Scientia Africana, Vol. 23 (No. 2), April, 2024. Pp109-116
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

PROXIMATE AND MICROBIAL QUALITY OF PROCESSED GRUBS OF AFRICAN PALM WEEVIL (*Rhynchophorus phoenicis* F., COLEOPTERA: CURCULIONIDAE) SOLD AT TORU-ORUA, BAYELSA STATE, SOUTHERN NIGERIA

Uzakah, R.P., and Immanuel, O.M.
Department of Biological Sciences, University of Africa, Toru-Orua, Sagbama local Government Area, Bayelsa State, Nigeria
Correspondence: richard.uzakah@uat.edu.ng

Received: 05-03-2024
Accepted: 21-03-2024

https://dx.doi.org/10.4314/sa.v23i2.11

Journal Homepage: http://www.scientia-african.uniportjournal.info
Publisher: *Faculty of Science, University of Port Harcourt.*

ABSTRACT:

The African palm weevil, Rhynchophorus phoenicis F. (Coleoptera: Curculionidae) constitutes a significant component in diets of the Niger Delta of Nigeria. This study aimed to determine the proximate composition and microbiological quality of processed grubs (steamed, dried, fried and fresh which served as control) purchased from food vendors in Toru-Orua community. Proximate composition determinations followed official methods recommended by the Association of Official and Analytical Chemicals (AOAC), while microbial load was determined by total plate count. Steamed grubs had the highest moisture content of 15% while fresh had the least moisture content of 9.3%. Steamed grubs had the highest ash content of 11.47% while fresh had the least ash content of 4.73%. Fresh grubs had the highest crude protein of 41.75% while fresh had the least crude protein of 30.13%. Steamed grubs had the highest crude fibre content of 18.07% while fresh had the least crude fibre of 13.7%. Steamed and fried grubs had the highest crude fat content of 10.93% while fresh had the least crude fat content of 2.8%. Steamed grubs had the highest moisture content of 28.35% while dried grubs had the least moisture content of 20.66%. The total heterotrophic bacteria count ranged from 8.5 x 10^2 CFU/g – 3.7 x 10^6 CFU/g. Fungal count ranged from 2.2 x 10^2 - 3.4 x 10^3 CFU/g. The microbial investigations showed Pseudomonas aeruginosa, Escherichia coli and Staphylococcus aureus were the common microorganisms on the grubs. Frequent microbiological quality checks on such ready-to-eat foods, along with public enlightenment campaigns for food vendors is recommended, to guarantee food safety for consumers during processing/handling, storage and consumption.

Keywords: African palm weevil, entomophagy, microbial composition, processed grubs, proximate analysis, Rhynchophorus phoenicis

INTRODUCTION

Diverse insect species such as locusts, grasshoppers, caterpillars, beetle grubs, winged ants and termites, cicadas etc., constitute human foods and nutrition in different places worldwide (Bodenheimer, 1951, Banjo et al., 2006). Entomophagy, the consumption of edible insects and their products have been practiced since biblical times till date, particularly in Africa, Asia and Latin America (Bodenheimer, 1951, Defoliart, 1992, Banjo et al 2006, Quaye et al 2018); but has yet to receive global

acceptance due to people's sheer disgust (social non-acceptance) and ignorance of the grubs' nutritional attributes and qualities (Fasunwon et al., 2011).

Food and nutritional science, like every sphere of science is very dynamic and evolving not static. The Niger Delta region in Nigeria hosts a very rich biodiversity (Ayanlade and Proske, 2015) and has long relied on some indigenous fauna for sustenance. The African palm weevil (APW), *Rhynchophorus phoenicis* F. (Coleoptera: Curculionidae) for instance, is one of such local recipe and delicacy which though some climes may term unconventional, remains a culturally significant and popular diet and still gaining increasing popularity. It is widely harvested, marketed and consumed all over Bayelsa State, the entire Southern Nigeria and across the Niger Delta at large; and eaten either as raw (or fresh), boiled, fried, smoked or used in stew or soup (Okaraonye and Ikewuchi, 2008). APW grubs are cherished delicacy amongst all rural and urban dwellers and populace (Omotosho and Adedire, 2007); and are commonly called diverse descriptive names within the region viz: "Bayelsa suya" (Bayelsa and Rivers States), "edible worms or maggots" (Sapele, Delta State), "diet" (Warri, Delta State), "chaffer" (Rivers State) etc., (Lale, 1996; Immanuel et al., 2022).

