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Short Communication

Evaluating the Potential of Edible Insects (Palm Weevil- *Rhynchophorus Phoenicis* Larvae) as an Alternative Protein Source for Humans

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Abstract

Using 24 adults of *Rhynchophorus Phoenicis* (12 males and 12 females), a four-week experiment was conducted to determine an alternative substrate in raising the larvae as a protein source for humans and the microbial content associated with the production of the larvae. Three treatments were used; Oil Palm Yolk (OPY), Raffia Palm Yolk (RPY) and Sugarcane Substrate (SCS). The palm substrates were harvested and soaked for 3 days for preservative purposes. Five (5) kg each of OPY, RPY and sugar cane (SC) were replicated four times in plastic baskets using a Completely Randomized Design (CRD). The proximate composition of the OPY and RPY substrates were as follows: values for moisture content showed 60.4% for OPY and 61.7% for RPY, crude protein content of RPY (3.5%) and OPY (3.2%), crude fibre content of OPY was 31.1% compared with RPY (29.4%) and ether extract content of 1.2% and 1.6% were recorded for RPY and OPY respectively. The Ash, NDF and ADF values for OPY were 1.6%, 2.4% and 77.5% and that of RPY were 76.4%, 50.2% and 50.1% respectively. Adults placed on all treatments of SCS could not survive making that treatment unsuccessful. All parameters measured for RPS were significantly ($P<0.05$) higher compared with the OPS except for mortality rate which was statistically ($P>0.05$) similar. Higher microbial range of $3.4x10^7$ was recorded for OPY which was higher than the acceptable range of $5x10^6$ by the Food Administration Manual. Microbial content detected at the end of the experiment on isolated larvae from RPY and OPY treatments were $9.1x10^5$ and $4.9x10^5$ respectively, which was below the standard range making it acceptable for consumption. It was concluded that RPS was a better substrate for *Rhynchophorus phoenicis* larvae production since it produced a higher larvae number and also larvae with higher weights.

Keywords: *Rhynchophorus phoenicis*, raffia palm yolk, oil palm yolk.

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Introduction

The current food crises globally, have made scholars to evaluate some unconventional approaches to food production, particularly protein production (Durst and Shono, 2010). Entomophagy, which is described as the practice of eating insects, has been suggested as a strategic component to enhance food security due to the increasing growth of the global population which poses a threat to insufficient food resources for the future (Gahukar, 2011; Van Huis, 2013; Meyer-Rochow, 1975; Ramos-Elorduy, 1990).

Insects are very adept at converting what they have eaten into tissues that can be consumed by others and the food conversion efficiency of insects may currently be 20 times that of cattle (Durst and Shono, 2010). Robert (1989) observed that, a 10% increase in the global supply of animal proteins through mass production of insects can greatly eliminate the malnutrition issues and also reduce the pressure on other protein sources.

Rhynchophorus phoenicis larvae contains; 23.44% crude protein, 5.01% carbohydrate, 5.20% ash, 8.80% moisture, 54.20% ether extract and 3.35% crude fibre (Opara, 2012). In Ghana, palm weevils are collected from the wild after palm trees have been tapped for wine. Due to the rich source of nutrient found in the weevils, it has become necessary to grow them or cultivate them for consumption. Palm trees from which these weevils are gotten may become difficult to come by due to surface mining, extensive land clearing for buildings etc. Therefore, it has become important to grow them intensively.

Materials and Methods

Location and Substrates/Dessign Used

The experiment was conducted at the poultry section of Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi–Ghana. Forty eight adult *Rhynchophorus phoenicis* weevils were obtained from Aspire Food Group, an organization which promotes the consumption of edible insects. The weevils were coupled and allocated randomly to three dietary treatments, namely oil palm substrate (OPS), raffia palm substrate (RPS) and sugarcane (SC). The various treatments were replicated four times with four palm weevils (2 males and 2 females) per replicate using the complete randomize design (CRD).

