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Crude fat and protein analysis of Asian palm weevil (*Rhynchophorus ferrugineus*) larval grub as an alternative source of protein and a potential material for feed production

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Abstract

The demand for food and protein sources rises in tandem with the ever-changing global population, sparking a thorough search for sustainable protein sources for both direct and indirect human consumption. Because of their nutritional value and sustainability, using insects as food and feed represents a promising option. A locally infamous nuisance and edible bug, the Asian palm weevil (*Rhynchophorus ferrugineus*), was studied for its nutritional value using proximate composition as indexes. This study aimed to address the following objectives: to determine the composition of crude fat and crude protein of Asian palm weevil larvae, to formulate hog production feeds using readily available or local raw materials and to determine the cost efficiency of the locally formulated hog production. Asian palm weevil was collected and pulverized. The sample was then transported to the Department of Agriculture Taguibo, Butuan City laboratory for crude fat and crude protein analysis. The late larval stage contains the highest crude protein content of 21.00-22.81% whereas the early larval stage contains 27.09-29.43%. The early larval stage has the highest crude fat content of 54.00-56.73% whereas the late larval stage has the least value of 21.00-22.81%. This result can be interpreted in such a way that the late larval stage of the Asian palm weevil is a better source of protein than the early larval stage. Using the recorded data, a feed was formulated with the palm weevil larvae as one of the raw materials, and a sample costing was then computed to determine its cost efficiency. A much lower cost price per kg was obtained from the formulated feeds (Php 6700/50 kg) using batod as compared to the commercial feeds (Php 3200/50 kg).

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Introduction

Finding sustainable substitutes for traditional protein sources has become a top priority in a society that is dealing with problems related to food security and an expanding global population. Researchers are focusing on unusual but promising sources of nourishment as we look for creative ways to feed the world. Particularly the Asian Palm/coconut Weevil (*Rhynchophorus ferrugineus*) larval grub is one such source that has attracted a lot of interest because of its high protein content and potential as a substitute source of protein for both human consumption and the creation of animal feed. The palm weevil larvae have been found to represent good sources of iron, zinc, essential amino acids, and fat (Alamu *et al.*, 2013; Payne *et al.*, 2016). The amino acid profile detected in palm weevil larvae, generally, shows high values of essential amino acids that meet human diet requirements and suggest their potential as a good source of bioactive peptides (Cerda *et al.,* 1999; Elemo *et al.,* 2011; Ogbuaga and Emodi, 2014).

This dead palm/coconut tree insect known as the Asian Palm Weevil is a serious danger to the global forestry and agriculture industries. However, by utilizing its potential, we can turn this common bug from a nuisance into a useful tool for alleviating the world's protein shortage. The Asian Palm Weevil larval grub presents a special potential because of its high nutritional value, which includes an exceptional protein profile. Furthermore, by lowering the population of this pest species, its use can support sustainable pest management strategies.

Another thing that can be put into consideration in the future is the increase in world prices for the most important agricultural crops that will lead to an increase in prices for beef, pork, and poultry of more than 30% by 2050 compared with 2000 (Nelson *et al.,* 2013). The same study indicates that the situation may be aggravated by climate change, causing prices to increase by an additional 18-21%. The increase in food and feed prices in the future will prompt the search for alternative protein sources, e.g., cultured meat (Fayaz, 2011), seaweed (Fleurence, 1999), vegetables and fungi (Asgar *et al.,* 2010).

Considering the geographical location of the Philippines, it is already evident that there is insect abundance in the country. Insects are primarily harvested in the wild and typically considered a delicacy in many tropical countries; their consumption depends upon their seasonal availability (Milton, 1984; Paoletti *et al.,* 2000; Politis, 1996). Approximately 2 billion people in Asia, Africa, and Latin America consume more than 2000 species of insects as components of traditional diets (Akhtar and Isman, 2018). Accordingly, entomophagy-the consumption of insects as food-offers a promising avenue through which to sustainably address the nutritional needs of the Filipino people.

