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Amino Acids Profile Of Two Edible Insect Larvae In South Southern Nigeria: *Rhynchophorus phoenicis* Fabricius (1801) And *Oryctes owariensis* Beavois (1809)

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ABSTRACT
The above study investigated the Amino acids content of both edible insect larvae of *Rhynchophorus phoenicis* and *Oryctes owariensis* by laboratory analysis. A total of 100 fresh larvae respectively from each insect were used for the bioassay. Amino acids and proteins are the building blocks of life. Amino acids are the results of protein digestion, are used to synthesis protein and other nitrogenous compounds by the human body, break down food for growth and repair of body tissues. All classes of Amino acids were confirmed such as: Essential Amino acids examples Histidine, Lysine and Leucine. Nonessential Amino acids included Alanine and Serine. While Conditional Amino acids present were Glutamine, Glycine, Tyrosine and Arginine. When compared, *R. phoenicis* had higher Amino acids content for Glycine 4.77mg/100g; Tyrosine 6.33mg/100g and Alanine 8.25mg/100g. *O. owariensis* values were high for Leucine 6.66mg/100g; Valine 7.70mg/100g; Arginine 8.43mg/100g; Lysine 7.29mg/100g; Glutamine 8.25mg/100g and Histidine 3.18mg/100g for the fresh samples. Regarding the dried samples, *R. phoenicis* was high for Tyrosine 5.5mg/100g, Valine 5.35mg/100g; Alanine 6.66mg/100g and Glycine 5.85mg/100g. *O. owariensis* value was higher for Leucine 4.19mg/100g; Glycine 5.29mg/100g; Arginine 5.46mg/100g; Lysine 4.87mg/100g; Serine 3.33mg/100g and Histidine 1.61mg/100g. The grubs were reportedly rich in amino acids essential to the wellbeing of humans in trace to high amounts. Hence, are recommended as food supplement for incorporation in human daily meals as alternative sources to protein especially in these prevailing times of food scarcity.
Keywords: *Rhynchophorus phoenicis, Oryctes owariensis*, Amino acids, Histidine, Alanine, Supplement.

1. INTRODUCTION

According to reports, insects are crucial to human nutrition and help prevent food shortages (Bodenheimer, 1951; Ramos-elorduy et al., 1997). Insects and their products are significant as high-

nutrient alternative food sources, according to several research reports (Van Huis et al., 2013a and b). Both the larvae of *Rhynchophorus phoenicis* and *Oryctes owariensis* are accepted and eaten as delicacy by all and sundry in Southern Nigeria (Ukoroije and Bobmanuel, 2019a; 2019b). They are harvested from the wild, roasted and sold at markets and on the streets (Ekpo and Onigbinde, 2009).

In South South and South Western Nigeria, *Rhynchophorus phoenicis*, popularly known as red palm weevil, is one of the edible bug species that is widely recognized and commercialized. The grubs are cherished as food and regarded as good quality source of protein (Edijala *et al*., 2009). Nodu (2013) reported that humans in Bayelsa State were consuming palm weevil larvae (*Rhynchophorus* species) as an additional source of protein in their meals. From Senegal to Ethiopia, Nigeria, and South Africa, this species is widely dispersed throughout tropical and equatorial Africa. They are established as been destructive to palms basically oil palm.

Oryctes owariensis larvae have been reported to have high nutritional content and widely accepted as special cuisine by the people (both rural and urban dwellers). The third instar stage of the larvae, when they have soft and nourishing body tissue, is when they are typically hunted (Ukoroije and Bobmanuel, 2019a). Banjo *et al*., (2006) reported that the larvae are eaten as normal diet in seasons of abundance all year round in the west and central Africa as against the backdrop of being an emergency food against starvation. They are reportedly destructive insect pest of palms mainly Raphia, oil and coconut palms (Ramachandran *et al*., 1963; Bedford, 1980a and 1980b). Others include banana, sugarcane, pawpaw, sisal and pineapple (Manjeri *et al*; 2013). The larval stages though destructive to palms, have become known desired delicacy in both the South South and South western regions of Nigeria and notable in parts of the world (Mishra and Omkar, 2017).

