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Oils of *Rhynchophorusphoenicis* Larva and *Brachytrupesmembranaceus*: Chemical Properties, Fatty Acid Composition and its Effects on Serum Lipid Profile of Wistar Albino Rats

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ABSTRACT: The present work was aimed at extracting oil from two edible insects, *Rhynchophorusphoenicis* larva and *Brachytrupesmembranaceus*, study their physicochemical properties, fatty acid composition as well as effect of their consumption on serum lipid profile of Wistar albino rats. The extracted oils were used as supplements to basal diet and administrated orally to rats for a period of 4 weeks to determine after dissection their effect on lipidemia. The physicochemical properties of the oil extracted from the *R. Phoenicis* and *B. membranaceus* revealed 196.01 and 180.30mg KOH/g for saponification value, 101.50 and 123.60mg/100g for iodine value, 8.25 and 11.67 meq/kg for peroxide value, 3.25 and 3.04 mg KOH/g for acidvalue and 60.92% and 18.52% for crude lipids respectively. *B. membranaceus* oil is rich in polyunsaturated fatty acid (41.37%) while *R. Phoenicis* is a rich source of monounsaturated fatty acids (47.57%) making *R. Phoenicis* to be hemi saturated oil (46.63%) compared to *B. membranaceus* that is unsaturated (58.56%) and rich in omega-3 fatty acid (39.12). *B. membranaceus* oil was found to produce a significant reduction ($p < 0.05$) in serum total, cholesterol, triglyceride and low-density lipoprotein (LDL) concentrations compared to control group. *R. Phoenicis* exhibited contrary effects. A similar corresponding significant increase ($p < 0.05$) in activities of the serum enzymes ASAT and ALAT were observed in rats fed *R. Phoenicis* oil. The implications of these findings demonstrate the hypocholesterolemic effect of *B. membranaceus* oil and suggest that the oil could be exploited for domestic, pharmaceutical and industrial purposes.

KEYWORDS: Oil, *Rhynchophorusphoenicis*, *Brachytrupesmembranaceus*, Fatty Acid, Lipid Profile, Hypocholesterolemic, Lipoprotein

I. INTRODUCTION

The scarcity of the existing source of animal protein (beef, mutton, pork, and poultry) is at a high rate as a result of the increasing growth of human populations. This fact is also buttressed by the rising standard of living in Cameroon. There are however, several other unconventional sources of meat which have not been fully exploited. Edible insects are the unexploited unconventional sources of meat. Insects commonly consumed are mostly those which can be

collected in large numbers and in Cameroon these include locust in the gregarious phase, winged termites, caterpillars, grasshoppers, palm weevil and the large African cricket "*Brachytrupes*" [1]. In Africa, cricket *Brachytrupes membranaceus* (Gryllidae) is eaten as a common source of food. The larva of *Rhynchophorus phoenicis*, a Coleoptera from the family Curculionidae, and gryllus has been found to be used as traditional food in several countries in the world [2, 3]. It is a delicacy in many parts of Cameroon and other countries in Africa where it is found. Proximate compositions of these insects have been studied in Central Africa [4], South Africa [5, 6] and South America [7]. Previous researchers have reported that Crickets provide more than twice the protein of beef with is best kind containing all the essential amino acids. These insects also contain oils and little nutritional detail on cricket oil is readily available to an international readership.