Due to the facts stated, the researchers came up to an idea that the larval grub of *Rhynchophorus ferrugineus* or batod, could be a potential alternative to protein sources as this specie serves as the major pest in coconut plantations in the Philippines yet has high significant nutrition content. Moreover, batod can also be a potential raw material for feed formulation that is locally available within Caraga Region. There are still few if none researches conducted about the nutrition content of batod here in the country and this reason pushed the researchers to conduct a study about it, as this offers a great promise as potential raw material in feed formulation for poultry and livestocks but also as a potential exotic delicacy of the city. Thus, this study aimed to determine the composition of crude fat, crude fiber and crude protein of Asian palm weevil larvae, and formulate hog production feeds using readily available or local raw materials; and determine the cost efficiency of the locally formulated hog production.

Materials and methods

Sample collection and preparation

The sample of Asian palm weevil was collected from an agricultural coconut farm in Bgry, Del Pilar and Brgy. 9 in Cabadbaran City. The samples were put into containers and filled with the starchy pulp of the coconut trunk, which is the natural environment of the palm grub and on which they feed (Opara, 2012).

Thereafter, the samples were sun-dried and oven-dried at a temperature of 60 degrees Celsius. The samples were weighed every five hours after the 72 hours of oven drying or sun drying. After attaining three (3) consecutive of similar weight measurements, the samples were assumed dried. The dried samples were crushed and pulverized using mortar and pestle. A 300g sample was weighed and placed in a ziplock to avoid contamination. The sample was then transported to the Department of Agriculture Taguibo, Butuan City laboratory for crude fat and crude protein analysis.

Proximate and nutrient analysis

The proximate biochemical composition was carried out at the Department of Agriculture Laboratory Taguibo, Butuan City to determine the crude fiber (CF), crude protein (CP), and crude fat (CF) according to the standard method (Baur, 1997)

Moisture content was determined using the Oven method. A 2.0g of each fresh sample was heated to a constant weight in a crucible placed in an oven maintained at 135±2°C. The dried sample was used in the determination of the other parameters. Crude protein (% total nitrogen × 6.25) was determined by the Kjeldahl method, using 1.0g samples; crude fat was obtained by exhaustively extracting 1.0g of each sample in a Soxhlet apparatus using petroleum ether (boiling point range 103-105°C) as the extractant. Ash was determined by the incineration of 2.0g samples placed in a muffle furnace maintained at 600°C for 2h. Crude fiber was obtained by digesting 2.0g of sample with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace maintained at 525±15°C for at least 3h. Each analysis was carried out in triplicate.

Feed formulation and components

The procedure of feed formulation used in this study was adapted from the Team Bahug of One DA Sustainable Feed Development Program of the Department of Agriculture in Caraga Region which aims to formulate cost-effective and sustainable feeds using locally available raw materials as feed ingredients. Below are the procedures in feed formulation:

1. Choose the raw materials to be used with the known %CP.
2. Formulate 100 kilogram feeds. Just estimate the volume of each raw material.
3. Calculate the %CP from the known %CP and the volume used.
4. Calculate %CP = Known %CP x Volume Raw Materials.
5. Compare the calculated %CP and the %CP requirements (Chicken Grower – 15.50%).
6. Balance the %CP to achieve the requirement.

Costing and cost analysis

The costs for each raw material were based on the local market of Cabadbaran City, Agusan del Norte. Information on the prices of raw materials, labor cost in the production involved in the collection of the raw materials and other expenses were also considered during the costing. The total cost of the formulated feeds was calculated and compared with the cost of the commercial feeds in the market.

Results and discussion

This chapter contains a detailed presentation and discussion of the proximate analysis and the results of this study. This part will show the result for the moisture, ash, crude fat, crude protein, and crude fiber analysis of Asian palm weevil.

Table 1 shows the moisture, ash, crude protein, crude fat, and crude fiber content of the palm weevil larva. The moisture content was the highest during the late larval stage, ranging from 6.80% to 7.19%. The moisture contents of all the stages were lower than the values reported by Omotoso and Adedire (Omotoso and Adedire, 2017) for *Rhynchophorus phoenicis* (4.79%), early larval stage and (11.94%) late larval stage, and Okoli *et al.* (2019) for *Rhynchophorus phoenicis* (16.50). Moisture content affects the appearance, texture, weight, taste, and shelf life of food products (Appoldt and Raihani, 2017). Low moisture content is a desired characteristic in the food processing industry since it equates to lower food spoilage.