A better understanding or exposé on this product especially via proximate and microbial analyses would enlighten consumers and the general public about its nutritional contents/benefits and its health and safety status and it will boost peoples' acceptance and confidence-levels in taking or consuming this food/meal. The fore-going therefore, formed the overarching goal and main objective of this study. Previous preliminary works on the proximate analysis have shown that APW grubs contain protein, carbohydrates, fats and diverse nutrients; Ukoroije and Bobmanuel (2019) also affirmed that they are a very rich source of animal fats and high energy. Van Huis (2013) reported that APW larvae contain 21.06% protein, 66.6% lipids and 7.63% carbohydrates and energy value of 714.25 kCal from dry weight of the material. The crude protein content according to Chaney (2006) is higher than levels found in cow, milk, eggs, termites and beef and thus can contribute significantly to the daily human protein requirements of about 23-53g. Womeni *et al.* (2012) showed that the grubs contained all essential amino acids (EAA), lysine, valine, leucine, isoleucine, phenylalanine, threonine and methionine. According to Womeni *et al*. (2012), EAA like lysine and threonine normally deficient in grain and cereals were in high concentration in the larvae. The presence of essential fatty acids linoleic and linolenic acids further elucidates the fact *R. phoenicis* is a highly nutritious food material.

Contamination of ready-to-eat foods is a serious health risk because they are a direct route for contracting foodborne diseases (Seiyaboh and Izah, 2020); and as such must necessitate comprehensive microbiological quality checks on them before consumption, to guarantee consumer protection and safety, as well as prevention of food-borne illnesses.

This study therefore, specifically aimed to determine the proximate and microbial compositions of APW grubs in the four main ways they are processed and consumed (i.e., fresh or raw, dried, steamed and fried). It is hoped that results of this study would provide better insights on the nutritional and health benefits, as well as the safety of consuming this local/traditional recipe and delicacy (Bayelsa suya); and ultimately popularize it even further.

MATERIALS AND METHODS

Study Area

This study was conducted at the Bio-Chemical Research Laboratory of the University of Africa Toru-Orua, in Sagbama Local Government Area, Bayelsa State. Toru Orua is one of the major communities in the Sagbama LGA., from where the differently

Scientia Africana, Vol. 23 (No. 2), April, 2024. Pp109-116
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

processed APW (or Bayelsa suya) were obtained.

Sample Collection

A total of one hundred and sixty (160) processed samples of APW grubs (i.e., 40 steamed, 40 dried, 40 fried and 40 fresh/raw as control) were obtained from vendors. All samples obtained were analysed within 24 hrs., of processing to prevent possible deteriorations, alterations and contamination. They were neatly placed in 4 well labeled transparent plastic containers according to how they were processed and brought to the laboratory for the studies.

Determination of Nutrient compositions

Samples of dried, steamed, fried and fresh APW (twenty each), were all washed with distilled water, allowed to dry and then macerated according to the methods of Ukoroije and Bobmanuel (2019) and Seiyaboh et al. (2020).

Samples were analyzed according to official methods of analyses recommended by the Association of Official and Analytical Chemicals (AOAC, 2005) for proximate composition of moisture, crude protein, ash, crude fat and total carbohydrate, respectively. All investigations were replicated twice; and each investigation or replication was always preceded by thorough washing and rinsing of blenders and mortars with sterile water.

