A COMPARISON OF THREE EARTHWORM SPECIES' AMINO ACID PROFILES AND THEIR IMPACTS ON SOIL QUALITY

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Abstract- Earthworms benefit soil quality by destroying buildups invigorating microbial decay, further developing soil fruitfulness, and evolving the actual soil properties like soil conglomeration and invasion. The objective of this study is to examine the essential amino acid profiles of three earthworm species (*Lampito marutii, Octochaetona serrata, Eudrilus eugeniae)* and also to study the changes in soil chemical, physical, and macromineral compositions. In light of the nutritional analysis, it is possible to argue that these three species of earthworm can provide sufficient protein and other trace elements to satisfy daily requirements. Currently, the use of worms as a feed source for cultured aquatic animals is still experimental. The amino acid profiles of the night crawlers species were kept in this concentrate through High-performance Liquid Chromatography (HPLC) and their qualities were communicated in Rate (%), Mean standard deviation, and Coefficient of Variation (CV) % among three unique species. The percentage of essential and nonessential amino acids was studied for all three species individually using a histogram. The level of an aggregate sum of amino acids from the three species diminished arranged by O. serrata followed by E. eugeniae and then L. mauritii. While contrasting and environmental characters, endogeic species show the most noteworthy qualities followed by epigeic and anecic species individually. With the rising expenses of traditional protein sources, such as fishmeal and soybean feast, it might involve time before the monetary benefits of delivering worms as a modest wellspring of protein become obvious to numerous water culturists and feed makers.

INTRODUCTION:

Most of the terrestrial and soil-dwelling creatures in the phylum Annelida are earthworms, which are classified as members of the class Oligochaetae. Earthworms are thought to have evolved in the Precambrian period approximately fifty-six million years ago and have been quiet witnesses to the evolution of plants and animals over many millions of years. Earthworm plays an essential role in biological, physical, and chemical role in ecology. It may be questioned if any other creatures have had as much of an impact on the world as these poorly organised personalities, according to Darwin. Other names for earthworms include rain worms (because they are abundant during rains), manure worms (because some varieties do well in manures and compost piles), angel worms (because they suddenly resemble angels after a few days of rain), and fish worms (because they are frequently used as fish bait and food).

Numerous experts have suggested using alternate animal protein feed ingredients to fish meal, such as earthworm meal [1]. An previous study found that the overall crude protein concentration of Lumbricus rubellus earthworm meal was 65.63% [2], Lumbricus terrestris earthworm meal had 32.60% protein [3] and Perionyx excavatus earthworm meal included 57.2% raw protein and had full amino acid composition [4]. Chickens, pigs, rabbits, and fish species are fed earthworms that contain a significant amount of high protein. Earthworm's amino acid profile is far better than that of snail, meat, and fish meal, for instance. Worm food has 4.13% arginine whereas fish meal only has 3.4%. The same goes for tryptophan, which is abundant in worm meal (2.29%), meat meal (1.07%), and fish meal (0.8%) [5].

Physical, chemical, and biological factors affect soil fertility [6]. Earthworms are the pulse of the soil. Healthier the pulse, healthier is the soil. Earthworms have a vital role in giving nutrients (N, P, K, and Ca) to the soil and/or the surface of the soil through influencing its physical qualities, turnover of nutrients, and plant development [7]. Compost has a high organic matter concentration and is a great source of nutrients. Compost may improve soil's physical and chemical properties, potentially enhancing the productivity of crops. As a result, using compost is a current necessity. The casts created improve nitrogen cycling-promoting microbial activity in soil. Vermi-casts have been found to have an impact on the physical characteristics of plants growing in substrates [8]. Land is the most important nonrenewable resource and bears the greatest threat of deterioration. The country's land resources are depleting at an alarming rate, generating environmental difficulties. Dedeke et al. (2010) discovered that animal needs were adequately represented and sufficient in earthworms [9]. As a result, the use of these species' meals as a form of mineral supplement in diets based on fish might be recommended. Priya and Santhi (2014) investigated the influence of vermicompost on Amaranthus plant development and soil fertility and found that it can boost soil fertility and plant growth [10].

Therefore, the purpose of this study is to evaluate the essential and non-essential amino acid profiles of three different species of earthworms, as well as to compare the macro mineral profiles of different soils and to analyse how the chemical and physical characteristics of soil have changed throughout time.

