO. Chemical composition and fatty acid profile of edible larva of *Cirina forda* (Westwood). Afr J Biomed Res. 2000;(3):93–96.
22. Barminas JT, Milam C, Emmanuel D. Mineral composition of non-conventional Leafy vegetables. Plant Food for Human Nutrition. 1998;53(1):29-36.
23. Stern BR. Essentiality and toxicity in copper health risk assessment: Overview, Update and regulatory consideration. Journal of Toxicology and Environmental Health. 2010;73:114-127.
24. Groff J, Gropper S, Hunt S. Advanced Nutritional and Human Metabolism. 2nd ed., New York. 1995;21-362.
25. Erdman G. Phytic acid and zinc bioavailability in human nutrition. Journal of Agricultural Food Chemistry. 1979;27(3):11-14.
26. Adesina AJ. Proximate and anti-nutritional composition of two common edible insects: yam beetle (*Heteroligus meles*) and palm weevil (*Rhynchophorus phoenicis*). Elixir Food Science. 2012;49:9782-9786.

27. Ladeji O, Akin CU, Umaru HA. Level of antinutritional factors in vegetables commonly eaten in Nigeria. Afr Journal Nat Sci. 2004;7:71-73.
28. World Health Organisation. Post harvest and pressing technology of staple food. Technical Compedium of WHO Agricultural Science Bulletin. 2003;88:171-172.
29. Akyildiz BN, Kurtoglu S, Kondolot M, Tunc A. Cyanide Poisoning caused by Ingestion of Apricot seeds. Ann Trop Paediatr. 2010;30(1):39-43.
30. Law M. Dietary fat and adult diseases and the implications for childhood nutrition: An Epidemiologic approach. American Journal Clinic Nutr. 2000;72:1291-1296.
31. Anita BS, Akpan EJ, Okon PA, Umoren IU. Nutritive and anti-nutritive evaluation of sweet potatoes leaf. Pak Journal Nutri. 2006;5:166-168.



*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*http://www.sciencedomain.org/review-history.php?iid=527&id=22&aid=4720*