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Unveiling nutritional disparities: A study of proteins, carbohydrates, and lipids in *Lasioderma serricorne* and *Sitophilus Oryzae*

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Abstract
In the human diet, cereals play a significant role. Cereals are our main source of carbs, but they also provide vitamins, trace minerals, and dietary fiber. Cereals have also been looked at for their antioxidant defense potential because of the recent rise in interest in the consumption of dietary antioxidants. This article examines the nutrients found in insects and the variables influencing their variability. A variety of insect species have different protein contents and amino acid profiles. The lipid quantity and fatty acid composition in several insect species are also tackled, with a focus on the fatty acids omega-3 and omega-6 in specific. Along with potential effects on nutrient availability, data presented on the carbohydrates, fiber, and chitin found in insects. *Lasioderma serricorne* and *Sitophilus oryzae* were studied to assess their total protein, lipid, and carbohydrate concentrations. Protein and carbohydrates are abundant in all animals due to their structural components. However, lipid levels are low across all species. These findings showed there is no correlation between protein, fat, and carbohydrate quantities. The ratios of protein, lipids, and carbohydrates also varied, even within the same genus.

Keywords: Protein, glucose, lipid, *L. serricorne* and *S. oryzae*

Introduction

Living organisms require organic compounds called "biomolecules." These biomolecules mainly consist of carbon, nitrogen, hydrogen, and oxygen. Simple, more compact organic molecules with lower molecular weight can be found in macromolecules. Typically, it serves as a macromolecule's building block. Protein, amino acids, minerals, vitamins, and trace elements are abundant in insects (Chen and Feng 1999). Additionally, insects are rich in mono and polyunsaturated fatty acids, trace minerals including copper, iron, magnesium, manganese, phosphorus, selenium, and zinc, and vitamins like riboflavin, pantothenic acid, biotin, and folic acid (Rumpold and Schluter 2013) [26]. According to studies by Melo *et al*., (2011) and Schluter *et al*., (2017), the typical protein content of edible insects is between 35% and 60% dry weight or 10% to 25% fresh weight, which is higher than the protein content of plant foods like cereal, beans, and lentils (Bukkens, 1997).

In general, carbohydrates calculated as nitrogen-free extract, are present in small amounts in insects (Finke 2013; Oonincx and Dierenfeld, 2011) [8]. Digestive enzymes convert complex carbohydrates (polysaccharides) like starch and glycogen into simple sugars like glucose, galactose, or fructose. Through Kreb's Cycle and oxidative phosphorylation, these simple sugars can be converted into ATP, which is a kind of energy. As an alternative, they can serve as the building blocks for chitin, which is a crucial part of the exoskeleton of insects. Some insects that overwinter store a significant amount of sugar (such as trehalose) in their blood and other fluids, which acts as an antifreeze to protect them from the usually dangerous effects of freezing temperatures.

The fat content of insects varies between 10 and 70% on a dry matter basis (Finke, 2013; Yang *et al*., 2006) [33]. The fatty acid composition of insects depends on the life stages as well as environmental factors such as diet, temperature, and light (Finke and Oonincx, 2017). Most of male insect species have smaller fat reserves than females (Kulma *et al*., 2019) [14].

Proteins are intricate organic nitrogen compounds comprised of amino acids. On hydrolysis, they release amino acids but have large molecular weight. It acts as the fundamental components of biological and cellular structures. Proteins make up muscles, enzymes, hormones, and other structural and functional component of the organism. The protein content of insects varies between 25 and 75% on a dry matter basis (Finke 2013; Oonincx and Dierenfeld, 2012; Oonincx and Van der Poel, 2011) [21, 22]. Proteins are disassembled into their individual amino acids by protease enzymes in the insect's digestive tract. These amino acids are used to create new enzymes and hormones in the cells, as well as the proteins required for cuticle, muscle, egg yolk, ribosomes, and many other biological processes. In contrast, insect species with high protein content have lower energy levels (Bednarova 2013). These proportions are commonly only slightly lower than those for egg protein (95%) and even greater than those for many plant proteins (Finke 2004) [7]. Since some nitrogen is also bound in the exoskeleton, measured levels of nitrogenous compounds in insects may be larger than their true protein content (Rooijackers *et al*., 2012) [12].