Insects either directly or indirectly offer high-quality food to humans since digested proteins are readily created from insect structures, contributing to the world's scarce number of proteins and lipids (Fasoranti and Ajiboye, 1993). According to Defoliart, (1988, 1989, 1991, 2002), indigenous populations of most third world countries experiencing protein scarcity, consume about thirty different species of insects since proven to be higher in proteins and fat content than plants. According to Fasoranti and Ajiboye (1993), many Nigerian rural residents eat palm weevil grubs as a main source of protein. This suggests that mass growing techniques for the insects should be developed for both dietary and commercial purposes. Chaney (2006) reports that the crude the protein level of *R. phoenicis* grub is greater than that of cow milk, termites, meat, and eggs, suggesting that the grub diet can substantially meet the 25–56g of protein that humans require daily. McGilvery and Goldstein (1983) also noted that the grubs are high in trace to high levels of amino acids, including phenylalanine, histidine, and methionine, which are vital to human health.

Through the formation of peptide bonds, amino acids unite to form proteins. They share a carbon atom with both amino and carboxylic acid molecules, along with a variety of side chains. It is also regarded as an organic substance having both an amino and a carboxylic acid functional group, according to the Oxford Dictionary. Medical Biochemistry (2022) states that amino acids and other nitrogenous chemicals are primarily utilized by the body as building blocks to create proteins. Amino acids and proteins are the building blocks of all living organisms. Amino acids are produced as by-products of protein metabolism and are used by the body to synthesize proteins for wound healing, tissue growth, and food digestion (Medline-Plus, 2023).

According to Maloy (2013), proteins were polymers with a constant peptide bond for the backbone and changeable side chains, or the "R" side chains of amino acids. Twenty Conventional amino acids can be identified in proteins and constitute the amino acids that are written down by the genetic code. Based on the orientation or electric charge distribution of the "R" group (side chain), they are categorized as standard. The main categories into which standard amino acids fall are as follows: Aspartate and glutamate are examples of acidic amino acids; Histidine, Lysine, and Arginine are examples of basic amino acids; Asparagine and glutamine are examples of hydrophilic amino acids; Glycine, Alanine, Serine, Threonine, Cysteine, Proline, Tryptophan, and Tyrosine are examples of intermediate amino

acids; and Phenylalanine, Methionine, Isoleucine, Leucine, and Valine are examples of hydrophobic amino acids (Veilan and Shih, 2003).

Amino acids are essential for carrying out a number of biological and chemical processes in many body sections, including tissue growth and repair, the breakdown of food, the synthesis and activity of enzymes, particle transport, and more. Only a limited number of amino acids are synthesised by human body; the remaining amino acids, known as essential amino acids, must be obtained from our regular diets in the form of meals high in protein. Foods made from plants such as broccoli, beans, beets, dry fruits, chia seeds, oats, pumpkin, cabbage, almonds, peas, carrots, cucumber, green leafy vegetables, onions, soybeans, whole grains, peanuts, legumes, and lentils are some examples of foods high in amino acids. Apples, bananas, berries, figs, grapes, melons, oranges, papaya, pineapple, and pomegranates are among the fruits high in amino acids. Dairy products, poultry, meat, eggs, seafood, and pork are examples of additional animal products.

Living cells synthesize amino acids from various primary metabolites; but, since most vertebrates, including humans, are unable to manufacture most amino acids, they must get them from their food. Nonstandard amino acids are those that are present in other compounds, such as peptides, or in the metabolic processes of cells, but are absent from proteins. These can be discovered in the proteins that bacteria and other microbes make. They can be created synthetically in a lab, found in natural materials, or made artificially. Examples include pyrolysine, which is necessary for controlling the expression of genes, and selenocysteine, which is utilized to produce proteins that contain selenium (Infinitylearn, 2024). Cystine, Desmosine, Isodesmosine, Hudroxyproline, and Hydroxylysine are further examples. According to Encyclopaedia Britannica (2013), nonstandard amino acids are essentially standard amino acids that have undergone chemical modification after being integrated into proteins.

