Journal of Agricultural Technology 2012 Vol. 8(3): 851-860
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Studies on the production trend and quality characteristics of palm grubs in the tropical rainforest zone of Nigeria

Opara, M.N.*, Sanyigha, F.T., Ogbuewu, I.P. and Okoli, I.C.

Department of Animal Science and Technology, Federal University of Technology, P.M.B. 1526, Owerri, Nigeria

Opara, M.N., Sanyigha, F.T., Ogbuewu, I.P. and Okoli, I.C. (2012) Studies on the production trend and quality characteristics of palm grubs in the tropical rainforest zone of Nigeria. Journal of Agricultural Technology 8(3): 851-860.

A large number of insect species are potential sources of valuable nutrients for humans and animals. Inadequate information and advocacy on them seem to make this valuable source under-utilized in animal husbandry. This study was conducted to determine the production trend, nutritive values and microbial profiles of freshly and heat processed larvae (palm grubs) of *Rhynchophorus phoenicis* (African palm weevil) in Bayelsa State, tropical rainforest zone of Nigeria. The results showed that the months of December to May were the peak, whereas those of June to November were the off peak periods of palm grub production in this area. The proximate composition of African palm weevil at different stages of development was determined using standard analytical techniques. In the palm grub larvae, the crude protein was 23.44%, ether extract (54.20%), crude fibre (3.35%), ash (5.20%), moisture (8.80%) and carbohydrates (5.01%), while the crude protein of the immature pupa was 33.10%, ether extract (42.70%), crude fibre (3.12%), ash (7.40%), moisture (7.0%) and carbohydrates (6.68%). In addition, the result of the proximate composition in the matured pupa yielded 34.94% crude protein, while the other values measured were ether extract (47.10%), crude fibre (2.40%), ash (3.0%), moisture (7.0%) and carbohydrates (5.56%). The adult beetle contained 34.05% crude protein, ether extract (44.70%), crude fibre (7.15%), ash (5.80%), moisture (4.27%) and carbohydrates (4.03%). Freshly and heat processed palm grub samples were cultured on nutrient agar and thereafter incubated at 37^0C for 24 - 48 hrs. The medium yielded *Staphylococcus sp*., *Escherichia coli* and *Klebsiella aerogene.* The occurrence of these pathogenic microbes in the palm grub, therefore poses a threat to the well being of man and animals that consume them. These results also suggest that the palm grub is highly nutritive and therefore recommended that it should be hygienically processed before its use in human diet.

Key words: *Rhynchophorus phoenicis,* Palm grub, crude protein, ether extract, crude fibre, ash, moisture and carbohydrates

* Corresponding author: Opara, M.N.; e-mail: oparamax@yahoo.com

Introduction

Low income countries such as Nigeria had been reported to consume 21 kilograms of meat and 40 kilograms of milk per capita per year on the average, while the developed nations with higher income consumed 76 kilograms of meat and 192 kilograms of milk in the first half of the 1990s, a trend that has not changed much (Delgado *et al.* 1999; Oluyemi and Roberts, 2000). This constitutes about 26% contribution to the daily protein allowance of about 65 - 75 g per adult in developing countries (FAO, 1986).

The huge Nigeria's livestock resources revealed that the bulk of animal proteins is from cattle, sheep, goat and poultry which are characterized by low productivity, high risk of diseases, and poor genetic potentials (Omole, 1999). The acute shortage of animal protein sources has been attributed to the phenomenal rise in the prices of conventional animal protein sources such as meat, milk and egg. This therefore calls for the need to research into other animal protein sources such as snails, cane rats, quail and insects that of lesser importance to man (Mcdowell, 1992; NRC, 1991; Amusan and Omole, 2000).

The practice of entomophagy in western and Niger Delta regions of Nigeria is not new (Ekop *et al.*, 2010). Archaeological evidence tells us that entomophagy has been practiced since mankind first made an appearance on this planet. According to López and Shanley (2004), insects have played an important role in the history of human nutrition and in Africa, Asia and Latin America; hundreds of species are still eaten. Some of the more important groups include grasshoppers, caterpillars, beetles, termites, bees, ant larvae and pupae, cicadas and palm grubs. Generally having a high cultural and symbolic value, insects are also rich in nutrients and are available in large quantities, without the risk of resource extinction. Specifically, palm grubs are known to contain phytic acid as the only prominent anti-nutrient, but Ekop (2004) showed that this toxic component is easily detoxified during processing, like – frying, boiling and roasting.