Determination of Microbial Load

Samples of dried, steamed, fried and fresh APW (twenty each), were all washed with distilled water, allowed to dry and then macerated. Stock solutions of the samples were prepared and serially diluted. Total viable count (TVC) of microbial species were determined by spread plate method. Isolation and enumeration of bacteria present was done by culturing on Nutrient Agar and MacConkey Agar plates. Total fungal was determined using potato dextrose agar.

Bacterial isolates were identified based on their cultural, morphological and biochemical characteristics. Biochemical test conducted for the identification of isolates included Simmons citrate test, catalase test, urease test, carbohydrate fermentation test, triple sugar iron (TSI) test, hydrogen sulphide production test, methyl red-Voges Proskauer test and indole test. Fungi were identified following the schemes of Salvamani and Nawa (2014).

Statistical Analyses

The results for the percent nutrient compositions from two experimental evaluations/replications are expressed in means and with standard error bars.

RESULTS

The proximate composition of the differently processed grubs of the African palm weevils for parameters which include moisture, crude fat, crude fiber, crude protein, ash and carbohydrate contents, are presented in Fig. 1. The average moisture content of the fried Bayelsa Suya was 13.55%; crude fat 13.07%, crude fiber 10.93%, crude protein 30.13%, ash content 9.96% while the carbohydrate was 25.21%. The composition for the dried Bayelsa Suya revealed an average moisture content was10.37%, crude fat 17.76%, crude fiber 09.67%, crude protein 33.85%, ash content 07.91% and carbohydrate content 20.66%. For the steamed Bayelsa Suya the results were moisture content 15.55%, crude fat 18.07%, crude fiber 10.93%, crude protein 34.6%, ash content 11.47% and average carbohydrate content of 28.35%. For the control (fresh/raw APW grubs) the moisture, crude fat, crude fiber, crude protein, ash and carbohydrate content was 9.34%, 15,57%, 2.8%, 41.75%, 4.73% and 26.09% respectively.

