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Evaluation of soybean stinkbug (*Riptortus pedestris*) powder, as a food ingredient and its nutritional composition

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Abstract: *Riptortus pedestris* is a potential edible insect, and its powder can be considered as an ideal nutrient source. This study sought to determine the nutritive quality of the powder from *Riptortus pedestris*. The protein and crude fat content of dried *R. pedestris* powder were 77.61 g 100 g^{-1} and 18.01 g 100 g^{-1}, respectively. It contained 18 amino acids and 6 fatty acids comparable to eggs and soybean. The total essential amino acid contents could meet the requirement of preschool children and adults. The unsaturated fatty acid content in *R. pedestris* powder was comparatively more than saturated fatty acid content. Essential unsaturated fatty acids content, especially linoleic acid, was quite high than egg or some other edible stinkbugs. Additionally, *R. pedestris* powder was rich in various mineral substances, and the macro-element and micro-element contents were more balanced than other edible stinkbugs. These results suggest that *R. pedestris* powder could be a highly nutritious, alternative novel nutrition source for humans.

Keywords: edible insect; nutrition; insect use; entomophagy

With the emerging world population and human welfare demand, the study of novel food source utilisation has great significance (Belluco et al. 2017; Pali-Schll et al. 2019). The source of nutrition for humans should be safe, nutritious, palatable, and acceptable to consumers (Poma et al. 2017; Gier and Verhoeckx 2018). The potential of edible insects as a new ingredient has been studied over the last few decades (van Huis 2020; Gorbunova and Zakharov 2021). The Food and Agriculture Organization of the United Nations (FAO) has proposed that edible insects could play an important role in improving global food and nutrition security due to being rich in protein and oil content and reasonable composition of amino acids and fatty acids (Mutungi et al. 2017; Lucas et al. 2020; D'Antonio et al. 2021; Ghosh et al. 2021). It could also satisfy the present and future food needs of humans (Xia et al. 2013; Kouřimská et al. 2020). According to Han et al. (2017), the global market value of edible insects would exceed

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USD 522 million by 2023. Entomophagy has a long history in many parts of the world (Bartkowicz and Babicz-Zielińska 2020). Caterpillars, beetles, bees, wasps, grasshoppers, crickets, stinkbugs, ants, and flies are the most commonly consumed insects (Chen et al. 2009; Feng et al. 2018; Hlongwane et al. 2021). The stinkbugs are one of the three groups frequently consumed in Hemiptera (Nowak et al. 2016; Feng et al. 2018). Due to the toxicity assessment data remaining incomprehensive, their safety evaluations need further analysis (Gao et al. 2018; Noh et al. 2018; Alves et al. 2019). So far, several stinkbugs have been determined for nutrition, including *Aspongopus chinensis*, *Cyclopelta parva*, *Dolycoris baccarum*, *Encosternum delegorguei*, *Eurostus validus*, *Eusthenes saevus*, *Lethocerus indicus*, *Mictis tenebrosa*, *Monosteria unicostata*, *Halyomorpha picus*, *Sphaerodema rustica*, *Tessaratoma papillosa*, *Urochela luteovaria* originated from South Africa, North America, and Asia with the custom of eating stinkbugs (Feng et al. 2000; Ozlem et al. 2007; Chen et al. 2009; Li and Li 2010; Ma 2012; Melo-Ruíz et al. 2016; Musundire et al. 2016; Feng et al. 2020). *Riptortus pedestris* Fabricius, belonging to the family Alydidae (Hemiptera), is widely distributed in East Asia and South-East Asia. It is a potentially nutritious edible insect that usually grows on pods and leaves of legumes (Lim 2013; Li et al. 2021). However, the nutritional composition of *R. pedestris* powder is still unknown. The objective of the present study was to evaluate the protein, essential amino acid, and minerals contents of powder from adults *R. pedestris*. The study results might provide insights into the use of *R. pedestris* as a novel food ingredient.

MATERIAL AND METHODS

Preparation of *R. pedestris*

R. pedestris were collected from Guizhou Province of China (26°30'15" N, 106°39'19" E). The colonies were continuously reared in nylon mesh cages (45 × 45 × 45 cm), fed with soybean grown in pots as food and refreshed every 2 or 3 days when needed. The colonies were maintained at 25 ± 1 °C, 65 ± 5% RH (relative humidity), and a 16 : 8 h L : D (light : dark) photoperiod. Then, the sub-cultured adults were collected and frozen in a –4 °C refrigerator (BCD-206TM; Midea Group Co. Ltd., China) when alive. The powder sample was pulverised, sealed, and stored in a –20 °C refrigerator.