Dietary fat can increase the level of serum cholesterol to levels which can place an individual at increased risk of cardiovascular diseases such as atherosclerosis and coronary artery disease [8-10] and if not treated will lead to sudden death [11], whereas oil that contain unsaturated fatty acids can reduce hyperlipidemia and will lead to the decrease in sudden death. Nutritionally, a high level of saturated fatty acids in foods might be undesirable because of the linkage between saturated fatty acids and atherosclerotic disorders [12]. Dietary intervention and epidemiological studies show that fatty acid intake plays a key role in human health. Reduction of dietary saturated fatty acids (SFAs) can decrease factor VII coagulant activity, which has been implicated as a risk factor for cardiovascular disease (CVD) as reviewed by Lefevre et al. [13]. Furthermore, SFAs may raise serum low density lipoprotein cholesterol, which is claimed to cause atherosclerosis [14, 15]. Consumption of polyunsaturated fatty acids (PUFAs) is of increasing interest as evidenced in the literature, especially n-3 PUFA, which has beneficial effects on reducing the risk of diabetes by reduction of glucose intolerance [16] and prevention of insulin resistance [17], decreasing thrombotic tendency by inhibition of TXA₂ (thromboxane A₂) formation [18] and lowering blood pressure [16, 19]. Many studies have proven that the balance of consumption of n-6/n-3 is associated with human diseases. Simopoulos [20] indicated that a low ratio of n-6/n-3 (lower than 5) had effects on the prevention of CVD, reducing total mortality; decreasing the risk of breast cancer and many chronic diseases.

Globally raised cholesterol is estimated to cause 29.7 million deaths and 2.6 million daily [21], Natural medicine from are cheaper than pharmacological drugs like Larcoferin which are very expensive. Besides this, synthetic drugs have side effects [22, 23]. It is therefore important to carry out this study as palm weevil larva and cricket oil are easily available to a large population in Cameroon and their oil may contain essential fatty acids; that can be an alternative therapeutic strategy to reduce cardiovascular disease. In this regard, the present study is aimed at establishing the fatty acid composition of *R. phoenicis* and *B. membranaceus* oils and their effects on serum lipids and activities of serum enzymes.

II. METHODOLOGY

II.1. Samples collection and preparation

Life *Rhynchophorus phoenicis* larvae and *Brachytrupes membranaceus* (Fig. 1) used for this study were purchased from a local farmer in South West Region, Buea, Cameroon and were identified by a taxonomist in the Department of Zoology and Animal Physiology, Faculty of Science, University of Buea, Cameroon. The insects were cleaned washed to remove dusts and put in air-tight, containers and used for oils extraction.



Fig.1 (A) *Rhynchophorus phoenicis* larvae ; (B) *Brachytrupes membranaceus*

II.2. Oil extraction

Lipids were extracted from fresh raw insects using the Bligh and Dyer method[24]. About 80 g of insect were introduced in a grinding machine (Panasonic, Kyoto, Japan) to which 100 mL of chloroform and 200 mL of methanol were subsequently added. The mixture was grinded for 3 min; followed by the addition of 100 mL of chloroform and 100 mL of distilled water. The mixture was again grinded for 1 min, and filtered. The final extraction was ensured by the addition of chloroform, in the order to attain the following proportion: 2:2:1.8 for chloroform, methanol, and distilled water respectively. After separating the different phases in a funnel, the organic phase was collected and dried using sodium anhydrous. The organic solvent was then eliminated by evaporation on a rotator evaporator at 45 °C under reduced pressure. The extracted oil was stored at 4 °C for further analysis.

II.3. Chemical properties of the oils: Evaluation of the oil quality

Free fatty acid: Free fatty acid (FFA) content was determined according to the method of AFNOR[25]. The fish oil sample (1g) was dissolved in 100 mL of ethanol and some drops of phenolphthalein were added as an indicator and swirled vigorously. The mixture was then titrated with potassium hydroxide (0.1M). The FFA was expressed as % oleic acid.

Iodine value: The iodine value (IV) of fish oil samples was determined using the Wijs method, as described by AFNOR[25]. The IV was expressed as g I₂/100g of sample.