2. MATERIALS AND METHODS

2.1 STUDY AREAS

To collect earthworms *Lampito marutii* and *Octochaetona serrata* were collected from SRM College Campus. *Eudrilus eugeniae* were collected from stock culture maintained in Koothur village, Thiruthani.

2.2 STUDY ANIMALS

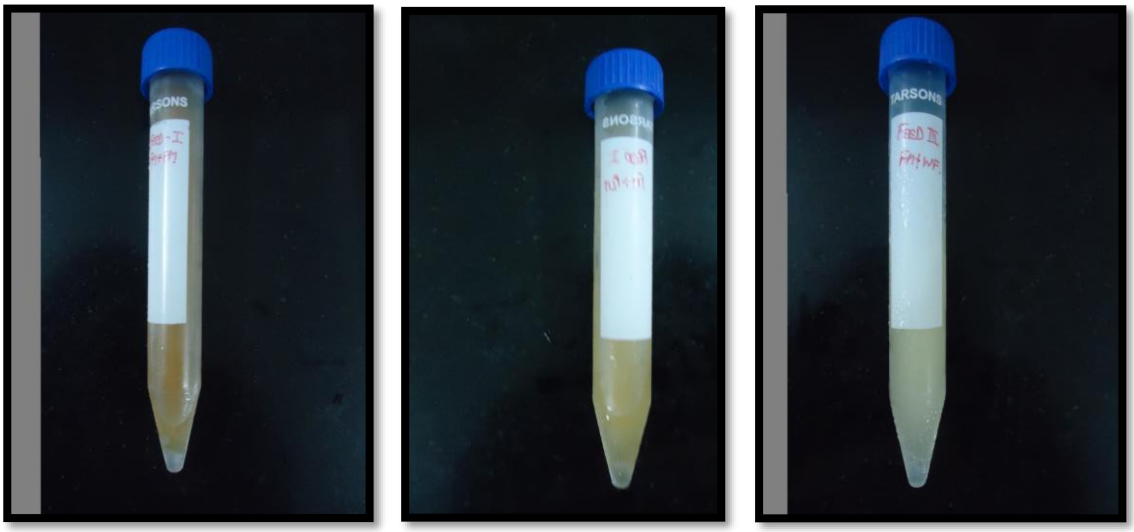
Eudrilus eugeniae belongs to family Eudrilidae and epigeic (litter dwelling), *Lampito mauritii* belongs to family Megascolidae and anecic (deep burrowing), *Octochaetona serrata belongs* to family Octochaetidae and endogeic (shallow dwelling).

2.3 METHODS OF COLLECTION

Earthworms are frequently discovered in the top 30 to 50 cm of the ground. The best time to harvest earthworms is around early in the morning in the summer and around midday in the winter. By manual sorting and digging, the worms are gathered. The surface area was initially cleansed of the grasses and plants. Earthworms were manually separated from the dug-up dirt, put into plastic containers with their home soil, and taken to a lab for identification.

2.4 SAMPLE PREPARATION

One gram of defatted earthworms was washed with tap water and kept in alcohols for few minutes and minced with scissors and then weighed and 2 ml of phosphate buffer was added (pH 7) and grinded well. The ground material was diluted to 5 ml with phosphate buffer and centrifuged for 10 minutes at 6500rpm. The supernatant was kept at -20° as a crude protein.



E. eugeniae **SAMPLE A** ***L.mauritii*** **SAMPLE B** ***O .serrata*** **SAMPLE C**

(CENTRIFUGED SUPERNATENT OF THREE SAMPLES)

2.5 AMINO ACID ANALYSIS

The amino acid that was tested was determined at Bio Zone Research Technologies Pvt Ltd. using **H**igh **P**erformance **L**iquid **C**hromatography **(HPLC).** 5-10 micro litre of the hydrolysed sample was loaded into cartridge of the analyser. The analyzer is meant to separate and evaluate unbound acidic, basic, and neutral amino acids.

The HPLC operation was determined by following methods

Column size I = 0.1 m φ = 4.6mm,

Stationary phase: Octadecylsilyl silica gel (3µm).

Mobile phase: Dissolve about 15.2 g of triethylamine in 800 ml of water, adjust to pH 3.0 using phosphoric acid and dilute to 1000 ml using water. Add 850 ml of this solution to 150ml of mixture v/v of propanol and v/v/v acetonitrile. The flow rate 1.0-1.5 ml/min, detector is done by spectrophotometer at 220 nm. The period lasts for 90 minutes. The presence of different amino acids was identified by using standard graph based on their intensity (mV) and retention time (min). The quantity of each amino acid in the sample was estimated in g/l00g crude protein according to Dedeke *et al.,* (2010).