Nutritional composition analyses

Basal components determination. Basal components, including moisture, protein, oil, ash, reducing sugar (glucose), and other ingredients, were detected according to the method of Codex Committee on Methods of Analysis and Sampling (CCMAS, CXS 234-1999, 1999).

Moisture: 5 g of the sample powder was placed in an electric constant temperature drying oven (BPZ-6033; JeioTech Co., Ltd, Korea) dried for 4 h, then weighed, and repeated twice until the weight remains the same. The moisture content was calculated as follows (Equation 1):

$$X_1 = \frac{m_1 - m_2}{m_1 - m_3} \times 100\% \tag{1}$$

where: X_1 – moisture content (g 100 g^{-1}); m_1 – quality of crucible and sample; m_2 – quality of dry crucible and sample; m_3 – quality of crucible.

Crude fat: The sample was directly extracted with petroleum ether, the solvent was removed by evaporation, and the free fat content was obtained by drying. The crude fat content X_2 was calculated as follows (Equation 2):

$$X_2 = \frac{m_1 - m_0}{m_2} \times 100\% \tag{2}$$

where: X_2 – crude fat content (g 100 g^{-1}); m_0 – quality of receiving bottle; m_1 – quality of receiving bottle and fat after at a constant weight; m_2 – quality of the sample.

Protein: Protein content was determined by the Micro-Kjeldahl method. Briefly, the protein was broken down under the condition of catalytic heating, and the ammonia produced combined with sulfuric acid to form ammonium sulfate. Ammonia was dissociated by alkalisation distillation and titrated with 0.05 M sulfuric acid standard solution after absorption with boric acid (20 g L^{-1}). The protein content X_3 was calculated as follows (Equation 3):

$$X_3 = \frac{(C - C_0) \times V_1 \times V_3}{m \times V_2 \times V_4 \times 1\,000 \times 100} \times 6.25 \times 100 (\%) \tag{3}$$

where: X_3 – protein content (g 100 g^{-1}); C – N content in determination solution of the sample (μg); C_0 – N content in determination solution of the control (μg); V_1 – volume of digestive solution (mL); V_2 – volume of digestion solution for sample solution prepared; V_3 – total volume of sample; m – weight of the sample (g); V_4 – volume of determination solution of the sample.

Ash: The sample was subjected to steam dry in a boiling bath and then carbonization to smokeless by using an electric cooker. Afterwards, it was burnt by a high-temperature furnace to obtain a constant weight. The ash content X_4 was calculated as follows (Equation 4):

$$X_4 = \frac{m_1 - m_2}{m_3 - m_2} \times 100 \tag{4}$$

where: X_4 – ash content (%); m_1 – quality of crucible and ash; m_2 – quality of crucible; m_3 – quality of crucible and sample.

Amino acid analysis. The amino acid composition was estimated using an amino acid analyser (L–8900; Hitachi, Japan) following the. Briefly, The *R. pedestris* samples in powder form were hydrolysed in 6 M HCl for 22 h at 110 °C under a nitrogen atmosphere, followed by concentrating in a rotary evaporator. The concentrated samples were reconstituted with sample dilution buffer provided by the manufacturer (0.2 M citrate buffer, pH 2.20). The hydrolysed samples were analysed for amino acid composition. Tryptophan content was determined as follows: 50 mg of samples were hydrolysed in 1.5 mL LiOH (4 mol L^{-1}) for 20 h at 110 °C under a nitrogen atmosphere, diluted with sodium acetate (0.0085 mol L^{-1}) to 25 mL, and determined with HPLC with a UV detector (HCT; Brucker, Germany) at 280 nm (Landry et al. 1992). The amino acid score (AAS) was calculated considering WHO/FAO/UNU guidelines (1985) as follows (Equation 5):

$$AAS = \frac{\text{Content of amino acid}}{\text{Nutritional requirement amino acid of infants}} \tag{5}$$

where: nutritional requirement amino acid of infants is recommended by the FAO/WHO/UNU (1985).