Saponification value: it was determined according to the method of AFNOR[25]. One gramme of oil sample was weighed into a 250-ml Erlenmeyer flask and 12.5ml of KOH 0.5N was added. The mixture was heated for 15-30 minutes in a water bath. Then, 5 drops of phenolphthalein indicator was added and the mixture shaken to dissolve the sample completely. The mixture was then titrated with 0.5N HCl while shaking vigorously until the endpoint is reached. The endpoint was indicated by a slight pink

$$Sv = (Vo - Vs) \times [HCl] \times 56.1 / m$$

color that persisted for 30s and later changed to colorless. The Saponification value was calculated using the following formula:

Where:

Sv= Saponification value;

Vo = Volume of blank;

Vs= Volume of sample;

[HCL] = concentration of HCl;

m= Mass of oil sample

Peroxide value (PV):The French Norm for fat and oil (AFNOR) was used [25]. 1 g of the oil sample was accurately weighed into a 250 mL Erlenmeyer flask closed immediately with glass stopper. 50 mL chloroform was added to dissolve followed by 1 mL of saturated potassium iodide solution, freshly prepared, and allowed to react for 60 seconds while agitating manually but vigorously the solution at least twice and kept in the dark for 10 minutes. After which 100 mL of water was added and shaken. The contain was then Titrated with sodium thiosulfate solution (0.01M), using 1 mL starch 1 % solution as an indicator from a purple blue to a slight yellow or colourless endpoint. A blank titration was carried out under the same conditions. Tests were performed in triplicate. The peroxide value calculated using the following formula:

$$PV = (V_1 - V_0) \times T \times C \times 1000/m$$

Where:

PV = peroxide value expressed in meq/kg;

V_1 = consumption of sodium thiosulfate solution in the main test, in mL;

V_0 = consumption of sodium thiosulfate solution in the blank test, in mL;

C = molar concentration (molarity) of the sodium thiosulfate solution in mol/L;

T = titer of the thiosulfate solution;

m = weighed portion of oil in grams.

II.4. Fatty acid composition

Fatty acid composition of the oil was investigated after conversion of their Fatty Acid Methyl Esters (FAME) by using boron trifluoride-methanol method. The lipids were saponified and esterified for fatty acid analysis by the method of IUPAC [26]. The fatty acid methyl esters (FAMES) were analyzed on a Hewlett-Packard (HP) 5880 gas chromatograph (GC) with a Flame Ionisation Detector (FID). The esters were separated on a 50m × 0.20mm I.D. wall-coated open tubular fused silica capillary column coated with Carbowax 20M. Column injector and detector temperatures were 200 and 300°C, respectively. Carrier gas was helium; split ratio was 100:1. Identification was achieved by comparison to retention times of authentic standards, argentation TLC followed by GC of the bands separated by a degree of unsaturation, and mass spectrometry.

II.5. Animals, diets and serum preparation

Albino Wistar rats (n=18) of both sexes and weighing 60-90g obtained from the animal laboratory of the Department of Biochemistry, University of Dschang, Cameroon were used for the study. Animals were housed singly in stainless steel metabolic cages with raised wire floor in a room with a 12hour light/dark cycle at a temperature of about 25 ±3°C and fed rat standard basal diet (commercial pellet formula adapted from Malathi et al., [27] and received water ad libitum for one week to acclimatize. The rats were then assigned randomly to three groups of six each (3 males, 3 females) designated: control group (A) and 2 test groups (B) and (C). They were placed on basal diet and water ad libitum for a period of 4 weeks. In addition, Group A received daily oral gavage of distilled water and in groups C and B water was replaced with daily oral gavage of *Rhynchophorusphoenicis* larva oil and *Brachytrupesmembranaceus* (crickets) oil respectively. During the experimental phase, daily feed consumption was recorded as well as weight gain by rats. Oil dose was 50ml/kg body weight. On the 30th day the animals were fasted overnight and each rat was individually anesthetized with chloroform and blood samples were collected by cardiac puncture, centrifuged at 10000g for 15min and the serum collected. The sera were kept at -20°C for analysis of lipid profile and serum enzyme activity. Organ weights were also recorded. Ethical guideline was maintained in animal handling during the study and approval was obtained from the ethic committee of the Faculty of Science, Department of Biology and Plant Physiology, University of Buea.