2.6 SOIL ANALYSIS

The soil samples physical and chemical characteristics were examined at the Tamil Nadu Agriculture Department's soil testing lab at Kakkalur, Thiruvallur.

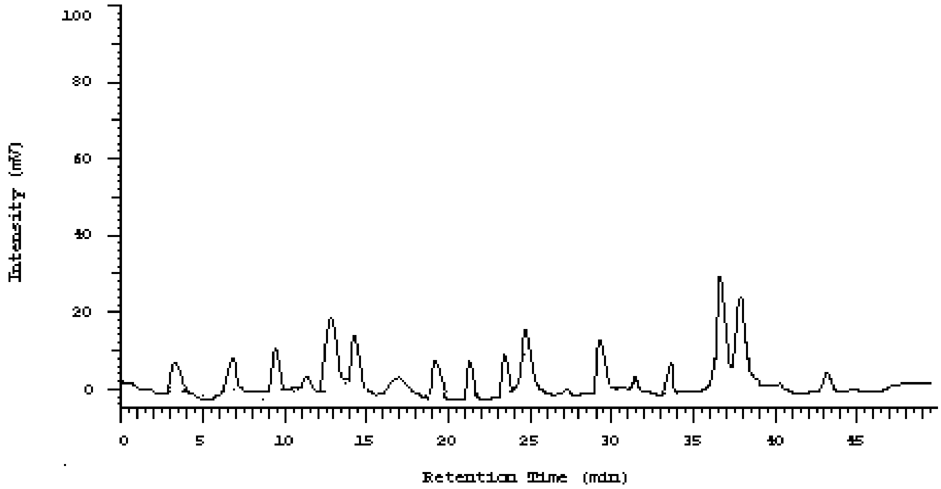
2.7 STATISTICAL ANALYSIS

The findings of the amino acid profile research were statistically analysed, and the data were reported for three distinct species in percentages (%), mean standard deviation (SD), and coefficient of variation (CV%). The results from duplicate (five) determinations for soil testing were analysed using Mean SD and One Way Analysis of Variance (ANOVA).

3. RESULTS

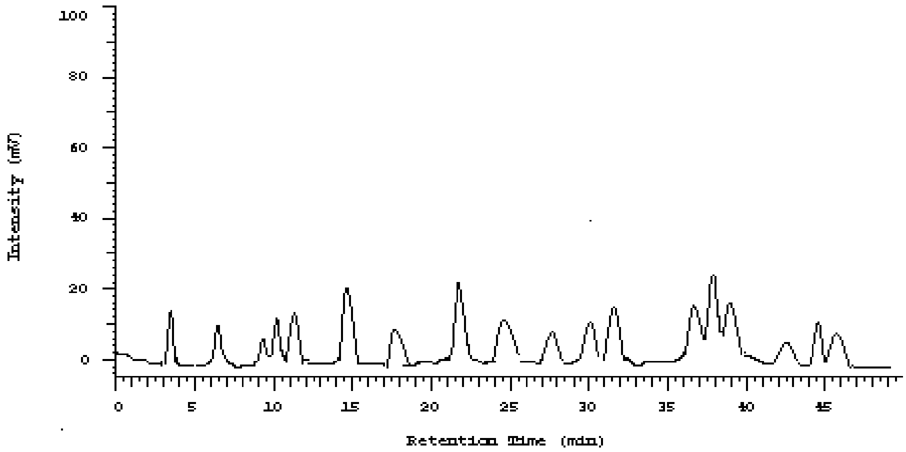
Amino acid analysis with HPLC showed that all the three species of earthworm such as *E. eugeniae, L. mauritii* and *O. serrata* had eight essential amino acid (Lysine, Histidine, Threonine, Valine, Isoleucine, Leucine, Phenylalanine and Tryptophan) and eight non-essential amino acids (Asparagine, Serine, Tryosine, Glutamic acid, Proline, Glycine, Alanine and Cystine) were recorded in this study through High Performance Liquid Chromatography.