Fatty acid composition analysis. A total of 19 fatty acid compositions were tested in *R. pedestris* powder and quantified using gas chromatography–mass spectrometry (7890A-5975C; Agilent, USA), following the method of CCMAS (1999). Briefly, the samples were hydrolysed by 8.3 M hydrochloric acid at 70~80 °C for 40 min. The fat extracted by ether was mixed with petroleum ether solution, followed by concentrating in a rotary evaporator. The samples were derivatised into fatty acid methyl esters (FAMEs), then identified and quantified by comparing the retention time and peak areas of standards from Sigma (China), and finally, analysed under the same conditions.

Mineral analysis. The minerals with nutritional importance were analysed following the standard procedures of the method of CCMAS (1999). Dried *R. pedestris* powder samples were digested in a temperature programmed microwave digestive system (MAS-II, Sineo Microwave Chemistry Technology Co., Ltd., China) from 120 °C to 190 °C for 1 h. The mineral contents were filtered with a 0.45 μM filter membrane (Syringe Filter, Tianjin Branch billion Lung Experimental Equipment Co., Ltd., China) and analysed by an inductively coupled plasma-mass spectrometry (Nexion 350X; PerkinElmer, USA).

Statistical analysis

The mean ± standard deviation (SD) were analysed by IBM SPSS Statistics 25.0. Hierarchical cluster analysis explained by Morpheus (Broad Institute of MIT and Harvard, USA).

RESULTS AND DISCUSSION

Chemical composition. *R. pedestris* powder contains water, protein, crude fat, ash, and reducing sugar (glucose). Protein, crude fat and water are the three main components. The dry weights of protein, crude fat, ash, and reducing sugar (glucose) in *R pedestris* were 77.61 g 100 g^{-1}, 18.01 g 100 g^{-1}, 4.15%, and 0.25 g 100 g^{-1}, respectively. The protein content of *R. pedestris* powder was much higher than soybean (40 g 100 g^{-1}) and egg (13 g 100 g^{-1}) [Table S1, see electronic supplementary material (ESM)]. The ratio of protein to crude fat was 4.31.

Cluster analysis for these four nutrients has been conducted based on the experimental results of *R. pedestris* and the data of 16 common edible insects (including *R. pedestris*) as well as soybean and egg cited from references (Figure 1). Crude fat and protein are two major nutritional compositions. Thus, the chemical composition of 16 kinds of edible stinkbugs was roughly divided into two categories, high fat and low protein (Representative species: *Cyclopelta parva*), low fat and high protein (Representative species: *Euschistus egglestoni* and *R. pedestris*). *R. pedestris* and *Sphaerodema rustica* are regarded as the highest protein containing stinkbugs. Similarly, *R. pedestris*,