According to Beckerman (1977) and Bedford (1980), palm grubs (larvae of African palm weevil) live and feed on the starchy pulp of the trunk of the Raphia palm (after which it takes its name), which is common in the tropical rainforest of Nigeria. The adult palm weevils have a plump, yellowish - cream body with a soft ridged texture and a hard shelled head. The larva burrows into the crown of the raphia palm, feeding on the young tissues, and sometimes destroys the growing point resulting in the death of the raphia palm tree.

Though African palm weevils are pests as they destroy valuable plant materials, the grubs are highly valued delicacies in western and Niger Delta regions of Nigeria, where they are either eaten raw or after cooking by boiling, roasting or frying while some are used for medicinal purposes (Oluyemi and

Roberts, 2000; Amusan and Omole, 2000; Onyeike *et al*. 2005). Palm grub has shown to be high in crude protein (23.44%), fatty acids, minerals (zinc and iron) and vitamins (thiamine and riboflavin) (Chinweuba *et al*. 2011). Hence, the need to exploit the nutrient potentials of palm grubs in order to bridge the gap between animal protein supply and consumption. This line of thought has therefore generated the present research interest in determining the production trend, nutritional value and microbial loads in differently processed palm grubs.

Materials and methods

The Study Area

The palm grubs were collected from Bayelsa State and brought to the laboratory of the department of Animal science and Technology, Federal University of Technology for further analyses. A preliminary field survey was carried out to identify palm grub harvest sites and their hawkers in the tropical rain forest of Amassoma. The study was conducted from June, 2006 to July, 2006.

Bayelsa state is situated in the south – south, the crude oil rich region of Nigeria. The vegetation is typically rainforest with two seasons, the rainy and dry seasons. The period of rainy season is from the month of April to October, while the dry season runs through November to March. Bayelsa state is located within latitude 4'15^0 N and 5'23^{0}S and longitude 5'22^0 W and 6'45^0 E. It shares common boundaries with Delta state on the North, Rivers State on the East and the Atlantic Ocean on the west and south. People in the rural and semi urban areas are predominantly fishermen (Agboola, 1979). They also cultivate crops like cassava and vegetables among others.

Sample Collection

A total of 54 samples were collected from three selected zones of Amassoma rain forest in Bayelsa State, Nigeria. Each selected zone was visited thrice for sample collection during the study period. Already processed palm grubs were bought from palm grub hawkers along the major streets in the three selected zones. The samples were collected using sterile universal bottles and transported to the laboratory for analysis within 3 hours of collection.

Proximate biochemical composition

Samples of palm grub were dried and pulverized into fine powder using a mortar and pestle. The dried palm grubs were analysed for the proximate biochemical composition in the laboratory. The crude fibre, ether extracts and ash were determined according to the standard procedures of A.O.A.C. (1990). The nitrogen was determined by the Micro Kjeldhal method described by Pearson (1976) and the nitrogen content was converted to protein by multiplying it with a factor of 6.25. Nitrogen free extracts were obtained by the difference. Triplicate determinations were carried out and the mean determined. All the proximate values were reported in percentages.

Microbial analysis and Giemsa staining

A total of ten matured palm grubs were used for microbial analysis. The palm grubs were put in well labeled sterile universal bottles and transported to the laboratory for analysis. The samples were then allowed to stand for a pre-diffusion period of about one hour. Thereafter the samples were incubated at 37^0C for 24 hours after which the organisms were identified based on colony characteristics and biochemical reactions according to methods of Cheesbrough (2000). The isolates were stained according to Gram’s technique as described by Baker (1967).

Data Analysis

All the quantitative data obtained on production output, proximate compositions and microbial load counts of palm grubs were analysed using simple descriptive statistics such as means and percentages.