- **The chromatogram showing the amino acid profile of Eudrilus*eugeniae***

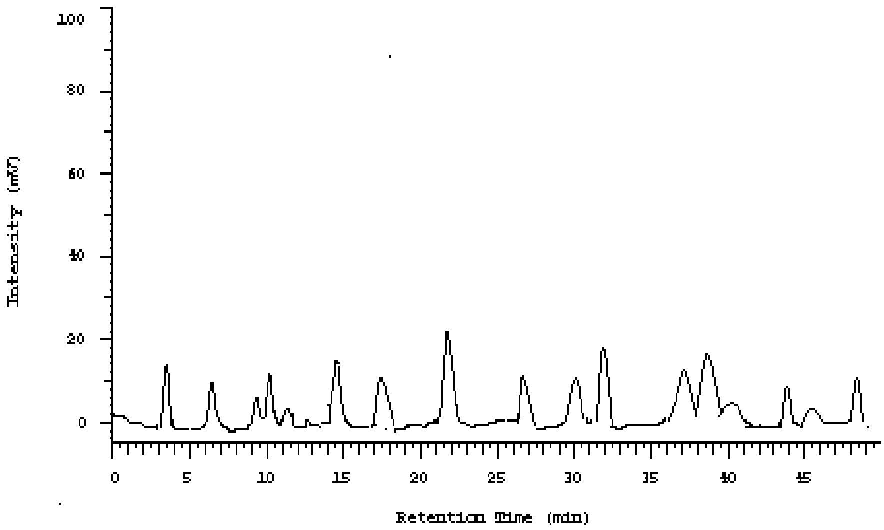


- Sixteen (16) peaks were recorded. The peaks on the right are representative of Tryptophan, Proline, Lysine, Leucine, Phenylalanine, Isoleucine, Valine, Histidine, Tyrosine, Cystine, Alanine, Threonine, Glycine, Serine, Asparagine and Glutamic acid.

- **The chromatogram showing the amino acid profile of *Lampito mauritii***



- Sixteen (16) peaks were recorded. The peaks on the right are representative of Tryptophan, Proline, Lysine, Leucine, Phenylalanine, Isoleucine, Valine, Histidine, Tyrosine, Cystine, Alanine, Threonine, Glycine, Serine, Asparagine and Glutamic acid.
- **The chromatogram showing the amino acid profile of *Octochaetona serrata***

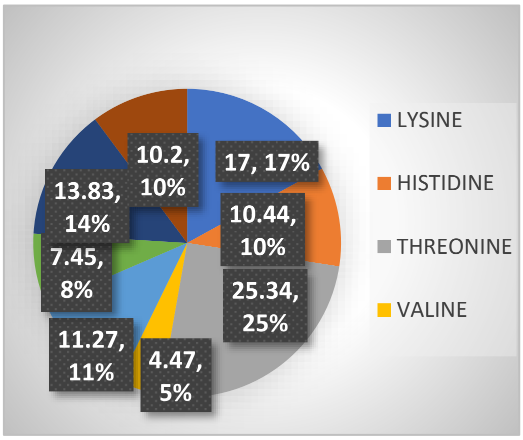


- Sixteen (16) peaks were recorded. The peaks on the right are representative of Tryptophan, Proline, Lysine, Leucine, Phenylalanine, IsoLeucine, Valine, Histidine, Tyrosine, Cystine, Alanine, Threonine, Glycine, Serine, Asparagine and Glutamic acid.

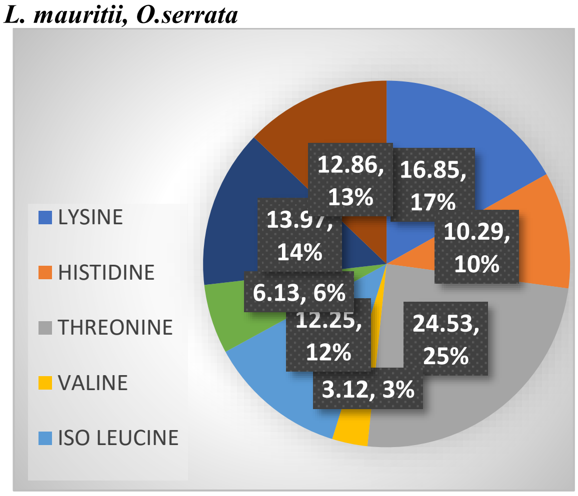
Essential amino acid profile of three species of earthworm:

Essential Amino Acids	Eudrilus eugeniae	Lampito mauritii	Octochaetona serrata	Total Average %
Lysine	5.7 (17.00)	5.5 (16.85)	4.8 (14.33)	16.05
Histidine	3.5 (10.44)	3.36 (10.29)	2.6 (7.67)	9.49
Threonine	8.5 (25.34)	8.01 (24.53)	6 (17.61)	22.58
Valine	1.5 (4.47)	1.02 (3.12)	5.2 (15.52)	7.74
Isoleucine	3.78 (11.27)	4 (12.25)	4.7 (14.03)	12.52
Leucine	2.5 (7.54)	2 (6.13)	2.9 (8.66)	7.42
Phenylalanine	4.64 (13.83)	4.56 (13.97)	3 (8.96)	12.24
Tryptophan	3.42 (10.20)	4.2 (12.86)	4.3 (12.84)	11.96

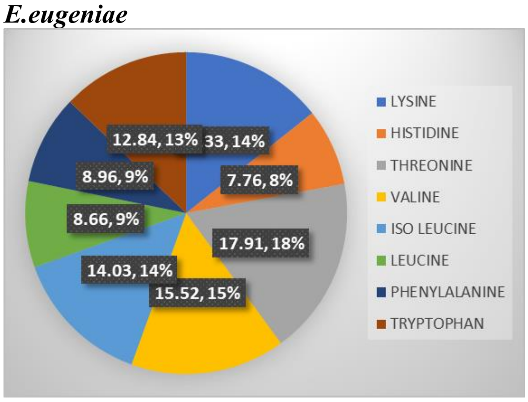
Percentage of essential amino acid content in *E.eugeniae, L. mauritii, O.serrata*



E.eugeniae



L.mauritii



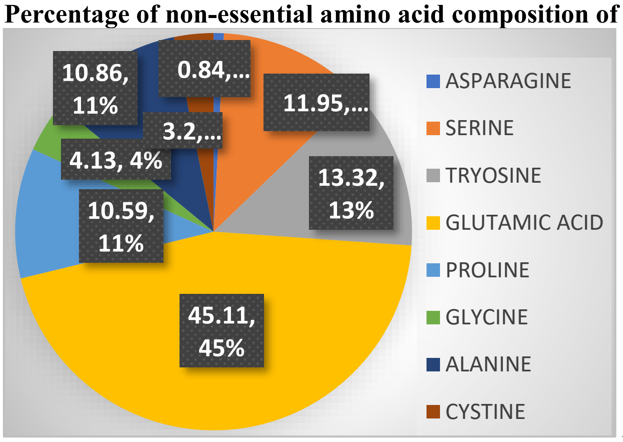
O.serrata

The percentage of total amount of amino acids from the different species of earthworm decreased in order of *O. serrata* (33.67%) > *E. eugeniae* (33.62%) > *L. mauritii* (32.72%). Earthworm species with the greatest necessary amino acids were threonine (22.58%) ranged from (17.91%-25.34%) followed by lysine (16.05 %) (14.33%-17.0%), isoleucine (12.52%) (11.29%-14.03%) and phenylalanine (12.24%) (8.96%-13.97%). The least percentage of essential amino acid was valine and leucine (7.74) (13.21%-15.52%) and (7.42%) (6.13%-7.45%) respectively.

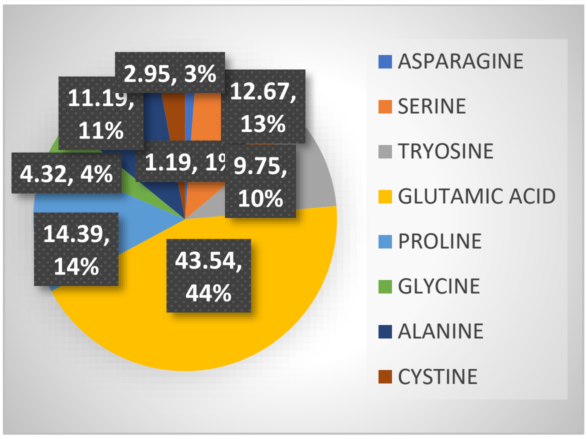
Non-essential amino acids profile of three species of earthworms