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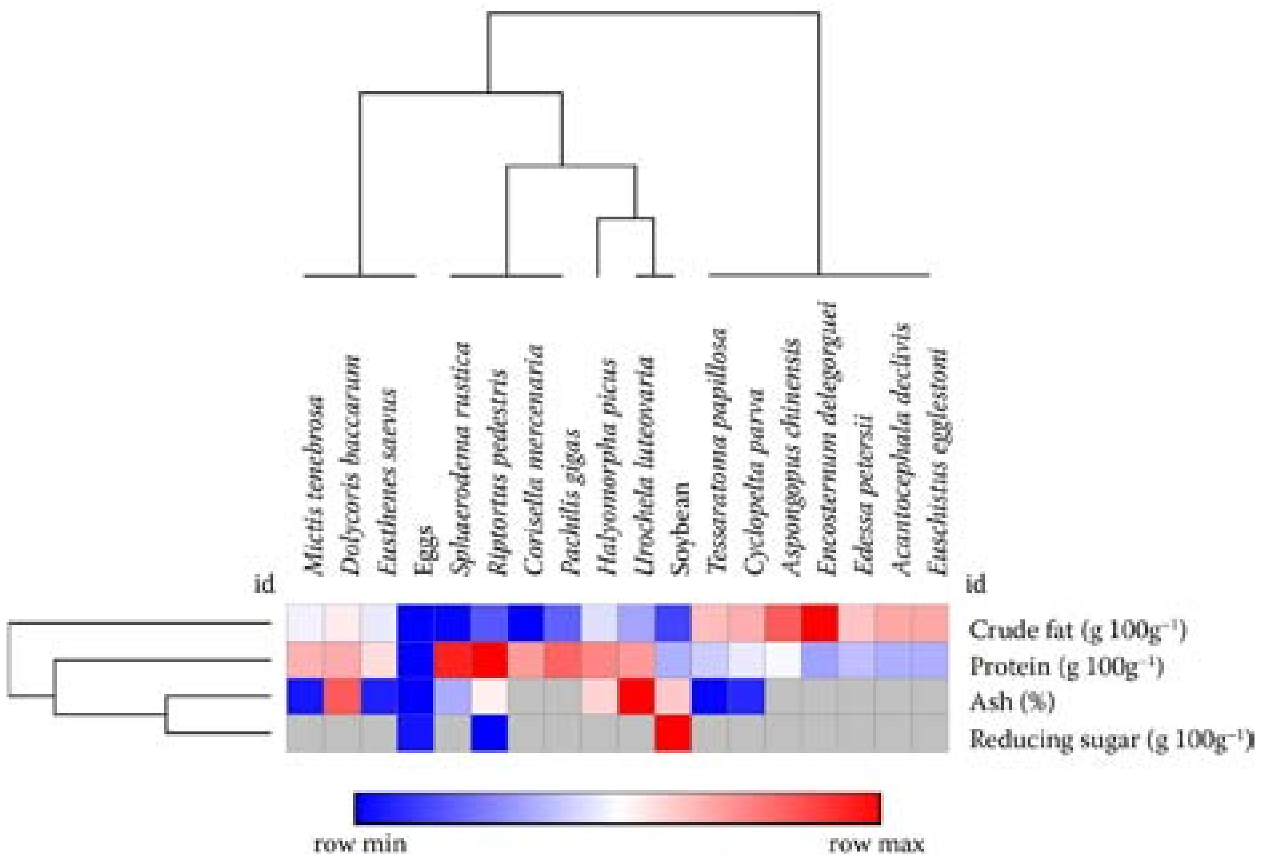

Figure 1. Hierarchical cluster analysis of the chemical composition of edible stinkbugs

Sphaerodema rustica, and *Corisella mercenaria* are the lowest crude fat containing stinkbugs (Table S1, see ESM). *R. pedestris* have the same protein content as conventional meat and lower fat. Additionally, considering the high protein content, a non-protein nitrogen, such as chitin could overestimate 'protein content'. Finke (2007) proposed that the amount of chitin derived from nitrogen is rather small. The crude protein calculation (nitrogen × 6.25) could provide a reasonable estimate of the net protein contents for most insect species, indicating the protein amount (77.61 g 100 g^{-1}) of *R. pedestris* powder to be almost accurate. The results suggested that *R. pedestris* powder could be used as a good nutritional source due to its richness in protein and low fat. However, Gier and Verhoeckx (2018) reported that some Hemiptera insects could induce allergic reactions in some people. Therefore, the protein digestion rate and allergenicity needs need further investigation. Further processing methods, including types of heat treatment, could largely affect the nutritional values of edible insects (Montowska et al. 2019; Ochiai et al. 2019).

Amino acids. The amino acid contents accounted for 64.29 g 100 g^{-1} of the total content and 76.17 g 100 g^{-1} of the dry weight (Table 1). Furthermore, based on cluster analysis of amino acid contents in 14 edible insects samples, the hierarchical cluster graph was also drawn. The results indicate that the amino acid composition of most of the latter species is closer (Figure 2). Of the essential amino acids, valine was the highest and leucine was the second, while isoleucine was the lowest. Of the nonessential amino acids, glutamic acid, proline, glycine, and alanine were the highest. There are 18 amino acids, including 8 essential amino acids (EAA), in the human body. When EAA content was calculated, cysteine and tyrosine were also included as they could transform into methionine and phenylalanine, respectively. Thus, EAA accounted for 38.97% of the total amino acids (TAA) and 67.12% of the total non-essential amino acids (NEAA). The ratios of EAA/TAA were close to FAO/WHO/UNU (1985) recommended value (EAA/TAA ≥ 40%), while the ratios of EAA/NEAA were higher than the EAA/TAA values (EAA/NEAA ≥ 60%).