II.6. Biochemical Assays (serum analysis)

Serum lipid profile was determined with the use commercial kits (CHRONOLAB SYSTEMS, SL, Spain). Total cholesterol was analyzed enzymatically with CHOD/PAP Method [28-30] and HDL was estimated with precipitation [31-32] using commercial kits. Triglyceride was determined enzymatically also by using commercially available kit. Serum LDL was determined according to the Friedewald et al. [33] formula with the use of HDL and total cholesterol value. HDL/LDL ratio was calculated. Serum activities of alanine aminotransferase (ALT) and aspartate

aminotransferase (AST) were measured using commercially available kits by the methods described by Tietz[34], Doumas et al., [35] for ALT and Murray-Kaplan et al., [28] for AST. ELISA plate reader (Labsystems, Multiskan EX, Finland) was used to analysespectrophotometrically the lipid profile.

II.7. Statistical Analysis

The data are presented as means \pm SD. The mean values of the control and test groups were compared using Bonferroni tests performed using Graph pad Insat 2000 software.

$P < 0.05$ considered to be significant.

III. RESULTS AND DISCUSSION

III.1. Chemical properties of *R. phoenicis* and *B. membranaceus* oils

Chemical properties of oil extracted from *Rhynchophorusphoenicis* larva and *Brachytrupesmembranaceus* are presented in Table 1. Acid values are used to measure the extent to which triglycerides in the oil have been decomposed by lipase action and other physical factors such as light and heat into free fatty acids (FFAs) in a given amount of oil.

Acid value is therefore an indirect method for determination of free fatty acid in oil samples and its edibility [36]. Acid values and free fatty acids (as % oleic acid) are important indexes of chemical properties of oil used to indicate the quality, age, edibility and suitability of oil for a particular use. Oil with low free fatty acids has more significant usage [37]. The total acid value recorded in the present study was 3.04 ± 0.06 , and 3.25 ± 0.86 for *B. membranaceus*, and *R. phoenicis* respectively. These values were found in the permissible limits i.e 10mg KOH of oil and found to be suitable for dietary purpose, as they contain lower fatty acid contents [38]. Ekpo et al., [39] reported acid value of 3.60 ± 0.06 and 3.5 ± 0.06 for *Macrotermisbellicosus* and *Rhynchophorusphoenicis* larvae which are close to acid value obtain in this work. Low acid value is an indication of the oils having lower susceptibility to rancidity. Values obtained in the present study were found to be lower than that of oil extracted from winged termite *Macrotermisbellicosus* (4.07 ± 0.99) [40]. The free fatty acid value of 1.57 % and 1.62% falls within the maximum limit of 5% for free fatty acids as recommended by FAO [41].

The iodine value is the number of grams of iodine absorbed per 100g of fat. It is a measure of the degree of unsaturation in oil and could be used to quantify the amount of double bonds present in the oil which reflects the susceptibility of oil to oxidation. Fats and oils with higher unsaturation show higher iodine values [42, 43]. The iodine value of *B. membranaceus* (123.60) oil was high and this reflected the presence of high percentage of unsaturated fatty acids in the oil compared to *R. phoenicis* (101.50 ± 0.68). Ekpo et al., [39] have earlier shown that *Macrotermisbellicosus* and *Rhynchophorusphoenicis* have iodine values of 108 ± 0.15 and 123.6 ± 0.24 g/100g respectively. Lepidopterous larvae and *Phytophagouschrysomefids* were found to have iodine values of 112 to 159 and 106.6 to 118 g I₂/100g respectively [44] while iodine value for olive oil (refined or virgin) range between (75-94) [41]. The iodine index found in this work is comparable to those reported for most insect lipids suggesting a reasonable amount of unsaturated fatty acids. These values were found in the Permissibility range for edible oils [41].