Chemical Analysis

Proximate analysis was performed on the OPY and RPY using the methods of AOAC (1990), in Animal Science Nutrition laboratory, KNUST, Kumasi.

Metabolizable energy (ME) was calculated using the equation: $[3.5\ (\%\ CP) + 8.5 \times (\%CF) + 3.5 \times (\%\ NFE)] \times 10$ (NRC, 1994).

Microbial Analysis

Microbial analysis was performed on the following; Sample A= fresh substrates, Sample B= water for soaking substrates, Sample C= oozed water from substrates, Sample D= decayed substrates and Sample E= crushed larvae, using the method of Braide *et al.*, (2011), in the Microbial Analysis laboratory, KNUST, Kumasi.

5 kg of each substrate was added to each replicate basket weekly as the palm weevils consumed the feed. The parameters measured for growth performance were total larvae number and weight, feed consumption, feed conversion ratio (FCR) and mortality.

Statistical Analysis

The data obtained was analyzed using GenStat statistical software release 12.1 for windows (GenStat, 2015). The least significant difference (L.S.D.) was used to determine significant difference among treatments means. Values were considered significant at five percent probability ($P<0.05$).

Results and Discussion

Proximate Composition of OPY and RPY

Table 1 indicates the proximate composition of OPY and RPY. The value for moisture content for OPY (60.4%) was lower than that obtained for RPS (61.7%). The crude protein content of RPY and OPS were similar but RPY recorded the highest crude protein content of (3.5%) and OPY recorded the least value (3.2%). The crude fibre content of OPS recorded the highest value (31.1%) followed by RPY (29.4%). The ether extract content of RPY (1.2%) was lower than that of OPY (1.6%). The numerical value of NDF content of RPY (76.4%) was lower to that of OPY (77.5%). The ADF content of OPY (50.2%) was higher than that of RPY (50.1%). The ash content of OPY (1.6%) was lower than that of RPY (2.4). The metabolizable energy of RPY (2.7%) was lower than that of OPY (2.8%).

Table 1: Proximate composition of oil palm substrate and raffia palm substrate.

Sample type	Parameters (%) on dry matter basis							
	CP	**CF**	**EE**	**NDF**	**ADF**	**ASH**	**MOISTURE**	**ME (MJ/KG)**
Raffia palm substrate	3.5	29.4	1.2	76.4	50.1	2.4	61.7	2.7
Oil palm substrate	3.2	31.1	1.6	77.5	50.2	1.6	60.4	2.8

CP: crude protein, CF: crude fibre, NDF: neutral detergent fibre, ADF: acid detergent fibre, EE: ether extract, ME: metabolizable energy.

The CP content of OPY (3.2%) was higher than the values obtained by Zahari (2000) for crude protein (2.8%). Also, the CF content of OPY (31.1%) was lower than the values obtained by Zahari (2000) who obtained 37.6% CF content. The EE content of OPY (1.6%) was higher than the values obtained by Zahari (2000) who obtained 1.1% EE content. The NDF content of OPY (77.5%) was lower than the values obtained by Zahari (2000) who obtained 79.8% NDF content. The ADF content of OPY (50.2%) was lower than the values obtained by Zahari (2000) who obtained 52.4% ADF content. The Ash content of OPY (1.6%) was lower than the values obtained by Zahari (2000) who obtained 2.8% Ash content. The ME content of OPY (2.8%) was lower than the values obtained by Zahari (2000) who obtained 5.95% ME content. The variations in the chemical composition may be partly due to the part of the trunk harvested, the age of the plant and the time of harvest.

Feed Intake, Weight Gain and Feed Conversion Ratio (FCR)

There was a significant difference ($P<0.05$) between the level of feed consumed by larvae produced from the RPY (6960 g) as to that consumed by those of OPY (4800 g). This was because the larvae number recorded for RPS was more than twice of what was recorded in OPY (Table 2). The overall feed conversion ratio of RPY was however the highest (1.36) but was not significantly different ($P>0.05$) from that of OPS of (1.21). This indicates that the larvae of RPY will require a much higher feed for a unit weight gain of larvae.