While we also compared the amino acid scores for further evaluation. According to the nutritional requirement pattern recommended by FAO/WHO/UNU (1985), the score excluding histidine was 384.27,

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and the score including histidine was 413.58 (Table 2). This score did not reach the recommended amino acid model for infants but exceeded for preschool children (2–5 years old), preschool children (10–12 years old), and adults. The chemical scores of histidine, tryptophan and phenylalanine + tyrosine were higher than 100, which were higher than the recommended model for infants. For the 2–5 years old preschool children and 10–12 years old preschool children, the contents of other essential amino acids, except for isoleucine, lysine, and threonine, were higher than those recommended values. For the adult, the essential amino acid content was higher than the recommended value. Therefore, the essential amino acid content of *R. pedestris* powder was higher than the recommended values. Considering the diversified requirements of different people, *R. pedestris* powder could match other foods with high essential amino acid content to achieve complementary protein composition. The first, second, and third limiting amino acids were isoleucine, methionine + cystine, and leucine, with AAS scores of 0.32, 0.06, and 0.07, respectively. The results showed that *R. pedestris* powder was rich in nutrition with all-sided amino acids but not balanced. Therefore, it is necessary to strengthen the intake of limiting amino acids to improve the utilisation rate of amino acids.

Table 1. The amino acid contents of *R. pedestris* and common foods (%)

Amino acid	*R. pedestris*[x]	Egg[a]	Milk[a]	Soybean[a]
Isoleucine	1.14 ± 0.06	2.40	1.04	2.14
Leucine	5.69 ± 0.08	3.99	2.21	3.26
Lysine	3.41 ± 0.07	3.24	1.87	2.58
Methionine	1.42 ± 0.03	1.39	0.59	0.44
Cysteine	1.21 ± 0.05	0.94	0.25	0.60
Phenylalanine	3.41 ± 0.04	2.37	1.02	2.13
Tyrosine	3.41 ± 0.03	1.88	1.06	1.35
Threonine	2.38 ± 0.03	2.20	0.91	1.66
Tryptophan	1.35 ± 0.06	0.85	0.34	0.53
Valine	6.26 ± 0.41	2.67	1.21	1.99
Histidine	2.27 ± 0.16	1.31	0.56	1.12
Aspartic acid	5.97 ± 0.49	4.39	1.61	4.62
Serine	4.27 ± 0.05	3.31	1.29	2.13
Glutamic acid	7.96 ± 0.32	5.97	4.76	7.23
Proline	7.75 ± 0.09	1.66	2.66	2.15
Glycine	7.18 ± 0.17	1.49	0.41	1.85
Alanine	7.75 ± 0.09	2.48	0.75	1.78
Arginine	3.34 ± 0.04	2.81	0.76	3.28
Total of amino acid	76.17	45.35	23.27	40.83
Total of essential amino acids	29.68	21.93	10.49	16.68
Total of non-essential amino acids	44.22	22.11	12.23	23.04
EAA/TAA	38.97	48.35	45.06	40.84
EAA/NEAA	67.12	99.15	85.78	72.39

R. pedestris – *Riptortus pedestris*; [x]data are expressed as mean ± SD (standard deviation, n = 3); [a]data are cited from Yang (2018)

The total amino acid content in *R. pedestris* powder was more than those in other edible stinkbugs, milk, and soybean (Table S2, see ESM). Of the essential amino acids, the contents of valine (6.26%), leucine (5.69%), lysine (3.41%), and phenylalanine (3.41%) in *R pedestris* powder were much higher than others. Of the nonessential amino acids, the contents of aspartic acid, serine, glutamic acid, glycine, proline, and alanine in *R. pedestris* powder were the highest. In this study, isoleucine was found as the first limit amino acid of *R. pedestris* powder, while tryptophan is the first limiting amino acid of *Encosternum delegorguei*, *Euschistus egglestoni*, *Pachilis gigas*, and *Edessa petersii* (Ramos-Elorduy 1997; Musundire et al. 2016). Methionine is the first limit amino acid of *Sphaerodema rustica*, *Mictis tenebrosa*, *Eusthenes saevus*, *Cyclopelta parva*, and *Tessaratoma papillosa* (Feng et al. 2000). Cysteine is the first limit amino acid of *Halyomorpha picus*, *Dolycoris baccarum*, and *Urochela luteovaria* (Ma 2012). Threonine is the first limit amino acid of *Aspongopus chinensis* (Li and Li 2010). Further, the EAA/TAA value of *R. pedestris* powder approximates to other stinkbugs. The results showed that amino acids were abundant in *R. pedestris* powder, indicating its potential as a good protein source due to its richness in protein and low fat. These insects are expected to be utilised as alternative dietary food ingredients to satisfy people's nutrient requirements (Cole et al. 2018; Kim et al. 2019; Köhler et al. 2019).