Results and discussions

Daily production of palm grubs at different periods of the year in Bayelsa State is shown in Table 1. It was observed that during the months of December to May (peak season), 800 - 1100 palm grubs were harvested whereas during the months of June to November (off season) 200 - 400 palm grubs were harvested. The result also showed that during the off season period (June to November), the price rose from 50 Kobo / 6 palm grubs sold during the peak season to N100 per 8 palm grubs. The market trend for palm grubs during the two seasons seemed to obey the basic laws of supply and demand. It was also observed from the present study that more money was made during the off season than during the peak season.

Table 1. Daily Production/Cost Analysis of palm grub of different periods of the year

Period	Approximate quantity produced/day	cost
December - May	800 - 1100	Six for 50 k
June - November	200 - 400	Eight for N100

The proximate biochemical composition of raphia palm sap is shown in Table 2. Ash content, crude protein, nitrogen free extract and ether extract were relatively higher in the sap from where the larvae were harvested than that from where their pupa counterparts were collected. The relatively moderate ash content of raphia sap agreed with the earlier report of Obahiagbon *et al.* (2007). The crude fiber value of the sap were the larvae were harvested was 14.99% less than that of the pupa and this could be attributed in part to the fact that the digestive system of the pupa is more developed to handle fibre than that of the larvae. The low crude protein content in both habitats probably suggests that *R. phoenicis* requires less protein at the larval and pupal stages of development. The ether extract and carbohydrate values in this study were in agreement with the earlier reports of Bernard *et al.* (1989) and Obahiagbon (2007) that raphia palm were high in disaccharides.

Table 2. The proximate biochemical composition of raphia palm sap from which the larvae and pupae were harvested

Parameters (%)	Larvae habitat	Pupae habitat
Crude fibre	30.46	45.45
Ether Extract	1.80	0.30
Moisture	8.20	8.90
Ash	4.00	2.80
Crude protein	4.14	3.02
Nitrogen free extract	51.38	39.24

The percentage moisture content of sap from which the larvae and pupae were harvested (Table 3). It was observed that the sap from the larvae habitat contained 61% moisture content and 39% dry matter whereas that of the pupal stage had 40% moisture content and 60% dry matter. The high moisture content observed in larvae habitat could be attributed in part to the delicate nature of this insect. It might require such in order to survive.

Table 3. The percentage moisture content of raphia palm sap from which the larva and pupa were harvested

Habitat	Before Drying	After Drying	Differences	Percentage moisture content
Larvae	208.04	80.50	127.54	61.31
Pupa	150.00	88.93	61.07	40.71

The result of the proximate composition of *R. phoenicis* at different stages of development is presented in Table 4. The larva has the highest moisture content (8.80%), while the adult beetle gave the least value (4.27%). The moisture content of the four stages of *R. phoenicis* development was generally low. This indicates that they can all be preserved for a reasonable period of time without the risk of microbial deterioration and spoilage. The moisture value of 4.27 - 8.80% obtained in the present study are slightly higher than the value of 3.41% reported by Banjo *et al*. (2006a) for cricket and 0.96 – 1.18% reported by Ekop *et al*. (2010) for other edible insects. This disparity here agrees with the reports of Banjo *et al*. (2006a), that stages of development and vegetation types affect moisture content of insects.

The ash content recorded herein was lower than 10.26% reported for *C. forda* and similar to 5.39% reported for *T. germintus* (Banjo *et al*., 2006a). The result of ash content compared favourably with 5.79% reported for the larvae of *R. phoenicis* by Ekpo *et al*. (2009). This agreed with the earlier findings that insects contain moderate amount of mineral elements (Ene, 1963; Oduor *et al*., 2008; Ekop *et al*. 2010). The crude fiber value of adult *R. phoenicis* was moderately high and this could be attributed in part to its well developed exoskeleton (Oduor *et al*. 2008). This also agreed with the physiological role of crude fiber in maintaining proper peristaltic movement of the intestinal tract (Oduor *et al*. 2008). A diet very low in fiber, could therefore lead to constipation which might bring discomfort to the body system with running stool (Groff *et al*. 1995). The results of crude fiber content observed in the present study were higher than 0.2 - 3.3% reported by Banjo *et al*. (2006a) for similar species. The appreciably high crude fiber value of *R. phoenicis* especially the adult agreed with report of Ekop (2004) that insects contain moderate fiber content. Hence, *R. phoenicis* based diets could aid the emptying of gastro-intestinal content.