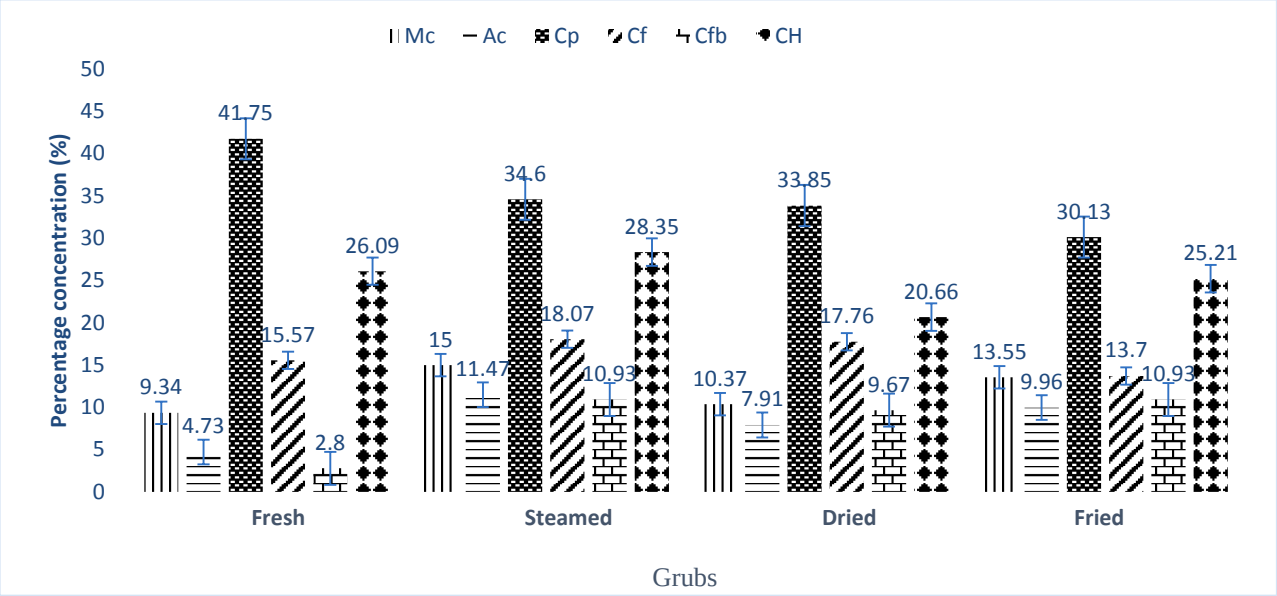

Fig.1: Proximate composition of fresh, steamed, dried and fried African palm weevil sold at Toru-Orua community

Keys: Mc=moisture content, Ac=ash content, Cp=crude protein, Cf=crude fat, Cfb=crude fibre, CH=carbohydrate

Table 1 shows that the shows the total heterotrophic bacterial count (THBC) of fresh, steamed, dried and fried African palm weevil ranged from 8.5 x 10^2 CFU/g – 3.7 x 10^6 CFU/gwhile total fungal count (TFC) ranged from 2.2 x 10^2 - 3.4 x 10^3CFU/g

Table 2 shows the presence of bacterial species in fresh and steamed processed APW.

Table 1: Microbiological composition of fresh, steamed, dried and fried African palm weevil

Bacteria	Fresh	Steamed	Dried	Fried
THBC (CFU/g)	3.7 x 10^6	2.2 x 10^4	1.8 x 10^3	8.5 x 10^2
TFC (CFU/g)	3.4 x 10^3	1.9 x 10^3	2.2 x 10^2	6.4 x 10^2

Keys: THBC=total heterotrophic bacterial count, TFC=total fungal count

Table 2: Distribution of bacterial species in fresh, steamed, dried and fried African palm weevil

Bacteria	Fresh	Steamed	Dried	Fried
Salmonella sp. (CFU/g)	+	+	-	-
Escherichia coli (CFU/g)	+	+	-	-
Staphylococcus aureus (CFU/g)	+	+	-	-

+ = present; - = absent

DISCUSSION

The moisture content of the APW ranged from 9.34% to 15.55% with steam having the highest moisture content and the dried sample had the lowest moisture content value of 10.37%. The moisture content of the APW is in agreement with the report by Omotosho, (2018) but higher than values reported by Banjo *et al.* (2016) and Ekpo *et al*. (2009) for edible insects. Moisture content enhances metabolic processes in both plant and humans thereby creating proper environment for good functioning of the body system (Wang *et al*., 2023). The sulphated ash content of the APW gave a value that ranged from 4.73% to 11.47% with steamed sample having the

Scientia Africana, Vol. 23 (No. 2), April, 2024. Pp109-116
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

highest value of 11.47% and the fresh sample having the lowest value of 4.73%, which is in agreement with the report of Ekpo *et al.,* (2009). The carbohydrate values which ranged from 20.66% to 28.35% is lower than values reported by Banjo *et al.,* (2006). This could be attributed to the difference in methodology employed in this study. Regarding crude fat, steamed grubs had the highest values (18.70%) and fried grubs has the lowest (13.70%). The values are in agreement with those of Banjo et al. (2006), Ekpo *et al*. (2009) and Omotoso (2018) for *Oryctes* species. The crude protein for the APW ranged from 30.13% to 41.75%. The crude fibre content ranged from 2.80% to 10.93% with fresh grubs having the least while both steamed and fried grubs had the highest

Microbiological analysis of fresh and ready-to-eat samples of *R. phoenicis* showed the presence of *Salmonella* spp., *Escherichia coli* and *Staphylococcus aureus.* These microorganisms have been commonly associated with edible insects sold in Africa (Braide and Reginald, 2011; and Ebenebe et al., 2015; Ramashia *et al*., 2020). The THBC ranged from 8.5 x 10^2 CFU/g – 3.7 x 10^6 CFU/g while TFC ranged from 2.2 x 10^2 - 3.4 x 10^3; which is close to the average microbial load of THBC, 1.08 × 10^5 CFU/g and TF, 9.2 × 10^2 CFU/g reported by Braide and Reginald (2011). The identified bacteria were all present in the fresh samples and steamed, but not in the dried and fried samples. This could be as a result of the different conditions of preparations, because processing and preservation affect the microbiological quality of food (Teke et al., 2022).