Fatty acid composition analysis. *R. pedestris* powder contained 6 types of fatty acids (2 saturated fatty acids, 4 monounsaturated fatty acids) (Table 3). Moreover, the unsaturated fatty acid content (79.36%) was higher than the saturated fatty acids (20.64%). Of the unsaturated fatty acids, the contents of oleic acid ($C_{18:1}$), linoleic acid ($C_{18:2}$), linolenic acid ($C_{18:3}$), and arachidonic acid ($C_{20:4}$) were 37.1%, 39%, and 3.21%, respectively. Of the saturated fatty acids, palmitic acid ($C_{16:0}$) was 15.3%, while stearic acid ($C_{18:0}$)

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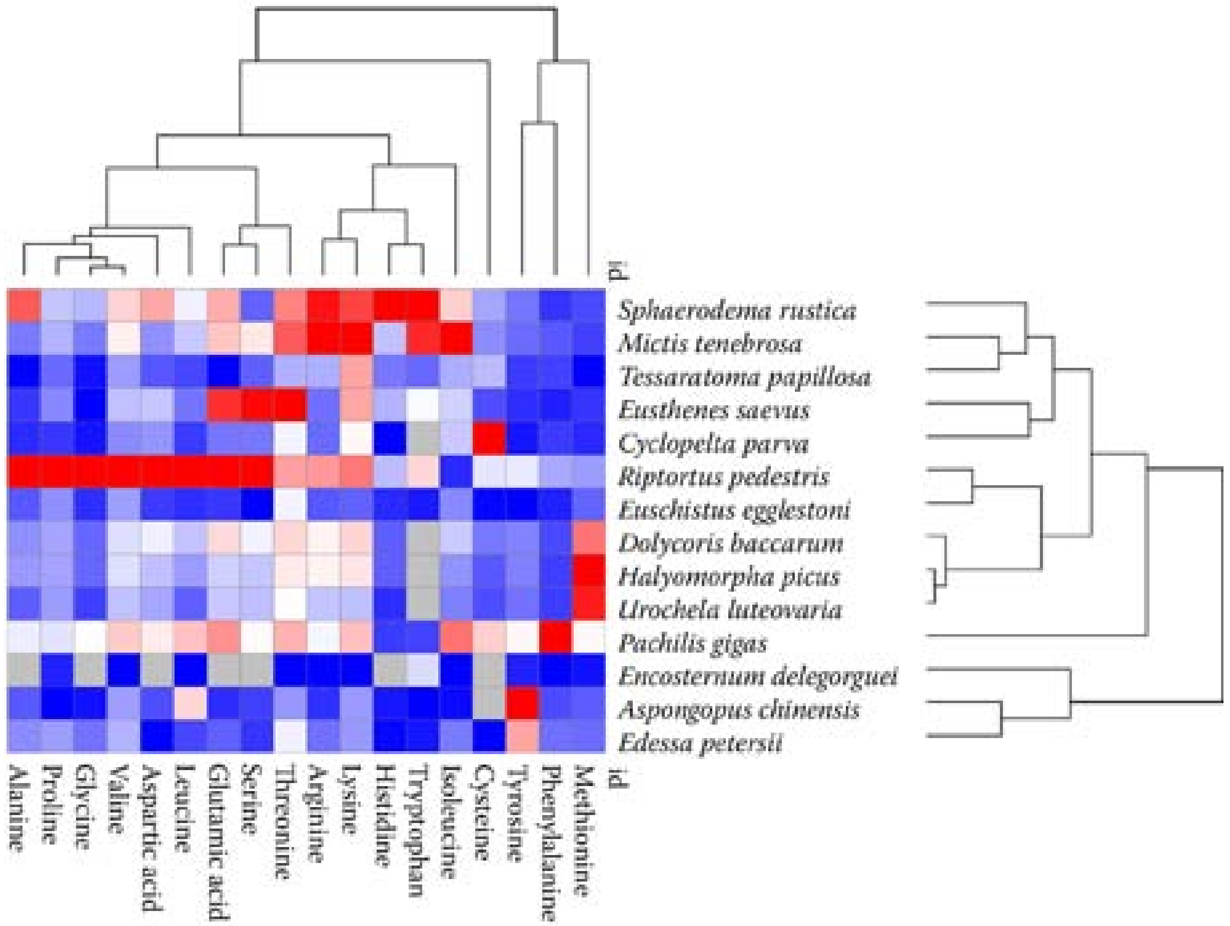