There was a significant ($P<0.05$) difference between the average weight gain/larvae between that of RPY (5.10 g) and OPS (3.94 g). This is as a result of higher feed intake from larvae produced from RPY. The results of this study is similar to that of Saeed *et al.*, (2005), where they stated that as fish consumed more feed, there was a linear increase in their growth rate.

Mean Larvae Number, Mean Larvae Weight and Mortality

Table 2 indicates that there was a significant ($P<0.05$) difference between the mean quantity of larvae harvested from OPY and RPY. RPY recorded the highest larvae quantity (31.20) followed by OPS which recorded the least values (13.20).

Previous study indicated a higher moisture content of the raffia palm (Oduah and Ohimain, 2015). This could be the reason for the higher survivability of eggs on the RPY. The higher moisture content perhaps created a good environment for the eggs to be hatched.

At the end of the experiment, the treatment SCS was unsuccessful. The entire adult placed on each replicate of that treatment did not survive. This was because sugarcane contains high fiber content (Hemmasi *et al.*, 2011) and less moisture content (Girighar and Rao, 1986) which made it difficult for the adult to feed as a result of their sucking mouthpart (Tambe *et al.*, 2013).

Table 2: Growth Parameters of the Larvae on the Treatments.

Growth Parameters	TREAMENTS			P-value	LSD
	OPS	RPS	SCS		
Larvae Number	13.20[b]	31.20[a]	0.00	0.001	10.76
Larvae Weight (G)	52.00[b]	159.00[a]	0.00	0.006	83.00
Weight Gain (G)	3.94[b]	5.10[a]	0.00	0.004	1.12
Feed Intake (G)	4800[b]	6960[a]	0.00	0.041	1.74
Fcr	1.21	1.36	0.00	0.071	0.93
Mortality	1.75	2.25	0.00	0.31	3.27

[ab]: Mean values in the same row with common superscripts or without any superscripts are not significantly (P>0.05) different. LSD- Least Significant Difference.

Mean Heterotrophic Count of Bacterial Colonies

Results from Table 3 shows that there were high levels of microbial count of the samples taken to the laboratory for analysis during the research. At the end of the study, the microbial content that was recorded by crushing some of the larvae from the OPY and RPY were 4.9×10^5 and 9.1×10^5 respectively. These results according to the Food Administration Manual (1995) were lower than the standard of 5.0 $\times10^6$ proposed on meat and this makes the larvae consumable with any normal food processing procedure although E. *coli* tested positive.

Table 3: Levels of Microbial Count on Different Samples of the Experiment.

Samples	OPS (CFU/g)	RPS (CFU/g)	Acceptable Range	Indole Test	
				Klebsiella	**E. *Coli***
Sample A	1.9×10^6	5.1×10^6	5.0×10^6	Positive	Negative
Sample B	1.1×10^7	6.5×10^6	5.0×10^6	Positive	Negative
Sample C	3.4×10^7	1.3×10^7	5.0×10^6	Positive	Negative
Sample D	6.1×10^6	8.8×10^6	5.0×10^6	Negative	Positive
Sample E	4.9×10^5	9.1×10^5	5.0×10^6	Negative	Positive

Sample A= fresh substrates, Sample B= water for soaking substrates, Sample C= oozed water from substrates, Sample D= decayed substrates, Sample E= crushed larvae, *cfu/g = colony forming unit per gram.

The test for *E. coli* was very important because there are several serotypes of the bacteria that makes it more than just a harmless intestinal inhabitant (Kaper *et al.,* 2004). Serotypes like O157:H7, O26 and O111 are versions of *E. coli* that have acquired specific virulence attributes which indicates an increased ability to adapt to new niches and allows them to cause a broad spectrum of diseases (Kaper *et al.,* 2004). High levels of *E. coli* and other microbes present in foods that require further cooking can be destroyed with adequate heat treatment (Zealand, 2001).