Peroxide value is an index of rancidity, thus low peroxide value indicates low spoilage during storage. The peroxide value of *R. phoenicis* is low (8.25 mEq/Kg) compared to *B. membranaceus* (11.6 mEq/kg). The maximum acceptable value is 10 milliequivalents /kg oil or up to 15 milliequivalents /kg oil for virgin crude oils as set by the Codex Alimentarius Commission for edible oils [41]. The *R. phoenicis*oil is thus more stable and would not easily go rancid compared to *B. Membranaceus* since because *R. phoenicis*oil has lower iodine value is. The lower peroxide value obtained for the oil from these edible insects is an indication of the lower level of spoilage of the oil because oil with high peroxide values are known to be rancid [45].

The saponification value from *R. phoenicis* and *B. membranaceus* oils were 196 mg KOH/g and 180 mg KOH/g. Ekpo, et al., [39] recorded saponification values of 193.4 ± 0.3 and 198.9 ± 0.25 mg KOH/g for *Macrotermisbellicosus* and *Rhynchophorusphoenicis* respectively. The saponification values obtained here for these two insects were lower than that obtained from rape seed oil [41, 46] and for coconut oil [41, 47] but higher than 122.30 mgKOH /g obtained by Sallau et al., [40]. Since saponification value is inversely proportional to the weight of the fatty acid present in the oil, it can be deduced that the oil extracted from *R. phoenicis* and *B. membranaceus*

contained glycerides with lower molecular weight fatty acids than those of palm oil, palm kernel oil and coconut oil [48-50].

The low-level acid value and free fatty acid and low peroxide values show that the oils from these insects have high stability to oxidation, an indication of their lower susceptibility to rancidity and lipase action. The low acid values also are a testimony to the freshness of the crude oil and suggest that these fatty acids are not degraded by processing stage. These parameters are a measure of the level of spoilage of oil [51].

Table 1. Chemical properties of oil extracted from *Rhynchophorusphoenicis* larva and *Brachytrupesmembranaceus*

Chemical properties	<i>Brachytrupesmembranaceus</i>	<i>Rhynchophorusphoenicis</i>
Oil content (%)	18.52 ± 0.12	60.92 ± 0.35
Acid value (mgKOH/g)	3.04 ± 0.06	3.25 ± 0.86
Free fatty acid (% as Oleic)	1.57 ± 0.01	1.62 ± 0.31
Wij's iodine value (g I ₂ /100g)	123.60 ± 1.00	101.50 ± 0.68
Saponification value (mgKOH/g)	180.30 ± 0.30	196.01 ± 2.76
Peroxide value (mEq O ₂ /Kg)	11.67 ± 0.20	8.25 ± 0.37

III.2. Fatty acid composition

Table 2 shows the fatty acid profile of the larva of *R. Phoenicis* and *B. membranaceus* oils. The major fatty acids present in *R. Phoenicis* oil are palmitic, oleic, linoleic and linolenic acid. Total saturated fatty acids account for 46.63% of the fat represented mainly by palmitic acid (38.97%) and stearic acid (5.00%). Unsaturated fatty acids constitute 53.68% of the total larva fatty acid and 47.57% of these are mono unsaturated. Oleic acid accounts for 88.61% of the monounsaturated fatty acid and has been shown to be hypocholesterolemic[52]. The larva contains 6.11% of polyunsaturated fatty acid, (linolenic acid, Linoleic Acid and arachidonic acid).

Table 2 Fatty acid composition of the larva of *R. phoenicis* and *B. membranaceus* oils