Figure 2. Hierarchical cluster analysis of amino acid contents of edible stinkbugs

was 5.34%. The long chain fatty acids (C_{16}~C_{18} fatty acids) shared more than 99.9% fatty acids. Short chain contents, medium chain, and super long chain fatty acids were less than the long chain fatty acids. In long chain fatty acids, the total linoleic acid ($C_{18:2}$) and oleic acid ($C_{18:1}$) contents were more than 76%, which was close to that in soybean (77.1%) and much higher than in egg (55.9%) (Yang 2018). The essential unsaturated fatty acid content accounted for 42.21% of the total fatty acid. More importantly, *R. pedestris* powder contained linoleic acid and α-linolenic acid, which are the essential fatty acids that cannot be synthesised in the human body and can only be provided through food. Briefly, lipids represented the second largest nutrient in *R. pedestris powder*. The long chain fatty acid content, a potential alternative to edible oil, was quite higher than in many insects (Rumpold and Schlüter 2013; Anaduaka et al. 2021; Gao et al. 2021). The types of fatty acids among stinkbugs differ from each other. The total contents of essential fatty acids, oleic acid ($C_{18:1}$), linoleic acid ($C_{18:2}$), and linolenic acid ($C_{18:3}$) were higher, which were close to *Monosteria unicostata*. Notably, myristic acid ($C_{14:0}$) and dodecanoic (lauric) acid ($C_{12:0}$), responsible for cholesterol raise were not detected in *R. pedestris* powder. The unsaturated fatty acid contents in *R. pedestris* powder were much more than the saturated fatty acids. Similarly, the unsaturated fatty acid contents in *R. pedestris* powder were significantly higher than in *Monosteria unicostata*, *Aspongopus chinensis,* and *Encosternum delegorguei* (Ozlem, 2007; Liu and Yu 2008; Musundire et al. 2016).

Mineral Analysis. *R. pedestris* powder was found to be rich in ordinary elements, and microelements (Table 4). Of the ordinary elements, potassium, calcium, sodium, and magnesium were the rich components. Similarly, of the microelements, manganese, zinc, iron, and copper were the essential trace elements for the human body. Additionally, the mineral sub-

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Table 2. Amino acid score (AAS) of essential amino acids in *R. pedestris* (mg g^{-1} protein)

Essential amino acids	Content of amino acid	Nutritional requirement pattern[a]				AAS
		infants	preschool children (2–5 years old)	school age children (10–12 years old)	adults	
Histidine	29.31	26 (18–36)	(19)[x]	(19)[x]	16	1.13
Isoleucine	14.66	46 (41–53)	28	28	13	0.32
Leucine	73.28	94 (83–107)	66	44	19	0.70
Lysine	43.97	66 (53–76)	58	44	16	0.88
Methionine + Cysteine	35.72	42 (29–60)	25	33	17	0.60
Phenylalanine + Tyrosine	87.94	72 (68–118)	63	33	19	1.22
Threonine	30.69	43 (40–45)	34	38	9	0.71
Tryptophan	17.40	17 (16–17)	11	(9)[x]	5	1.02
Valine	80.61	55 (44–77)	35	25	13	1.47
Total (excluding Histidine)	384.27	434 (390–552)	320	222	111	–
Total (including Histidine)	413.58	460 (408–588)	339	241	127	–

R. pedestris – *Riptortus pedestris*; [a]recommended by FAO/WHO/UNU (1985); [x]values (in parentheses) are interpolated from smoothed curves of requirement versus age

Table 3. Fatty acid composition of edible stinkbugs (%)