The presence of *Salmonella* sp. in food is an indicator of poor hygiene and post processing contamination of food. Absence of *Salmonella* in the dried and fried grubs of the APW may be due to the effect of heat treatment. *Salmonella* sp. is one of common food-borne zoonotic pathogens with significant health and economic impacts in humans and animals (Garba et al., 2021).

The presence of *Staphylococcus aureus* in ready-to-eat food is usually as a result of human contamination through improper handling during preparation (Teke *et al*., 2022). When the processed APW were not sufficiently heated, spoilage organisms could have accumulated and proliferated in them. When foods are subjected to heat (steamed, dried or fried) it is very rare to find any pathogens present on them because of the heating process they under-go. A situation whereby ready-to-eat APW is not eaten on the day of preparation, it is advisable to preserve it by refrigeration or in a sterilized ovum till the next day to avoid food spoilage. Above all, heating is a very effective method of preserving APW evidenced by the report that *Salmonella* sp., *Escherichia coli* and *Staphylococcus aureus* were not detected in dried and fried samples. This report was corroborated by Ramashia et al. (2020).

CONCLUSION

The study on the effects of processing method on the proximate composition and bacterial loads of Bayelsa suya provides important insights into the food safety practices associated with this popular street food. The findings highlight the significance of proper storage and handling procedures in ensuring the microbial safety of Bayelsa suya and minimizing the risk of foodborne illnesses. Also revealed in this study is that different processing methods influenced the proximate composition of edible grubs.

REFERENCES

AOAC (2005). Official Methods of analysis. Association of Officiating Analytical Chemists. 18th edition, 1-45, Washington DC, USA

Ayanlade, A. and Proske, U. (2015). Assessing wetland degradation and loss of ecosystem services in the Niger Delta, Nigeria. *Marine and Freshwater Research*. 67(6):828–836.

Banjo, A.D., Lawal, O.A. and Sonovnga, E.A. (2006). The nutritive value of fourteen species of edible insects in

Southern Nigeria. *Agric J. Biotechnol*. 5:291-301

Bodenheimer, FS (1951). Insects as human food. In: W. junk. The Hague, 352.

Braide, W. and Reginald, N. (2011). Assessment of microbiological quality and nutritional values of a processed edible weevil caterpillar (*Rhynchophorus phoenicis*) in Port Harcourt, southern Nigeria. International Journal of Biological and Chemical Sciences 5(2). DOI: 10.4314/ijbcs.v5i2.72059

Chaney, SG (2006). Principles of Nutrition 1: Macronutrients. In: Textbook of Biochemistry with Clinical Correlation. Devlin, TM (ed). 6th edition, John Wiley and Sons, New York, 1091-1120

Defoliart, G. (1992). A concise summary of the nutritional value of insects. *Crop protection.* 11: 395-399.

Ekpo, KE, Onigbinde, AO and Asia, IO (2009). Pharmaceutical potentials of the oils of some popular insects consumed in southern Nigeria. *African Journal of Pharmacy and Pharmacology.*3 (2): 051-057

Fasunwon, B.T., Banjo, A.D. and Jemine, T.A. (2011). Effect of Dermestes maculatus on the nutritional qualities of 2 edible insects. *African Journal of Agriculture, Nutrition and Development.* 11 (7):5600-5613.