Conclusion and Recommendation

At the end of this study, it was concluded that raffia palm was the best substrate for the production of the larvae since it produced larger and heavier number of larvae. Further research should be conducted to find alternate substrate for the production since the raffia palm may not be available at all time and also more hygienic methods during harvesting of the yolk and production of the larvae to reduce the level of microbial contamination.

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References

AOAC (1990). Association of Official Analytical Chemists. Official Methods of Analysis. Assoc. Anal. Chem., Washington, DC, USA.

Braide W, Nwaoguikpe RN (2011). Assessment of microbiological quality and nutritional values of a processed edible weevil caterpillar (*Rhynchophorus phoenicis*) in Port Harcourt, Southern Nigeria. Int. J. Bioch. Sci., 5(2): 410-418.

Durst PB, Shono K (2010). "Edible forest insects: exploring new horizons and traditional practices." Forest insects as food: humans bite back: Proceedings of a workshop on Asia-Pacific resources and their potential for development, 19-21 February 2008, Chiang Mai, Thailand.

Gahukar RT (2011). "Entomophagy and human food security." Int. J. Trop. Insect Sci., 31(3): 129-144.

Girighar KJ, Rao RMVGK (1986). Moisture Absorption Characteristics of Natural Fibre Composites. J. Reinforc. Plast. Compos., 5: 141-150. http://doi.org/10.1016/j.compositesb.2013.08.014.

Hemmasi AH, Samariha A, Tabei A, Nemati M, Khakifirooz A (2011). Study of Morphological and Chemical Composition of Fibers from Iranian Sugarcane Bagasse. American-Eurasian J. Agri. Environ. Sci., 11(4): 478-481.

Kaper JB, Nataro JP, Mobley HLT (2004). Pathogenic Escherichia coli. Nat. Rev. Microbiol., 2(2): 123-140. http://doi.org/10.1038/nrmicro818.

Meyer-Rochow VB (1975). "The dioptric system in beetle compound eyes." The compound eye and vision in insects: Entomol. Res., pp. 299-314.

Microbiological Reference Criteria for Food (1995). Food Administration Manual: S. 11. Microbial Criteria, Version 2.0. pp. 1-25.

National Research Council (NRC) (1994). Nutrient Requirements of domestic animals: National Requirement of poultry, 9th revised Edition. National Academic Press, Washington DC, USA.

Oduah AA, Ohimain IE (2015). Ethnobotany of raffia palm (*Raphia hookeri*), productivity assessment and characterization of raffia palm oil from the Niger Delta, Nigeria. Res. J. Phytomed., 1(1): 33-38.

Opara MN (2012). "Studies on the production trend and quality characteristics of palm grubs in the tropical rainforest zone of Nigeria." J. Agr. Technol., 8(3): 851-860.

Ramos-Elorduy J (1990). "Edible insects: barbarism or solution to the hunger problem." Ethnobiology: implications and applications; Proceedings of the First International Congress of Ethnobiology (Belém, 1988).

Robert K (1989). The application of industrial technology for production of insects as food. The food Insect Newsletter. 3: 3.

Saeed M, Salim M, Noreen U (2005). Study on the Growth Performance and Feed Conversion Ratio of *Labeo Rohita* Fed on Soybean Meal, Blood Meal and Corn Gluten 60%. Pak. Vet. J., 25(3): 121-125.

Tambe JTAT, Iolo PR, Kolle JNO, Sidoro NI, Anciulli PPF (2013). Sexual size differences and colour polymorphism of Rhynchophorus phoenicis in the Southwest region of Cameroon, Bull. Insectol., 66(1): 153-159.

Van Huis A (2013). The Annual Review of Entomology. 58: 563-83.

Zahari M (2000). "Oil palm by-products and urea molasses mineral blocks as feed resources for buffaloes in Malaysia." Third Asean Buffalo Congress, Kandy, Sri Lanka. Palm Oil Dev., 40: 5-9.

Zealand N (2001). Guidelines for the microbiological examination of ready - to - eat foods, (December), 1-7.