Fatty acid	*Riptortus pedestris*[x]	*Aspongopus chinensis*[a]	*Monosteria unicostata*[b]	*Encosternum delegorguei*[c]
Myristic acid ($C_{14:0}$)	–	3.49	1.87	1.23
Myristoleic acid ($C_{14:1}$)	–	1.17	–	0.82
Palmitic acid ($C_{16:0}$)	15.3 ± 1.16	24.03	23.23	25.61
Palmitoleie acid ($C_{16:1}$)	–	24.14	7.22	22.22
Stearic acid ($C_{18:0}$)	5.34 ± 0.23	0.63	9.94	10.67
Oleic acid ($C_{18:1}$)	37.1 ± 0.17	20.41	27.3	0.74
Linoleic acid ($C_{18:2}$)	39.0 ± 1.32	4.15	24.17	10.06
Linolenic acid ($C_{18:3}$)	3.21 ± 0.10	–	3.25	–
Arachidic acid ($C_{20:0}$)	–	1.40	–	1.64
Arachidonic acid ($C_{20:4}$)	0.09 ± 0.01	–	1.12	–
Eicosapentaenoic ($C_{20:5}$)	–	–	1.35	–
Behenic acid ($C_{22:0}$)	–	1.40	–	–
Erucic acid ($C_{22:1}$)	–	5.36	–	–
cis-13,16-docosadienoic acid ($C_{22:2}$)	–	0.39	–	–
Lignocerid acid ($C_{24:0}$)	–	5.33	–	–

[x]data are expressed as mean ± SD (n = 3); [a, b, c]data are cited from Liu and Yu (2008), Ozlem (2007) and Musundire et al. (2016), respectively

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Table 4. Content of chemical elements in some stinkbugs

Minerals	*Riptortus pedestris*[x]	*Tessaratoma papillosa*[a]	*Cyclopelta parva*[a]	*Eusthenes saevus*[a]	*Sphaerodema rustica*[a]	*Halyomorpha picus*[b]	*Dolycoris baccarum*[b]	*Urochela luteovaria*[b]	*Aspongopus chinensis*[c]	*Encosternum delegorguei*[d]
	(mg kg^{-1})									(% DM)
Potassium (K)	784 ± 12.16	270	4 720	610	2 720	113.46	102.87	112.84	250	0.79
Calcium (Ca)	513 ± 6.07	1 140	480	280	1 320	630.35	1 005.01	972.6	100	0.56
Sodium (Na)	79 ± 4.00	420	1 680	760	1 550	46.16	75.68	66.91	nd	0.25
Magnesium (Mg)	469 ± 5.57	370	1 530	260	1 060	0.76	0.92	0.71	1 260	0.16
Zinc (Zn)	30.9 ± 1.65	42.3	155.8	78	174.2	0.9	0.9	1.19	90	0.02
Phosphorus (P)	nd	1 200	8 200	1 520	460	8 660	nd	6980	360	1.39
Iron (Fe)	79.20 ± 3.70	38.4	119.7	98.3	702	224.74	386.43	368.53	360	0.07
Manganese (Mn)	41.30 ± 1.13	3.3	19.9	16.3	75.8	33.89	65.61	27.45	20	nd
Copper (Cu)	9.24 ± 0.25	73.5	2.4	45.4	162.2	21.23	28.49	29.61	nd	0.02
Selenium (Se)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Strontium (Sr)	1.3 ± 0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd

[x]data are expressed as mean ± SD (n = 3); [a, b, c, d]data are cited from Feng et al. (2000), Ma (2012), Li and Li (2010); nd – the chemical element was not detected or not tested; DM – dry matter

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stance in *R. pedestris* powder was rich in variety, and the content of macro-elements and micro-elements were more balanced compared with other edible stinkbugs (Feng et al. 2000; Li and Li 2010; Ma 2012; Musundire et al. 2016). This indicates *R. pedestris* powder is a good source of minerals, not phosphorus. The mineral contents in *R. pedestris* powder can be used to define the nutritional value of insect foods and products. Therefore, considering the functional food application, *R. pedestris* powder can be utilised in category-rich diets for preventing mineral deficiency.

CONCLUSION

The aim of this study was to determine the nutritional composition of *R. pedestris* powder due to its richness in protein, low fat, and novel source of nutrition. *R. pedestris* can be consumed as whole or ground into a powder or paste and with other foods. The excellent characteristics of proteins and fatty acids confirmed their suitability for use in the edible insect industry. Therefore, the study results elucidated that *R. pedestris* powder could be a novel high-quality nutritional source. At present, small-scale breeding can be realised. However, the rearing process should be established before the commencement of any large-scale controlled production. Consumers with allergic tendencies should be cautious because insects have as many allergens as other arthropods.

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