Essential amino acids, nonessential amino acids, and conditional amino acids are the three main categories of amino acids. Diets high in protein can provide essential amino acids, which are amino acids that must come from food sources (Willis and Sinskey, 2001). There are nine of them that the human body is incapable of producing. The following are some examples: valine, phenylalanine, histidine, isoleucine, leucine, lysine, methionine, and tryptophan. The eleven amino acids known as non-essential amino acids are those that the body produces on its own, and they include arginine, aspartic acid, glutamine, proline, serine, and tyrosine. These are only essential in times of stress and illness. They are seven in total including Arginine, Cysteine, Glutamine, Tyrosine, Glycine, Prolinr and Serine (Medline-Plus, 2023). This study seeks to explore the amino acids profile of both insect grubs and to compare which is of higher value.

Plate 1. *O owariensis* larvae; source: Authors

Plate 2. *R. phoenicis* grubs; source: Authors

2. MATERIALS AND METHODS

Collection, Preparation and analysis of *O. owariensis* larvae samples

The larvae of *Oryctes owariensis* and *Rhynchophorus phoenicis* were harvested from the wild, respectively from raphia and oil palms here in Bayelsa State. They were transported in a crumb of dead trunks of raphia palms to the laboratory. The species were identified and killed by asphyxiation. Employing the methods of Womeni *et al*., 2012, fresh larvae (1 kg) were cleaned using distilled water, digested and stored for 24 hours. Others were digested in a porcelain mortar and dried at 50°C for 48 hours to produce a rough, semi-solid shape. Using concentrated sulfuric acid (5 milliliters of concentrated H2SO4) to digest 0.5 grams of the samples and micro Kjedahl (1.5 grams of CuSO4 and 1.5 grams of Na2SO4) as a catalyst, the protein composition was ascertained (AOAC, 2000). After cooling, the digest was treated with 10ml of 40% sodium hydroxide (NaOH), diluted with distilled water, and then distilled using a Kjedahl distillation flash. Titrimetric analysis was used to assess the total nitrogen content of the ammonia that had been freed and collected in a flash holding 10ml of a 5% boric acid solution. 6.25 gravimetric coefficient for protein was used to calculate the proportion of protein in the samples.

According to a prior publication by Benitez (1989), the amino acid profile in the known samples of digested fresh and dried *R. phoenicis* and *O. owariensis* was identified. In summary, 4 g of the dried sample were defatted in a chloroform/methanol (ratio of 2:1) for 15 hours after 10 g of the sample had been dried to constant weight (AOAC 1999). A glass ampoule was filled with two grams of the defatted material and seven milliliters of 6N HCL. This was heated for 22 hours at 105±5°C in an oven that was pre-set. The residue was dissolved in 5 milliliters of acetate buffer (pH 2.0) after the hydrolysate was vacuum-dried to dryness at 40°C. The Technicon Sequential Multi-Sample (TSM) Amino Acid Analyzer (Technicon Instruments Corporation, Dublin, Ireland) was filled with ten microliters of hydrolysate. The 76-minute analysis was completed. For every amino acid, the approximate area of each peak on the chromatogram was found. The formula NE = (Area of norleucine peak/area of each amino acid) was used to determine the Norleucine Equivalency (NE) for each amino acid in the standard mixture. For every amino acid in the standard mixture, a constant S was determined as follows: Sstd = NEstd × molecular weight × µM AAstd, where AA stands for amino acid. Next, the following formula was used to determine each amino acid's concentration in g/100g of protein in the sample:

Concentration (g/100 g protein) = Sstd x C x NH (width at NH/2).