Fatty acid	Oil composition (g %)	
	<i>Rhynchophorusphoenicis</i>	<i>Brachytrupesmembranaceus</i>
Lauric acid (C12:0)	0.12 ± 0.03	–
Myristic acid (C14:0)	2.66 ± 0.00	4.80 ± 0.03
Pentadecylic acid (C15:00)	–	6.80 ± 0.04
Docosanedioic acid	–	6.41 ± 0.13
Palmitic acid (C16:0)	38.97 ± 0.04	11.98 ± 0.18
Palmitoleic acid (C16:1)	3.30 ± 0.20	6.58 ± 0.73
Stearic acid (C18:0)	5.00 ± 0.00	8.29 ± 0.63
Oleic acid (C18:1 n-9)	47.57 ± 0.40	10.60 ± 0.94
Linoleic acid (C18:2 n-6)	3.80 ± 0.00	2.25 ± 0.51
α-linolenic acid (C18:3 n-3)	0.80 ± 0.00	0.68 ± 0.53
γ-linolenic acid (C18:3 n-6)	2.03 ± 0.03	–
Arachidonic acid (C20:4 n-6)	1.20 ± 0.04	38.44 ± 1.54
Total saturated fatty acid (SFA)	46.63 ± 0.01	38.27 ± 1.67
Total unsaturated fatty acid (UFA)	53.68 ± 0.04	58.56 ± 1.10
Monounsaturated fatty acid (MUFA)	47.57 ± 0.02	17.19 ± 0.24
Polyunsaturated fatty acid (PUFA)	6.11 ± 0.14	41.37 ± 1.59
Omega-3 fatty acids	0.80 ± 0.00	39.12 ± 2.56
Omega-6 fatty acids	7.03 ± 0.15	2.25 ± 0.03
Σ PUFA /SFA	0.13 ± 0.13	1.08 ± 0.02

The fatty acid profile of the cricket oil in this study showed that the oil contains myristic (4.80%), stearic (11.98) palmitic (38.44) and stearic acid (11.98). Oleic (8.29) is the most dominant monounsaturated fatty acids (MUFA), while myristic (C14:0), palmitic (C16:0), and stearic (C18:0) are the dominant saturated fatty acids (SFA) while arachidonic acid is the dominant polyunsaturated fatty acid. The presence of both saturated and unsaturated fatty acids in given oil is advantageous since both seem to compliment the function of one another. These same fatty acids were

reported by Paiko et al., [53] in *B. membranaceus* but with different percentages. A PUFA/SFA ratio of 0.2 has been associated with high cholesterol level with high risk of coronary heart disorders, while a ratio as high as 0.8 is associated with desirable levels of cholesterol and reduced coronary heart diseases (Mann, 1993). The high UFA/SFA ratio, PUFA/SFA and omega-3 fatty acid in cricket oil compared to the larva oil clearly indicates the cholesterol lowering potential of cricket oil. PUFA/SFA ratio of 1.08 in *B. membranaceus* oil tends to suggest that this insect has the potential of being used in the dietetic management of certain coronary heart diseases. This result is very similar to the value of 1.70 observed by Akinnawo and Ketiku for *Cirinaforda*[55].

III.5.Rat bioassay

III.5.1.Feed consumption

Table 3 presents results obtained the weekly food consumed by rats for a period of 30days. There was no significant difference ($p > 0.05$) between the amount of food consumed in the acclimatization week between the control and the test groups, but during the experiment, a significant increase of the quantity of food was observed between weeks. There are a number of reasons for this variation; as an animal gets larger and big, the food requirements on a per kilogram body weight increase. Since body Weights and water and food Consumption rates per day/week are related. Peter et al., [56]obtained the similar results when working on pigs' productions.

Table 3 Weekly food consumed by rats

Parameters	Week 1	Week 2	Week 3
Control group (A)	15.34 ± 0.14 ^a	18.45 ± 0.14 ^a	24.80 ± 0.14 ^a
Test group (B) <i>Rhynchophorusphoenicis</i> larva oil	17.49 ± 2.30 ^a	19.76 ± 1.60 ^a	26.55 ± 2.51 ^a
Test group (C) <i>Brachytrupesmembranaceus</i> oil	18.00 ± 3.01 ^a	20.25 ± 0.01 ^a	24.4 ± 1.01 ^b

^{a,b} Different superscript letters in a row indicate statistical difference ($p < 0.05$) between the groups

III.5.2. Weekly weight gain of experimental rats

Table 4 presents results for weights of rats recorded on weekly basis for a period of 30days.No significant differences in weight gain was observed during the first, second and third weeks between the control and the test groups that received oral treatment with insect's oils. However, during the experimental phase as animals grew, daily feed intake increased.