Non-essential Amino Acids	E. eugeniae	L. mauritii	O. serrata	Total Average %
Asparagine	0.245 (0.84)	0.34 (1.19)	0.4 (1.36)	1.10
Serine	3.5 (11.95)	3.61 (12.67)	3.7 (12.58)	12.30
Tyrosine	3.9 (13.32)	2.78 (9.75)	2.64 (8.97)	10.70
Glutamic Acid	13.21 (45.11)	12.41 (43.54)	12.84 (43.64)	44.10
Proline	3.1 (10.59)	4.1 (14.39)	4.3 (14.64)	13.30
Glycine	1.21 (4.13)	1.23 (4.32)	0.98 (3.33)	3.93
Alanine	3.18 (10.86)	3.19 (11.19)	3.54 (12.03)	11.36
Cystine	0.94 (3.20)	0.84 (2.95)	1.02 (3.47)	3.21

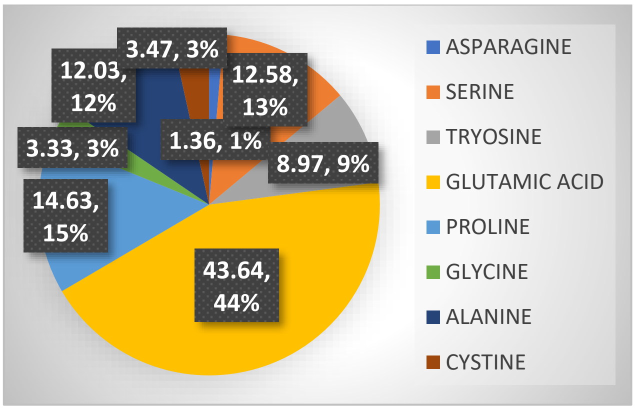
Percentage of non-essential amino acid composition of *E.eugeniae, L. mauritii, O. serrata*



E.eugeniae



L. mauritii



O. serrata

The non-essential amino acid composition of three different species of earthworm were dominated by glutamic acid (44.1%) ranged from 12.41% - 13.21%. The percentage of proline was 13.30% (10.59% - 14.62%) followed by serine (12.30%) (11.95% - 12.67%)

and alanine (11.36%) (10.86% - 12.03%). The least non-essential amino acid was asparagine consists of 1.10% ranging from 0.84% - 1.36%.

The values of essential and non-essential amino acid of three species of earthworm *(E. eugeniae, L. mauritii* and *O. serrata)* with respect to CV %

Co variation % of essential amino acid between three species of earthworm

Essential Amino Acids	Eudrilus euginae (g/100g crude protein)	Lampito mauritii (g/100g crude protein)	Octochaetona serrata (g/100g crude protein)
Lysine	5.7	5.5	4.8
Histidine	3.5	3.36	2.6
Threonine	8.5	8.01	6
Valine	1.5	1.02	5.2
Isoleucine	3.78	4	4.7
Leucine	2.5	2	2.9
Phenylalanine	4.64	4.56	3
Tryptophan	3.42	4.2	4.3
Total	33.54	32.65	33.5
Mean	4.19	4.08	4.18
SD	2.15	2.13	1.22
Variance (SD)	4.62	4.56	1.50
CV%	51	52	29

SD – Standard Deviation CV % - Coefficient of Variation Percentage

The coefficient of variation percentage ranging between three species of earthworm was 29 - 52%. The CV % of *L. mauritii and E. eugeniae* were found be the highest (52% and 51% respectively). So that there is less variable in the content of essential amino acids between the above two species. While the lowest value of CV % (29%) is recorded in *O. serrata* hence there is more variable in the content of essential amino acids of *O. serrata* than the other two species.

Co variation % of non-essential amino acid between three species of earthworm

Non-essential Amino Acids	Eudrilus euginae (g/100g crude protein)	Lampito mauritii (g/100g crude protein)	Octochaetona serrata (g/100g crude protein)
Asparagine	0.245	0.34	0.4
Serine	3.5	3.61	3.7
Tyrosine	3.9	2.78	2.64
Glutamic Acid	13.21	12.41	12.84
Proline	3.1	4.1	4.3
Glycine	1.21	1.23	0.98
Alanine	3.18	3.19	3.54
Cystine	0.94	0.84	1.02
Total	29.3	28.5	29.5
Mean	3.66	3.56	3.67
SD (σ)	4.08	3.82	3.97
Variance (SD)	16.6	14.65	15.78
CV%	116	107	108

SD – Standard Deviation CV % - Coefficient of Variation Percentage

The coefficient of variation (CV %) ranging between three species of earthworm is 107-116%. *E. eugeniae* was found to be the highest (116%). Whereas in *L. mauritii* and *O. serrata* CV % of non essential amino acids were 108 % and 107% respectively. So there is more consistent in the amount of non essential amino acids content between the above two species.