Dilution factor x 16/sample weight (g) x N% x 10 x volume loaded)/(NH x W) is the formula for Conc. N% is the proportion of nitrogen in the sample as ascertained by the Kjedhal method, W is the width at half the height of the peak, NH is the net height of the peak, and Nor is norleucine.

Statistical Analysis

Experiments were replicated thrice and results obtained were statistically analysed using SPSS version 24 and expressed in mg/100g of mean values.

3. RESULTS AND DISCUSSION

Laboratory analysis of both samples revealed the presence of the underlisted 10 Amino acids: Leucine (Leu), Glycine (Gly), Tyrosine (Tyr), Valine (Val), Arginine (Arg), Lysine (Lys), Alanine (Ala), Serine (Ser), Glutamine (Glu) and Histidine (His).

Table 1: Amino acids present in both *R. phoenicis* and *O. owariensis* grubs.

Amino acids	Symbol
Leucine	Leu
Glycine	Gly
Tyrosine	Tyr
Valine	Val
Arginine	Arg
Lysine	Lys
Alanine	Ala
Serine	Ser
Glutamine	Glu
Histidine	His

The listed Amino acids were found present in samples of R. phoenicis. Samples were replicated thrice and results expressed in mg/100g.

Table 2: Amino acid profile of *R. phoenicis* grubs

R. phoenicis	Leu (mg/100g)	Gly (mg/100g)	Tyr (mg/100g)	Val (mg/100g)	Arg (mg/100g)	Lys (mg/100g)	Ala (mg/100g)	Ser (mg/100g)	Glu (mg/100g)	His (mg/100g)
Fresh	5.36	5.09	5.83	6.34	2.56	4.81	8.75	2.78	7.98	0.56
	5.01	4.36	5.16	6.71	2.13	4.95	7.05	3.01	7.84	1.27
	4.38	4.87	8.01	5.15	2.45	4.63	8.95	3.57	7.54	1.67
	4.92±0.3[a]	4.77±0.2[a]	6.33±0.9[a]	6.07±0.5[a]	2.38±0.1[a]	4.80±0.1[a]	8.25±0.6[a]	3.12±0.2[a]	7.78±0.1[a]	1.17±0.3[a]
Dried	3.25	4.01	6.12	5.02	2.01	4.05	6.58	2.00	5.81	0.07
	3.06	4.00	6.31	5.66	2.00	2.82	6.39	2.04	5.63	1.00
	3.52	3.81	4.21	5.38	1.36	3.17	7.01	2.17	6.11	1.12
	3.28±0.1[a]	3.94±0.1[a]	5.55±0.7[a]	5.35±0.2[a]	1.79±0.2[a]	3.35±0.4[a]	6.66±0.2[a]	2.07±0.1[a]	5.85±0.1[a]	0.73±0.3[a]

Different superscript indicates significant variation ($p<0.05$). There was difference between the fresh and dried ***R. phoenicis*** but not significant at $p<0.05$.

The listed Amino acids were found present in samples of *O. owariensis*. Samples were replicated thrice and results expressed in mg/100g.

Table 3: Amino acid profile of *O. owariensis* larvae

O. owariensis	Leu (mg/100g)	Gly (mg/100g)	Tyr (mg/100g)	Val (mg/100g)	Arg (mg/100g)	Lys (mg/100g)	Ala (mg/100g)	Ser (mg/100g)	Glu (mg/100g)	His (mg/100g)
Fresh	6.78	3.76	4.67	6.89	7.85	6.71	5.56	4.38	7.81	3.45
	6.56	3.64	4.81	7.76	8.91	7.67	6.70	4.31	8.92	3.02
	6.67	3.58	4.16	8.45	8.54	7.48	5.81	4.56	8.01	3.06
MN±S.E	6.67 ± 0.1^{b}	3.66 ± 0.1^{b}	4.55 ± 0.2^{b}	7.70 ± 0.5^{b}	8.43 ± 0.3^{b}	7.29 ± 0.3^{b}	6.02 ± 0.3^{b}	4.41 ± 0.1^{b}	8.25 ± 0.3^{b}	3.18 ± 0.1^{b}
Dried	4.01	2.46	1.44	3.78	5.76	4.91	3.81	4.02	5.08	1.46
	4.06	1.38	2.01	4.45	5.61	4.98	5.55	4.00	6.10	0.87
	4.51	1.45	2.46	3.61	5.02	4.73	5.81	3.56	5.32	2.51
MN±S.E	4.19 ± 0.2^{b}	5.29 ± 0.3^{b}	1.97 ± 0.3^{b}	3.95 ± 0.3^{b}	5.46 ± 0.2^{b}	4.87 ± 0.1^{b}	5.06 ± 0.6^{b}	3.86 ± 0.2^{b}	5.50 ± 0.3^{b}	1.61 ± 0.5^{b}