The ether extract value of the larvae of *R. phoenicis* as observed in the present study was higher than 28.90% reported by Ekpo *et al*. (2009). However, the ether extract value compared favourably with the value reported by Banjo *et al*. (2006a) for similar species. The crude protein value observed in the present study was also comparable to 22.06% reported by Ekpo *et al*. (2009) and lower than those values reported for periwinkle (55%) and *T. caltifera* (56.44%) by

Mba (1980). These differences could be due to variations in the dietary habits of the insects, age (stage of development) or as a result of different ecotypes. The high lipid content of *R. phoenicis* was a pointer that insects can provide supplementary dietary fat in feed formulation for animal husbandry. The relatively high ether extract value in the larval stage relative to those in the 3 other stages agreed with the report that many insects accumulate fat during larval development (Chapman, 1980). The numerically high crude protein value of *R. phoenicis* was an indication that *R. phoenicis* can contribute significantly to the recommended human daily protein requirement of 23 – 56% stipulated by NRC (1989).

The carbohydrates values were similar to 5.53% recorded by Ekpo *et al*. (2009). However, carbohydrate value reported herein was slightly higher than the values reported by Dunkel (1996) for similar insects. The low carbohydrate content of *R. phoenicis* probably suggests that insects are not an energy giving food. This could probably suggest why they are used as food supplement by the rural people (Ekpo *et al*. 2009).

Table 4. Proximate composition of the different stages of growth of *R. phoenicis*

Parameter	**Larva (palm grub)**	**Immature pupa**	**mature pupa**	**Adult**
Crude fibre	3.35	3.12	2.40	7.15
Ether extract	54.20	42.70	47.10	44.70
Moisture	8.80	7.00	7.00	4.27
Ash	5.20	7.40	3.00	5.80
Crude protein	23.44	33.10	34.94	34.05
Carbohydrate	5.01	6.68	5.56	4.03

The identity of microbes in heat processed and freshly harvested palm grubs are presented in Table 5. Some insects serve as vectors or passive intermediate hosts of vertebrate pathogens such as bacteria, protozoa, viruses or helminths (Gorham, 1991). From the study, it was evident that palm grub carries an appreciable microbial flora which is mainly bacteria. The bacteria flora seen in palm grub included *Staphylococcus* sp, *Escherichia coli* and *Klebsiella aerogenes*. This finding is similar to the previous report of Duquid *et al*. (1984) and Baumgartner (1975) who isolated similar species of bacteria from dried fish and Banjo *et al*. (2004; 2005) who isolated these species from the insects *Alphitobius diaperinus* and *Hermetia illucens* respectively. Conversely, Osinubi (1989) isolated *Salmonella* sp, *Shigella* sp and *Enterobacter* sp. from dried fish. The reason for this microbial growth might be due to the dirty nature of the habitat and also improper handling of the food materials during processing. Careless exposure of the food to the environment by street hawkers and inadequate sanitary measures in our markets could be other reasons for the contamination.

The predominance of *Staphylococcus* sp. in heat processed palm grub is probably due to the fact that reports had shown that apparently healthy humans including fish and meat sellers and also palm grub sellers are healthy carriers of the organisms in most parts of the world including Nigeria (Lamikanra and Olusanya, 1989; Banjo *et al.* 2006). Similarly, the presence of *Escherichia coli* which is an enteric pathogen on all the samples might be due to the presence of these organisms in the water used for domestic purposes in many parts of Nigeria (Olusanya and Olusanya, 1989; Banjo *et al.* 2006), which is equally used in processing the palm grubs. Microbes such as *Escherichia coli* and *Klebsiella aerogenes* cause various infectious diseases in humans and animals. Therefore, proper breeding and processing of these insects with a view to reducing the microbial load are necessary before consumption by man and other animals.

Table 5. Microbial loads on processed palm grubs procured from hawkers and fresh palm grubs collected from skewers in Bayelsa State, Nigeria.