Nowadays human insect-eating is usually accomplished in 113 countries around the world. There are around 2000 bug species that can be cooked. Beetles, caterpillars, bees, wasps, and ants are the species that are eaten most frequently on a global scale. Grasshoppers, locusts, crickets, cicadas, leafhoppers, beetles, termites, dragonflies, flies, and other species come after them (Jongema 2015) [11]. Insects have nutritional value that is comparable to that of normal meats. Consideration should be given to using edible insects as an animal protein source given the expanding human population and the rising demand for traditional meats like beef, pork, and chicken (Dreon and Paoletti 2009) [5]. In general, as compared to other traditional food groups,

insects have a high protein content and outstanding production efficiency (Kohler *et al*., 2019; Nongonierma and FitzGerald, 2017; Zielinska *et al*., 2015) [13, 20, 36]. The goal of this study was to determine the nutritional content of macronutrients in adult *L.serricorne* and *S.oryzae* that have a good impact on human health in the environment.

Materials and Methods

1. Methods for Protein Content Determination

Lowry reagent preparation

Solution A -1g Na2CO3 in 100 ml 0.1M NaOH; 0.1M NaOH -0.4g NaOH in 100ml distilled water.

Solution B – 0.05g CuSO4 and 0.1g sodium potassium Tartrate in 10 ml distilled water.

Folin-Ciocalteu solution: Before using diluted ratio of 1.2 with distilled water.

Lowry reagent- 50 ml sol A+ 1ml sol B. **STD**: BSA – Bovine Serum Albumin

Procedure

Take 100-500 µl of working standard solution. Take 100 µl of protein sample in another test tube. Make up to 1 ml of distilled water including blank. Add 5 ml of Lowry reagent all the tubes. Mix thoroughly, incubate all the tubes at room temperature for 15 minutes. Add 500 µl of Folin Phenol reagent (1:2) mix well. Incubate for 30 min at dark room and observe blue colour. Protein assay method was applied to each standard solution (Lowry *et al*., 1951) [19]. In a spectrophotometer at 620nm was read and the data values y=0.001x-0.014 R^2=0.9986 were calculated. Plotting the standard's concentration against its absorbance on the Y-axis will result in a standard graph.

Calculation

$$\text{Protein} = \frac{\text{Absorbance of sample}}{\text{Absorbance of standard}} \times \text{Conc. of STD}$$

2. Methods for carbohydrates content determination

Anthrone reagent preparation

2g of anthrone reagent dissolve in 1 litre of concentrated sulphuric acid. Use freshly prepared solution for the assay

STD: Glucose

Procedure

Take different volumes of standard and sample to the test tubes. Make up the volume to 1ml.Add 1ml of distilled water to blank. Now add 4 ml of anthrone reagent to all the test tubes and incubate at 90°C for 17 minutes or boiling water bath for 10 minutes. After cool it for 10 minutes in room temperature and observe blue-green complex colour. Glucose assay method was applied to each standard solution (Am. 1950) [2]. In a spectrophotometer at 620nm was read and the data values y=0.143x-0.029 R^2=0.9965. Plotting the standard's concentration against its absorbance on the Y-axis will result in a standard graph.

Calculation

$$\text{Carbohydrate} = \frac{\text{Absorbance of sample}}{\text{Absorbance of standard}} \times \text{Conc. of STD}$$

3. Methods for lipid content determination

Vanillin reagent preparation-60mg vanillin in 10ml of hot distilled water with 40ml of 85% ortho phosphoric acid.

STD: Olive oil/ Malondialdehyde

Procedure

Take samples in different concentrations in all the test tube and add 100 µl of concentrated H_2So_4 and heat at 100˚C for 10 minutes. Allow it to cool and add 2.4 ml of vanillin reagent and incubate at 37˚C for 5 minutes. Observes for pink colour development. Lipid assay method was applied to each standard solution (Abraham Saifer 1971) [1]. In a spectrophotometer at 490nm was read and the data values y=0.158x-0.008 R^2=0.895. Plotting the standards concentration against its absorbance on the Y-axis will result in a standard graph.

Calculation

$$\text{Lipid} = \frac{\text{Absorbance of sample}}{\text{Absorbance of standard}} \text{ Conc. of STD}$$

Results

Table 1: Total amount of protein, carbohydrate and lipid found in *L. serricorne* and *S. oryzae*.

Species Name		Sample Concentrations (100 µl)		
		Protein	Glucose	Lipid
L. serricorne	O.D values	0.28	0.33	0.27
	Amount (µg)	280	480	140
S. oryzae	O.D values	0.20	0.35	0.19
	Amount (µg)	200	520	100

The result revealed that the amount of protein level was tested against the adult stored pest of *L. serricorne* and *S. oryzae* and the data obtained in the experiment are shown in table 3.1 and figure 3.1. The maximum amount of protein was observed from 280 µg/g in *L. serricorne* and 200µg/g in *S. oryzae*. Similarly the carbohydrate level increased from 520 µg/g in *S. oryzae* and 480µg/g in *L. serricorne* and the data obtained in the experiment are shown in table 3.1 and figure 3.2. Likewise, lipid level also increased from 120 µg/g in *L. serricorne* and 85µg/g in *S. oryzae* respectively (table 3.1 and figure 3.3).