Different superscript indicates significant variation ($p<0.05$). There was a difference between the fresh and dried ***O. owariensis*** but not significant at $p<0.05$.

Table 4: Amino acid profile of fresh *R. phoenicis* and *O. Owariensis* grubs.

Sample	Leu (mg/100g)	Gly (mg/100g)	Tyr (mg/100g)	Val (mg/100g)	Arg (mg/100g)	Lys (mg/100g)	Ala (mg/100g)	Ser (mg/100g)	Glu (mg/100g)	His (mg/100g)
Fresh *R. phoenicis*	5.36	5.09	5.83	6.34	2.56	4.81	8.75	2.78	7.98	0.56
	5.01	4.36	5.16	6.71	2.13	4.95	7.05	3.01	7.84	1.27
	4.38	4.87	8.01	5.15	2.45	4.63	8.95	3.57	7.54	1.67
	4.92 ± 0.3^{a}	4.77 ± 0.2^{a}	6.33 ± 0.9^{a}	6.07 ± 0.5^{a}	2.38 ± 0.1^{a}	4.80 ± 0.1^{a}	8.25 ± 0.6^{a}	3.12 ± 0.2^{a}	7.78 ± 0.1^{a}	1.17 ± 0.3^{a}
Fresh *O. owariensis*	6.78	3.76	4.67	6.89	7.85	6.71	5.56	4.38	7.81	3.45
	6.56	3.64	4.81	7.76	8.91	7.67	6.70	4.31	8.92	3.02
	6.67	3.58	4.16	8.45	8.54	7.48	5.81	4.56	8.01	3.06
MN±S.E	6.67 ± 0.1^{b}	3.66 ± 0.1^{b}	4.55 ± 0.2^{b}	7.70 ± 0.5^{b}	8.43 ± 0.3^{b}	7.29 ± 0.3^{b}	6.02 ± 0.3^{b}	4.41 ± 0.1^{b}	8.25 ± 0.3^{b}	3.18 ± 0.1^{b}

Different superscript indicates significant variation ($p<0.05$). There was a difference between the fresh grubs of ***R. phoenicis*** and ***O. owariensis*** but not significant at $p<0.05$.

Table 5: Amino acid profile of dried *R. phoenicis* and *O. Owariensis* grubs

Samples	Leu (mg/100g)	Gly (mg/100g)	Tyr (mg/100g)	Val (mg/100g)	Arg (mg/100g)	Lys (mg/100g)	Ala (mg/100g)	Ser (mg/100g)	Glu (mg/100g)	His (mg/100g)
Dried *R. phoenicis*	3.25	4.01	6.12	5.02	2.01	4.05	6.58	2.00	5.81	0.07
	3.06	4.00	6.31	5.66	2.00	2.82	6.39	2.04	5.63	1.00
	3.52	3.81	4.21	5.38	1.36	3.17	7.01	2.17	6.11	1.12
MN±S.E	3.28 ± 0.1^{a}	3.94 ± 0.1^{a}	5.55 ± 0.7^{a}	5.35 ± 0.2^{a}	1.79 ± 0.2^{a}	3.35 ± 0.4^{a}	6.66 ± 0.2^{a}	2.07 ± 0.1^{a}	5.85 ± 0.1^{a}	0.73 ± 0.3^{a}
Dried *O. owariensis*	4.01	2.46	1.44	3.78	5.76	4.91	3.81	4.02	5.08	1.46
	4.06	1.38	2.01	4.45	5.61	4.98	5.55	4.00	6.10	0.87
	4.51	1.45	2.46	3.61	5.02	4.73	5.81	3.56	5.32	2.51
MN±S.E	4.19 ± 0.2^{b}	5.29 ± 0.3^{b}	1.97 ± 0.3^{b}	3.95 ± 0.3^{b}	5.46 ± 0.2^{b}	4.87 ± 0.1^{b}	5.06 ± 0.6^{b}	3.86 ± 0.2^{b}	5.50 ± 0.3^{b}	1.61 ± 0.5^{b}