Source of palm grub	Number of palm grubs examined	Organism identified
Man	2	*Staphylococcus sp.*
Woman	2	*Staphylococcus sp.*
Boy	2	*Staphylococcus sp.*
Girl	2	*Staphylococcus sp.*
Skewer	2	*Klebsiella sp./ E - coli*

Conclusion

The relatively high nutrient value of palm grubs in this study highlights the need for its incorporation in both human and livestock diets as a source of animal protein. It is therefore, recommended that palm grub production should be increased in order to bridge the animal protein supply gap in the developing countries. However, more attention should be directed towards assessing the risk factors in the edible insect groups. From the experiment, it is obvious that the arthropods serve as subtle vectors or passive hosts of pathogens such as bacteria which can cause serious infections in man.

The contamination of heat processed palm grubs may be due to improper processing, handling during retail and purchase and exposure to air. The contamination of these products might lead to disease conditions in consumers when the food is consumed. Thus, it is suggested that careful attempt should be made to reduce as much as possible, contaminations due to exposure of the products to the environment and improper handling.

References

Agboola, S.A. (1979). An agricultural atlas of Nigerian. Oxford University Press, Oxford, London.

Amusan, J. A. and Omole, A. J. (2000). A paper presented on learning and sharing on snail farming management organized by DFID's capacity building for decentralized development on 5th - 7th July at JAR and T Ibadan.

AOAC (1990). Association of Official Analytical Chemists. Official Methods of Analytical Chemists. 15th ed. AOAC Inc. Atlanta Virginia, USA.

Baker, F.J. (1967). Handbook of bacteriological techniques. 2nd Ed. Butterworths, London, pp: 482.

Banjo, A.D., Lawa, O.A. and Songonuga, E. A. (2006)a. The nutritional value of fifteen species of edible insects in Southwestern Nigeria. African Journal of Biotechnology 5:298-301.

Banjo, A.D., O.A. Lawal and B.O. Osinuga (2004). Reseviour competence of *Alphitobius diapermus* (*Coleopteran: tenebrionidae*) in south west Nigeria poultry houses for microorganism. Asian J. Microbiol. Biotech. Env. Sci. 6:339-342.

Banjo, A.D., Lawal, O.A. and Adeyemi,A.I. (2006). The microbial fauna associated with the larvae of *Oryctes monocerus.* Journal of Applied Sciences Research 2(11):837–843.

Banjo, A.D., O.A. Lawal and O.O. Olusola (2005). Bacteria associated with *Hermetia illucens* (*Linnaeus*) Diptera: Strationmyides. Asian J. Microbiol. Biotech. Envt. Sci. 7:351-354.

Beckerman, S. (1977). The use of palms by the Bari Indians of the Maracaibo Basin. Principes 21 : 143 - 154.

Bedford, G.O. (1980). Biology, ecology and control of palm rhinoceros beetles. Annu. Rev. Entomol. 25:309-339.

Bernard, J.B., Allen, M.E. and Ullrey, D.E. (1989). Feeding captive insectivorous animals: Nutritional aspects of insects as food. Nutritional advisory group hand book. pp 1-7.

Chapman, R.F. (1980). The insects: structure and function. The English language book society. Stoughton and Hodder. Printed in Great Britain for Hodder and Stoughton Educational. pp. 83 -106.

Cheesbrough, M. (2000). Microbiological Test. In: District Laboratory practice in tropical countries Part 2. Cambridge University Press, Cambridge.

Chinweuba, A.J., Otuokere, I.E., Opara, M.C. and Okafor, G.U. (2011). Nutritional potentials of *Rhynchophorus phoenicis* (African raphia palm weevil): Implications for food security. Asian J. Res. Chem. 4 (3):452–454.

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S. and Courbois, C. (1999). The livestock revolution. In Livestock to 2020. The next food revolution. Food, agriculture, and the environment discussion paper 28. International Food Policy Research Institute. pp 1–4.

Dunkel, F.V. (1996). The Food Insects Newsletter. Vol. 9, No. 2. Montana State University.

Duquid, J.P., Marmion, B.P. and Swain, R.H. (1984). Mackie and McCartney, Medical Microbiology. 13th edition, pp 121 - 169.