Garba, A.A., Ochogwu, J., Usman, B.I. and Adadu, M.O. (2021). Assessment of the extent of microbial load of smoked dried African catfish (*Clarias gariepinus*) sold in Maiduguri markets. *International Journal of Fisheries and Aquatic Studies*. 9(3):278-287.

Immanuel, O.M., Omoko T.L. Egumandi, E.U. (2022). Preliminary screening of cellulase producing bacteria from the gut of African palm weevil larvae. *African Scientist*. 23(2):72-77.

Lale, N.E.S. (1996). Dictionary of Entomology, Mole Publishers Nigeria Limited, Maiduguri, Nigeria.

Okaraonye, C.C. and Ikewuch, J.C. (2008). *Rhyncophorus phoenicis* (F) larva meal: nutritional value and health implications. Journal of Biological Sciences 8(7): 1221-1225.

Omotosho, O.I. (2018). The nutrient profile of the developmental stages of Palm beetle *Oryctes rhinocerus*. *British Journal of Environmental Sciences. 6*(1): 1-11

Omotosho, O.T. and Adedire, C.O. (2007). Nutrient composition, mineral content and the solubility of proteins of palm weevil, *Rhynchophorus phoenicis* F. (Coleoptera: Curculionidae). *Journal of Zhejiang University Science.* 8(5): 318-322

Quaye, B., Atuahene, C.C., Donkoh, A., Adjei, B.M., Opoku, O. and Amankrah, M.A. (2018). Nutritional potential and microbial status of African palm weevil (*Rhycophorus phoenicis*) larvae rsied on alternative feed resources. *American Scientific Research Journal for Engineering, Technology and Sciences (ASRJETS).*48(1):45-52.

Ramashia, S.E., Tangulani, T., Mashau, M.E. and Nethathe, B. (2020). Microbiological quality of different dried insects sold at Thohoyandou open market, South Africa. Food Research. 1:1-9.

Salvamani, S. and Nawawi, N.M. (2014). Macroscopic and microscopic approaches for identification of fungi from plant soil of Cameron Highlands. *Bioremediation Science & Technology Research*. 2(1):14-18.

Seiyaboh, E.I. and Izah, S.C. (2020). Assessment of microbial characteristics of processed palm weevil *Rhyncophorus phoenicis* larvae sold in some market areas in Bayelsa State, Nigeria. *Journal of Advanced Research in Medical Science & Technology.* 7 (1):24-29.Doi:https://doi.org/10.24321/2394.6539.202004

Teke, E.C., Immanuel O.M., Oku, I.Y. and Okafor, H.C. (2022). Microbiological assessment of smoked *Clarias gariepinus* sold in Yenagoa. *South Asian*

Scientia Africana, Vol. 23 (No. 2), April, 2024. Pp109-116
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

Journal of Research in Microbiology. 14(1): 25-30.

Ukoroije, R.B. and Bobmanuel, R.B. (2019). The adaptability and knowledgeability of *Rhynchophorus phoenicis* (Coleoptera: Curculionidae) grub as food in Bayelsa State, Nigeria. *EAS Journal of Nutrition and Food Sciences.*1(5):115-121. DOI:10.36349/EASINFS, 2019v01(05,006)

Van Huis, A. (2013). Potential of insects as food and feed in assuring food security. *Annual Review of Entomology. 58*: 563-583.

Wang, H., Sun, C., Yang, S., Ruan, Y., Lyu, L., Guo, X., Wu, X. and Chen, Y. (2023). Exploring the impact of initial moisture content on microbial community and flavor generation in Xiaoqu baijiu fermentation. *Food Chemistry: X*. 20: /10.1016/j.fochx.2023.100981

Womeni, H.M., Tiencheu, B., Linder, M., Chouatcho,N.E., Tenyang, N., Tchouanguep,M.F., Villeneuve, P, Fanni, J. and Parmentier, M. (2012). Nutritional value and effect of cooking, drying and storage process on some functional properties of *Rhynchophorus phoenicis*. *International Journal of Life Science and Pharma Research.*2: 203-21