Table 1. Composition of the palm weevil (*Rhynchophorus ferrugineus*) larvae

Laboratory code	Sample code		Date analyze	Analysis results				
				Moisture (%)	Crude protein (%)	Crude fat (%)	Ash (%)	Crude fiber
2023-242	PW1	R1	05/24/2023	2.73	29.43	56.73	2.83	4.06
		R2	05/24/2024	2.98	29.00	56.47	2.68	4.27
		R3	05/24/2023	2.39	27.09	54.00	2.84	4.11
2023-243	PW2	R1	05/24/2024	7.19	43.96	22.81	9.05	12.31
		R2	05/24/2023	7.05	43.88	21.41	8.75	12.46
		R3	05/24/2024	6.80	44.43	21.00	8.98	12.72

PW1 – Early larval stage, PW2 – Late larval stage, and R – replicate

Table 2. Feed formulation using Asian palm weevil (*Rhynchophorus ferrugineus*) as one of the raw materials

Hog Starter (Std. Required % Crude Protein = 17.5)				
Raw materials	Known % crude protein	Weight (kg)	Calculated % crude protein	Max. Limit
Energy source (70%)				
Rice bran	0.1255	10	1.255	10
Corn	0.072	39	2.808	70
Water Hyacinth leaves	0.1127	6	0.6762	not indicated
Palm Kernel Meal	0.1482	10	1.482	10
Protein source (30%)				
Asian palm weevil (batod)	0.440944	10	4.409	10
Ramie-ramie	0.2815	25	7.0375	not indicated
Salt		5		
Total		100	17.67	

Table 3. Costing of the locally formulated hog production with Asian palm weevil (*Rhynchophorus ferrugineus*)

Hog Starter (Standard Required % Crude Protein = 17.5)					
Raw materials	Price per kg	Weight (kg)	Total price per 100 kg	Price per 50 kg or 1 bag	Price per kg/100
Energy Source (70%)					
Rice bran	18.00	10	180.00	90.00	1.8
Corn	15.00	39	585.00	292.50	5.85
Water hyacinth leaves	0.00	6	0.00	0.00	0.00
Palm kernel meal	7.50	10	75.00	37.50	0.75
Protein Source (30%)					
Asian palm weevil	30.00	1	300.00	150.00	3.00
Ramie-ramie	0.00	25	0.00	0.00	0.00
Labor	2.00	50	100.00	50.00	1.00
Total		100	1340.00	670.00	13.40

The late larval stage contained the highest ash content ranging from 8.75% to 9.05%. This data suggests that the late larval stage contains more minerals such as aluminum, calcium and manganese or iron deposition on the activated carbon or the presence of sand (Precisa, 2022) than the early larval stage. The ash contents of the early larval stage are comparable with the african palm weevil (2.37%) reported by Omotoso and Adedire (2007); however, the ash content of 8.75-9.05% for late larval stage is considerably higher than the 2.33% ash content recorded by the same study.

Highest crude protein content (44.43%) was recorded in the late larval stage. In comparison for the value reported by Rodriguez-Ortega et al. (Rodriguez *et al.*, 2022) for South American palm weevil (*R. palmarum*) (9.04%) and Mercer (1994) for *R. ferrugineus* (6.10%) the protein contents from the two developmental stages are higher. The study conducted by Parker et al. (2017) for African palm weevil (32-34%) resulted in a value closer than the ones mentioned above. But comparing the result, the highest value of insect protein was obtained from grasshoppers (53.10%) (Adedire and Aiyesanmi, 1999) of which the protein content of palm weevil is considerably lower. The crude fat for the early larval stage, which ranges from 54.00-56.73% is the highest. Fat is essential in diets for it increases the palatability of foods by maintaining their flavors (Aiyesanmi and Oguntokum, 1996).