Different superscript indicates significant variation ($p<0.05$). There was a difference between the fresh grubs of ***R. phoenicis*** and ***O. owariensis*** but not significant at $p<0.05$.

Sixteen percent of proteins are made up of amino acids. The body needs amino acids to synthesize proteins as well as other essential nitrogen-containing substances like creatine, peptide hormones, and some neurotransmitters (NIH, 1989). The people of South Southern Nigeria are well-aware of the edible insect larvae stages and firmly believe that the grubs possess excellent nutritional and therapeutic value. The study revealed the presence of ten amino acids which constitute all the three classes of Amino acids in both *R. phoenicis* and *O. owariensis* grubs. Essential amino acids include Leucine (Leu), Valine (Val), Lysine (Lys) and Histidine (His). Nonessential amino acids are Alanine (Ala) and Serine (Ser). While the Conditional amino acids are Glutamine (Glu), Glycine (Gly), Tyrosine (Tyr) and Arginine (Arg). The information above is consistent with the findings of McGilvery and Goldstein's (1983) report, which found that the grubs contained 18 recognized amino acids, including methionine, histidine, valine, lysine, and phenylalanine, in trace to high levels. These amino acids are important for human health.

One cannot overstate the roles that amino acids play in the human body.

One of the three branched-chain amino acids (BCAA) that is essential for protein synthesis and muscle repair is leucine, along with valine. In addition, it promotes wound healing, helps control blood sugar levels, and generates growth hormones. Additionally, Kubala (2023) states that it promotes the synthesis of proteins.

Kubala (2023) states that lysine is essential for the development and fixing of calcium in bones as well as for the construction and synthesis of hormones, enzymes, and antibodies. Lysine is essential for both the production of proteins and the absorption of calcium. It's also critical for the synthesis of collagen and elastin, energy, and the immune system.

Histidine is essential for numerous enzymatic reactions as well as the production of leukocytes, which are white blood cells, and erythrocytes, which are red blood cells. Histamine is a neurotransmitter that is essential for immunological response, digestion, sexual function, and sleep-wake cycles. The body makes histamine from histidine. It's essential for preserving the nerve cells' protective covering, the myelin sheath. Although it has recently been shown that adults also need histidine, it is an essential amino acid for babies (Cho et al., 1984; Kopple and Swendseid, 1981).

As one of the three branched-chain amino acid groups (BCAAs), valine's molecular structure has a chain that branches off to one side. In addition to its role in energy production, valine stimulates and promotes muscle development and repair BYJUS, (2019).

In addition to aiding in the synthesis of glucose along with other amino acids, alanyl extracts poisons from our bodies. It provides an energy source for muscular and the brain and breaks breakdown

tryptophan and vitamin B6 (Health Encyclopedia, 2024). It boosts immunity, keeps blood sugar levels from falling too low (hypoglycemia), and aids in the body's use of sugar. It is utilized as an addition in food and medicine.