Growing rats typically are self-feeders and can eat as much feed as they want since they were fed ad libitum. They adjusted their diet as they grew so that nutrients are supplied to match performance needs. That is why average weight gain is largely a result of feed intake. This same conclusion was reported by NRC, [57] when studying the nutrient requirement of different animals.

Table 4 Weekly weight gain

Parameters	Week 1	Week 2	Week 3
Control group (A)	21.80 ± 3.44 ^a	50.20 ± 1.26	70.67 ± 5.92 ^a
Test group (B) <i>Rhynchophorusphoenicis</i> larva oil	20.05 ± 4.24 ^a	49.01 ± 0.00 ^a	87.50 ± 14.85 ^a
Test Group (C) <i>Brachytrupesmembranaceus</i> oil	21.52 ± 1.64 ^a	46.90 ± 4.04 ^a	69.09 ± 6.67 ^a

III.5.3. Organ weight of rats

The table 5 shows the weight of organs between the three different rat groups after feeding with different diets for 30days. From table 5, the weight of the liver in the tests and control were observed to be significant ($p < 0.05$).

Table 5 Weight of organs

Rats groups	Liver	Kidney	Spleen
Control group (A)	6.20 ± 0.14 ^a	1.30 ± 0.42 ^a	0.35 ± 0.17 ^a
Test Group (B) <i>R. phoenicis</i> larva oil	7.95 ± 0.62 ^b	1.60 ± 0.64 ^a	0.45 ± 0.07 ^a
Test Group (C) <i>B. membranaceus</i> oil	6.10 ± 0.20 ^a	1.50 ± 0.14 ^a	0.47 ± 0.04 ^a

This result indicates that the liver in the test is larger than those of the control group; which could be due to the accumulation of fats around the liver causing it to have a weight increase. There was no significant increase ($p > 0.05$) in the weight of the kidney and spleen in the test groups relative to the control.

III.5.4. Biochemical parameters of experimental rats

Table 6 presents results obtained after feeding larva and cricket oil to rats. Results showed strong total cholesterol (TC), Triglyceride (TG) and low density lipoprotein (LDL) increasing effect on the test group that received larva oil. In the rats supplemented with the cricket oil, total serum cholesterol (TC) was the same with the control, Low density lipoprotein (LDL) and triglyceride (TG) decreased, while high density lipoprotein (HDL) increased as compared to the control group fed only with basal diet. The larva oil was noted to increase the serum TC, TG, LDL. The strong anticholesterol activity of cricket oil is because of ω -3 PUFAs, but it also contains ω -6 PUFAs, which are less active in lowering of blood lipid profile. The findings of this study were consistent with report by others. Nicolaysen and Regard [58] reported that dietary marine fish oil reduced blood cholesterol in the experimentally induced hypercholesterolemic rats. High level of serum cholesterol has been associated with risks of coronary heart disease [59-61].

Recently, anticholesterol effects of Hilsha fish oil were also reported in streptozotocin-treated diabetic rats [62]. Fish oil containing ω -3 PUFA is found to inhibit the activity of 3-hydroxy-3-methyl-glutaryl-CoA reductase (HMG-CoA reductase), which is the rate-limiting enzyme in cholesterol biosynthesis [63]. Kobatake et al., [64] reported that docosahexaenoic acid (ω -6 PUFA) is more effective in lowering serum cholesterol level of experimentally induced hypercholesterolemic. Oil obtained from palm weevil contains high level of saturated fatty acids with higher risk and predisposition to cardiovascular diseases [65]. The ratio of polyunsaturated to saturated fatty acid as well as HDL/LDL has been widely used to indicate the cholesterol lowering effect of a potential food (Mann, 1993). This ratio in palm weevil tends to suggest that this insect larva doesn't have the potential of being used in the management of certain coronary heart diseases associated with hyperlipidemia and diabetes.