Ekop, A.S. (2004). Effects of processing on the chemical composition of maize. 24th Annual Conference of Nigerian Society of Biochemistry and Molecular Biology. University of Calabar. Nov 24th - 27th.

Ekpo, K.E., Onigbinde, A.O and Asia, I.O. (2009). Pharmaceutical potentials of the oils of some popular insects consumed in southern Nigeria. African Journal of Pharmacy and Pharmacology 3(2):051-057.

Ekop, E. A, Udoh, A. I. and Akpan, P. E. (2010). Proximate and anti-nutrient composition of four edible insects In Akwa Ibom State, Nigeria. World Journal of Applied Science and Technology 2 (2):224–231.

Ene, J.C. (1963). Insects and man in West Africa. Ibadan University Press, Ibadan. pp. 11 - 13.

FAO 1986. Food and Agricultural Organization, Balance Sheet 1979 - 1990. Average, FAO of the UN, Rome, pp: 272.

Gorham, J.R., Ed. (1991). Ecology and management of food industry pests. FDA Tech. Bull. 4, Association of official Analytical chemists, Artington, V. A. pp : 595.

Groff, J., Gropper, S. and Hunt, S. (1995). Advanced nutritional and human metabolism. 2nd Edn., New York. pp. 221 - 362

Lamikanra, A. and O.I. Olusanya (1989). A long term study of nasal carriage of *S. aureus* in healthy Nigerian students. Trans of the Royal Soc. of Trop. Med. and Hyg. pp : 500 - 502.

López, C. and Shanley, P. (2004). Riches of the forest: For health, life and spirit in Africa, center for International Forestry Research. pp: 1 – 24.

Mba, A.U. (1980). Chemical composition of some local source of protein foods for man. Nigerian Journal of Nutritional Science. 1: 142 - 147.

Mcdowell, L.R. (1992). Minerals in Animal and Human Nutrition. Acad. Press, Inc. New York. pp: 26 -292.

NRC (1989). National Research Council, Recommended Dietary Allowances. 8th edn. Food and Nutrition Board: National Academy of Science, Nigeria. pp. 20 - 40.

NRC (1991). Micro livestock, little known small animals with a promising economic value. National Academy Press; Washington DC.

Obahiagbon FI (2007). *Raphia vinifera* Sap: Some physico-chemical and biochemical profiles - A comparative study. J. Res. Agric. 4:1-3.

Obahiagbon, F.I., Ukhun, M.E. and Eke, C.R. (2007). *Raphia* hookeri Sap: Recommended dietary allowances and roles of its dietary constituents in human nutrition. Int. J. Biosci. 2(1): 62 - 65.

Oduor, P.M., Struszczyk, M.H. and Peter, M.G. (2008). Characterization of chitosan from blowfly larvae and some crustacean species from Kenyan marine waters prepared under different conditions. Discovery and Innovation 20 (2):129-142.

Oluyemi, J. A and Roberts, F. A. (2000). Poultry production in warm wet climates. Revised edition. Spectrum books limited. Spectrum House Ibadan.

Olusanya, G. and Olusanya, O.I. (1989). *Campylobacter Jejuni* and *Yersins entercolitica* in rural and urban school children in Nigeria. J. Diass. Res., 5 : 102 - 107.

Omole, A.J. (1999). Snail production management. A paper presented at Lagos agricultural development project SMS monthly review meeting at LSAP, Agege, Lagos State on April 13 - 14, 1999.

Onyeike, E.N., Ayalogu, E.O. and Okaraonye, C.C. (2005). Nutritive value of the larvae of raphia palm beetle (*Oryctes rhinoceros*) and weevil (*Rhyncophorus pheonicis*). Journal of Science of Food and Agriculture 85 (11): 1822–1828.

Osinubi, A.O., 1989. Microbial contaminants of some Nigeria meat products. B.Sc. Project Report, Department of Microbiology, Olanbisi Olabanjo State University. pp: 54

Pearson, D. (1976). Chemical analysis of foods. 7th edition, London Churchill Livingstone, united Kingdom.

(Published in May 2012)