Serine aids in the production of immune system proteins and the development of muscle. Numerous physiological processes, such as protein synthesis, neurotransmission, the folate and methionine cycles, and the formation of sphingolipids, phospholipids, and sulfur-containing amino acids, depend on L-serine (Ye et al., 2021). The synthesis of the body's proteins, enzymes, and muscle tissue depends on serine. The correct metabolism of lipids and fatty acids requires serine. It aids in the synthesis of antibodies as well. Several cosmetics and skin care products contain serine as a natural moisturizing ingredient DrugBank, (2022). L-serine may have neuroprotective effects on neurological injury by promoting remyelination, improving cerebral blood flow, reducing inflammation, and recovering cognitive function in the brain under certain neuropathological conditions, according to mounting evidence (NIH, 2022). By activating the glycine receptor, L-serine also lessens neurotoxicity and prevents the production of inflammatory factors. L-serine has been shown to open up potassium and calcium channels on endothelial cells in an ischemic brain damage model, increasing cerebral blood flow in the affected area Ye et al., (2021).

In addition to supporting normal brain function, glutamine is required for the creation of DNA and RNA, two nucleic acids. There are many uses for glutamine, such as: protein synthesis substrate, anabolic precursor for muscle growth, kidney acid-base balance, liver ureogenesis substrate, hepatic and renal gluconeogenesis substrate, oxidative fuel for the intestine and immune system cells, inter-organ nitrogen transport, neurotransmitter synthesis precursor, nucleotide and nucleic acid synthesis precursor, and glutathione production precursor (Newsholme, et al., 2022). The functions of glutamine are related to the production of glutamate from glutamine.

Glycine plays a critical part in wound healing and aids in maintaining healthy cell growth and function. It has neurotransmitter properties. Furthermore, some amino acids—like arginine and glycine—are deemed conditionally essential during pregnancy because pregnant women require higher concentrations of these amino acids to maintain both their own and the fetus's health.

Arginine aids in wound healing, kidney detoxification, immune system maintenance, and the creation of proteins and hormones. Although it is seen as unnecessary, the body can't produce as much of it as needed when recovering from a significant injury or battling certain illnesses, like cancer. Arginine synthesis may not be sufficient for the urea cycle to work as it should when arginine is present in modest amounts compared to other amino acids (e.g., in intravenous solutions or amino acid combinations) or when liver function is impaired (Heird et al., 1972). To meet the body's needs, people take supplements containing arginine.

Tyrosine is essential for the synthesis of a class of neurotransmitters, the thyroid hormones T3 and T4, and melanin, the pigment that naturally occurs in our skin, hair, and eyes. Amino acids like cystine and tyrosine, which are typically not necessary, might become so under certain conditions (such as in premature infants or individuals with liver injury) due to defective conversion from their precursors (Horowitz et al., 1981).

In order to keep our bodies functioning properly and in good health, it is crucial that we incorporate all nine essential amino acids into our daily diet. A lack of amino acids can cause a variety of clinical conditions, such as anemia, sleeplessness, edema, diarrhea, hypoglycemia, appetite loss, hepatic fat accumulation, and hair loss in both children and adults. Pyke (1979) states that if the larva is dehydrated and defatted, the protein content of *R. phoenicis* grub can be comparable to that of most traditional protein sources, making it a useful tool in the fight against protein insufficiency. This demands that this edible grub be cultivated using cutting-edge scientific techniques in order to significantly reduce the general population's reliance on non-conventional protein sources FAO/WHO/UNU, (1991).

CONCLUSION

Insects contribute to the world's limited supply of proteins and lipids by processing their tissues more quickly than other plant tissues. This means that insects either directly or indirectly give humans high-

quality food (Fasoranti and Ajiboye, 1993). For this reason, these grubs must be consumed in addition to your usual protein consumption.

AUTHOR CONTRIBUTION

The work was conceptualized, planned, and overseen by URB and ORA. The literature search and manuscript writing were assisted by AG and URB. The manuscript was created by URB, while the data analysis and editing were completed by ORA. Each author accepted the submitted version of the paper and made contributions to it.

CONFLICT OF INTEREST

The research was carried out without any financial or commercial ties that might be seen as having a conflict of interest, the authors disclose.

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