Alanine aminotransferase (ALAT) and aspartate aminotransferase (ASAT) in addition to serum cholesterol and triglyceride are demonstrated to be constituent of some tissues (liver, kidneys, heart, adipose tissue, aorta and skeletal muscles etc). Damage to these tissues could result in leakage of these enzymes into the bloodstream. The observed high activities of ALAT and ASAT in the serum of rats fed with palm weevil larva oil could be as a result of the possible damage. A contrary result was obtained with the cricket, demonstrating the role of linoleic acid in maintaining cellular integrity. These results were found to be consistent with previous studies carried out on oils with high levels of unsaturated fatty acid. In Iran the hypolipidemic effect of fish oil (which has high level of unsaturated fatty acids) has been shown by Mahdi et al. [66].

Table 6. Transaminase concentration and serum lipid profile of rats

Parameters	Group A	Group B	Group C
Total cholesterol (mg/dL)	34.67 ± 38.30 ^a	91.59 ± 27.74 ^b	29.64 ± 2.37 ^a
Triglyceride (mg/dL)	96.23 ± 0.29 ^a	233.77 ± 40.27 ^c	118.12 ± 85.83 ^b
High-Density Lipoprotein (mg/dL)	80.83 ± 17.95 ^a	42.18 ± 3.11 ^b	98.58 ± 14.39 ^a
Low Density Lipoprotein (mg/dL)	32.90 ± 0.003 ^a	58.69 ± 0.00 ^c	30.55 ± 12.21 ^a
High-Density Lipoprotein / Low Density Lipoprotein	2.52 ± 0.001 ^a	0.72 ± 0.12 ^b	3.22 ± 0.23 ^a
Aspartate aminotransferase (ASAT)	173.25 ± 2.48 ^a	461.20 ± 7.34 ^b	134.50 ± 36.29 ^a
Alanine amino-transferase (ALAT)	22.75 ± 14.85 ^a	75.00 ± 8.89 ^b	35.43 ± 7.34 ^a

Data are presented as mean \pm SD; All the administered dose were 1.0 ml/kg day; ^{a,b,c} Values with different superscript on a same line are significantly different from the control at $p < 0.05$; A, B and C, are the different groups of rats; A : control group; B: Test group receiving *R. Phoenicis* oil; B: Test group receiving *B. membranaceus* oil.

The polyunsaturated fatty acid in cricket (*B. membranaceus*) oil compared to the larva oil as well as its cholesterol lowering properties in-vivo clearly indicates the cholesterol lowering potential of cricket oil. This tends to suggest that insect's oils have the potential of being used in the dietetic management of certain coronary heart diseases. Edible insects may be an alternative dietary source of essential fatty acids.

IV. CONCLUSION

The results of the present study suggest that consumption of *B. membranaceus* may help improve serum lipid profile and, in addition, positively mitigate the attendant adverse atherosclerosis following a high-fat diet, thus improving cardiovascular health. The current study concluded that consumption of local *B. membranaceus* oil normalise the blood lipid profiles, body weight gain percentage, and feed efficiency ratio as compared to *R. Phoenicis* oil. *R. Phoenicis* oil increase the plasma lipid profile that may precipitated to high risk of cardiovascular disease. *B. membranaceus* are riched in polyunsaturated fatty acids, and PUFA have been found to facilitate lipid transportation and metabolism, utilization of oils containing more unsaturated fatty acids like *B. membranaceus*oil is therefore recommended to reduce the risk of developing cardiovascular diseases.

Ethics Statements

This study was approved by the ethics committee of the Faculty of Science, Department of Biology and Plant Physiology, University of Buea. (Approval no. 2016/312UB/FS/FO/EC).

Conflict of interest

The authors have not declared any conflict of interests.

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