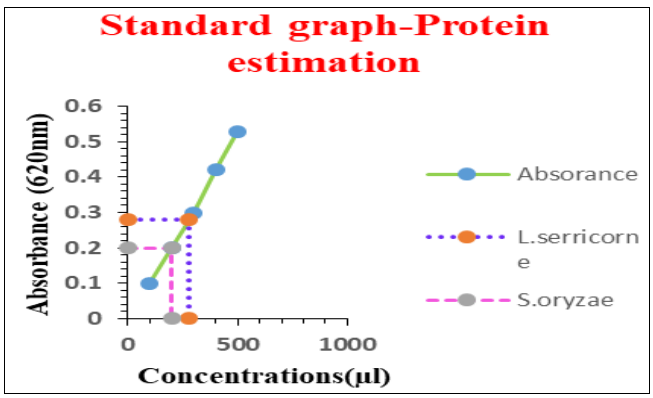


Fig 1: Total amount of protein found in *L. serricorne* and *S. oryzae*.

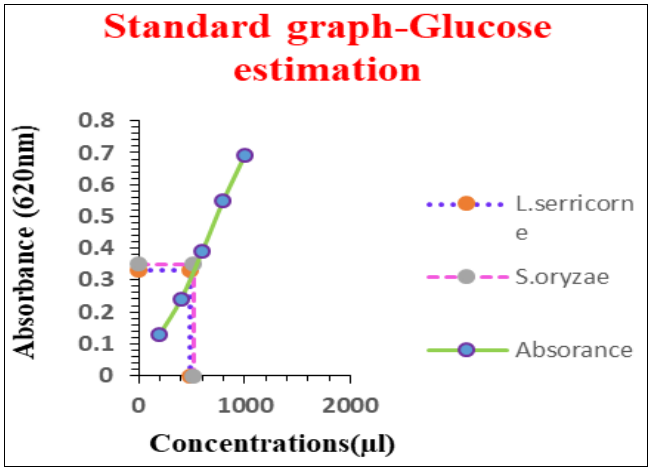


Fig 2: Total amount of carbohydrates found in *L. serricorne* and *S.oryzae.*

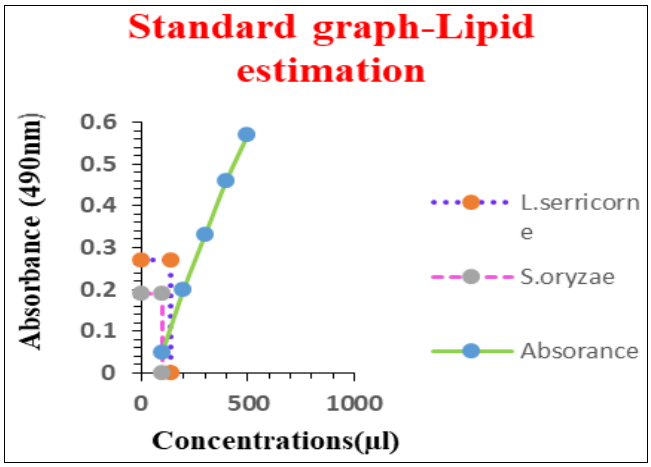
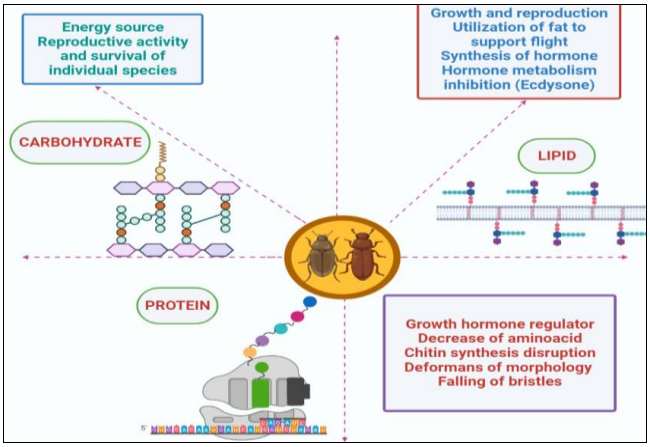


Fig 3: Total amount of lipids found in *L. serricorne* and *S. oryzae*.