Fat also plays a vital role in giving the body energy and supporting cell function. The recorded crude fat is comparable with the value obtained from the same species (52.4-60.1%) by Chinarak *et al.* (2020) and Parker et al. (2017) (53-56%). The crude fiber content of the late larval stage at 12.31-12.72% shows a greater result than that of the early larval stage (4.06-4.27%). The crude fiber result for the late larval stage is significantly higher than the result obtained by Abdel-Moniem *et al.* (2017) for the larval stage of *R. ferrugineus* at 5.30%, but lower than the findings of Omotoso and Adedire (2007) for the *R. phoenicis* which reached 22.14% for the early larval stage and 17.22% for the late larval stage. Having fiber in the diet is beneficial in treating and preventing constipation, diverticulosis, coronary heart diseases, hemorrhoids, and some types of cancer (Madhu *et al.*, 2017).

In feed formulation there are a lot of parameters to look into but in general, to check the quality of animal feeds is to determine the % Crude Protein of the formulated feeds. Table 2 shows how to formulate the feeds. In formulating the feeds, energy sources and protein sources are emphasized. Energy sources should be 70% whereas protein is 30%. This is a sample formulation of Hog Starter with a standard required % CP of 17.5. Known CP of each raw material is multiplied by its possible weight to calculate the % CP, we also have to consider the maximum limit of each raw material. By incorporating the batod with other analyzed raw materials, the calculated % CP (17. 67%) is still enough to supplement the required standard value of 17.5% for hog starter feeds.

Formulation of other types of local feeds can also be made for different livestock and poultry knowing the values of required standard %CP for each livestock/poultry, and the values of analyzed %CP for each raw material. The values of the analyzed raw materials can be accessed from the Team Bahug of One DA Sustainable Feed Development Program of the Department of Agriculture in the Caraga Region. A mobile application called “Bahug” was designed by Team Bahug that will be soon available in Play Store. This application stores the analyzed data (%CP) for different local raw materials intended for feed formulation. This study provides data to the Department of Agriculture Caraga on the measured value of protein of Asian Palm Weevil as one of the raw materials for feed formulation.

The example costing for the feed formulation (hog starter) used in hog production is shown in Table 3. The prices for each raw material were determined based on the Cabadbaran City, Agusan del Norte local market. The costing process also considered the prices of the raw materials, the labor costs associated with gathering the raw materials, and other costs. The cost of each raw material was multiplied by the target weight to obtain the price per 100 kg, which was then divided by two to obtain the cost per 50 kg. The price per kg of the formulated feed was then divided by 100 to obtain the price per kg. Compared to the commercial feeds on the market, which cost approximately P 1600 per 25kg of sack (B-MEG) the cost of the formulated feeds was P 670.00 per sack (50kg). Additionally, a sizable profit could be made. Feeding your animals, the proper amount of food, in addition to being organic, ensures that they receive the nutrition they require to remain healthy and effective. Making your own feeds cuts down on extra expenses while boosting your profit margin.

Conclusion

By testing the proximate composition of Asian palm weevil larvae, this study established that the larvae can be an alternative protein source and a potential exotic delicacy of Cabadbaran City. The result from both the early larval stage and late larval stage of the palm weevil larvae shows a considerably decent amount of crude protein, crude fat, and crude fiber. The consumption of palm weevil should be increased for all rural and urban settings due to its nutritional potentials and its capacity to contribute to the recommended human daily protein requirement.

The investigation revealed that Asian palm weevil is a good source of protein. On this basis, future researchers should examine the amino acid and mineral composition of the palm weevil to further determine its nutritional components. Additionally, extensive toxicity study on the larvae of the Asian palm weevil needs to be done to ascertain its safety level as food and feed.

It is recommended in the future study to evaluate also the cost-efficiency of the formulated feeds. Since cost-efficiency is not only based on the upfront cost of feeds but also considering the overall performance and outcomes achieved. These include the evaluation of the animal health, growth rates, and feed conversion efficiency to provide a more comprehensive assessment of the cost-efficiency of the formulated feeds using the Asian palm weevil larvae.

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