The amount of protein (100µl) present in the *L.serricorne* and *S.oryzae* is = 280 mg and 200mg
The amount of carbohydrate (100µl) present in the *L.serricorne* and *S.oryzae* is = 480 Kcal and 520Kcal
The amount of lipid (100µl) present in the *L.serricorne* and *S.oryzae* is = 140 mg and 100mg

Discussion

The growth and development of the insect as well as its metabolism and biochemical processes are adversely affected by all forms of insecticides. This study demonstrates that *L. serricorne* has higher levels of protein, fat, and acetyl cholinesterase than *S. oryzae*. In a similar way, *S. oryzae* had a greater glucose level than *L. serricorne* exhibited. Biological attack has produced several of the new pest management methods in recent years. In other words, biological control is the most significant tool in the fight against hazardous insects. Biology, physiology, and biochemistry are essential to understand in creating effective control systems. Proteins are the most abundant organic elements in animal tissues, including insects, and they are essential for energy production. Various agents, such as protein, are necessary for the synthesis of ATP during the growth process (Taşkn and Aksoylar, 2011).
According to Singh and Sinha (1977) [31], variations in protein, lipid, and carbohydrate levels were examined as *Sitophilus oryzae* (L.) and *S. granarius* (L.) developed while being raised on whole wheat. Maximum nutrients are present in the *S. granaries* life cycle compared to *S. oryzae*. Up until the prepupal stage, biomass growth increased the total amounts of carbohydrates and lipids which afterwards decreased slightly in both *S. oryzae* and *S. granarius*. In *S. oryzae*, the protein content increased until the prepupal stage, then slightly reduced in pupae and increased again in adults; in contrast, in *S. granarius*, the protein content increased continuously through all stages of the life cycle until adult emergence.
Another study looked at the impact of host density on *Bracon hebetor* Say's development time, egg dispersion, fecundity, sex ratio, longevity, and glycogen, total sugar, and lipid levels (Hymenoptera: Braconidae). According to the observations, host density had no significant effect on the glycogen levels of female and male wasps, although sugar and lipid levels varied between the sexes (Işıtan *et al*., 2011). Similarly, lipids are used as an energy source, hormone precursors, and structural elements in a variety of insects. It is stored in several parts of the insect's body. In particular, lipids found in the egg help supply the energy needs of the developing embryo (Boz and Gulel, 2012) [4].
Preeti Sharma *et al*., (2011) [24] explored the effects of the most effective petroleum ether extract of *Artemisia annua* and *Azadirachta indica* the total levels of carbohydrate, lipid, and protein on *Anopheles stephensi* and *Culex quinquefasciatus* larvae methods suggested by Nelson, Bragdon, and Lowry for protein, total fat, and carbohydrates (glucose) respectively. During treatment with petroleum ether extracts the glucose levels in anopheline larval tissues increased and anopheline larvae had lower total protein levels than culicine larvae. The insecticidal stress these extracts caused in both of the larvae may be responsible for the rise in glucose levels. Stress may cause glycogenolysis, which would lead to hyperglycemia. Nath *et al*., (1997) also reported increase in glucose level due to insecticidal stress.
Culex larvae also caused damage to the body wall and larval tissues, according to Sharma *et al* (2009) [30] the body wall consisting of chitin, a protein, and other proteinaceous tissues were damaged, resulting in a drop in the larvae overall protein levels.



The impact on carbohydrate, lipid, and protein content in treated *Schistocerca gregaria* larvae with *azadirachtin* is concluded to be species and specific extraction. Especially protein synthesis hormones are disrupted, leading to decreased protein synthesis (Rao and Subramanian (1986) [25]. On the other hand, physiological stress is induced and the metabolic activity is also altered by the extract according to its phyto chemical constituents. Senthilkumar *et al*. 2009

[27] also found that total lipid levels were lowered in *An. stephensi* larvae treated with plant extracts, which they attribute to physiological stress conditions generated by the extracts.

Furthermore, it was discovered in previous research that the alimentary canal of *Anopheles* species was severely injured during the extract treatments (Sharma *et al*., 2006a; Sharma *et al*., 2006b) [28, 29]. As a result of the larvae's inability to absorb the food, the glucose content increased. The barrier most likely prevented the larvae from feeding, resulting in a drop in glucose levels.

Conclusion

All types of insecticides have a negative impact on an insect's metabolism, growth, and development, as well as its biochemical activities. The loss of biochemical components shows that proper food digestion and nutrition have been disturbed. This study showed that, protein, and lipid levels substantially found to be elevated in *L. serricorne* than in *S. oryzae*. While *S. oryzae* has a higher glucose level than *L. serricorne*, following a similar pattern. This may be because *S. oryzae* intakes foods high in carbohydrates like rice, while *L. serricorne* obtains its nutrition from protein-rich foods like chickpeas.

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