Co variation % between essential amino acid among three different species of earthworm

Essential Amino Acids	E. euginae (g/100g crude protein)	L. mauritii (g/100g crude protein)	O. serrata (g/100g crude protein)	Mean	SD (σ)	CV%
Lysine	5.7	5.5	4.8	5.3	0.47	8.8
Histidine	3.5	3.36	2.6	3.15	0.47	14.9

Threonine	8.5	8.01	6	7.5	1.32	17.6
Valine	1.5	1.02	5.2	2.5	2.2	88
Isoleucine	3.78	4	4.7	4.16	0.48	11
Leucine	2.5	2	2.9	2.4	0.45	18
Phenylalanine	4.64	4.56	3	4.04	1.54	38
Tryptophan	3.42	4.2	4.3	3.9	0.52	13

CV% of eight essential amino acids was 8.8% (lysine), 14.9% (histidine), 17.6% (threonine), 88% (valine), 11% (isoleucine), 18% (leucine), 38% (phenylalanine) and (tryptophan) 13%. In this valine showed the highest CV% (88%) when compared with other essential amino acids indicated that it is more consistent. The lowest value of CV% (8.8%) in Lysine showed that there is a less consistent than the other essential amino acids.

Co variation % between non-essential amino acid among three different species of earthworm

Non-essential Amino Acids	E. euginae (g/100g crude protein)	L. mauritii (g/100g crude protein)	O. serrata (g/100g crude protein)	Mean	SD (σ)	CV%
Asparagine	0.245	0.34	0.4	0.32	0.076	23.7
Serine	3.5	3.61	3.7	3.6	0.1	2.7
Tyrosine	3.9	2.78	2.64	3.1	0.68	21.9
Glutamic Acid	13.21	12.41	12.84	12.82	0.40	3.1
Proline	3.1	4.1	4.3	3.8	0.64	16.8
Glycine	1.21	1.23	0.98	1.14	0.138	12
Alanine	3.18	3.19	3.54	3.3	1.43	40
Cystine	0.94	0.84	1.02	0.93	0.09	9.6

Coefficient of Variation percentage (CV %) for eight non essential amino acid was 23.7% (asparagine), 2.7% (serine), 21.9% (tryosine), 3.1% (glutamic acid), 16.8% (proline), 12% (glysine), 40% (alanine) and 9.6% (cystine).
In this alanine shows the highest CV% (40%) value while compared with other non essential amino acids. So the content of alanine was more homogenous. Whereas the lowest value of CV% (2.7%) in Serine implied that it is less homogenous among the non essential amino acids.

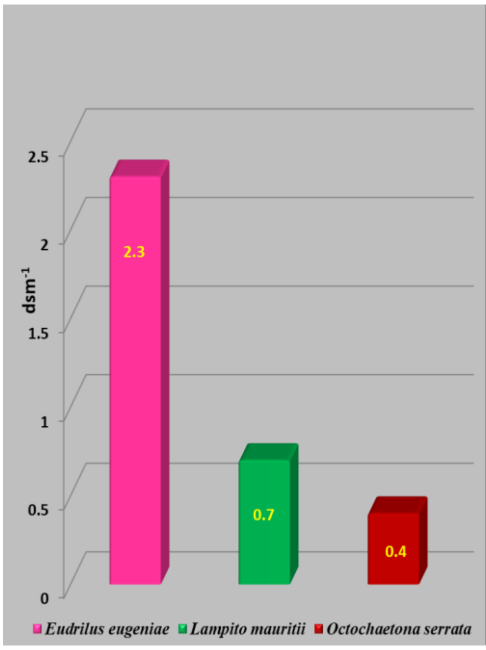
3.1 PHYSICAL AND CHEMICAL PROPERTIES OF THE SOIL

Soil physical and chemical parameters for three earthworm species (*E. eugeniae, L. mauritii* and *O. serrata)*. The pH value of *O. serrata* and *E. eugeniae* were higher when compared to *L. Mauritii*. The EC (Electrical Conductivity) value was higher (2.3 dsm^{-1}) in *E. eugeniae* than that of *L. mauritii* and *O. serrata* (0.7 and 0.4 dsm^{-1}).

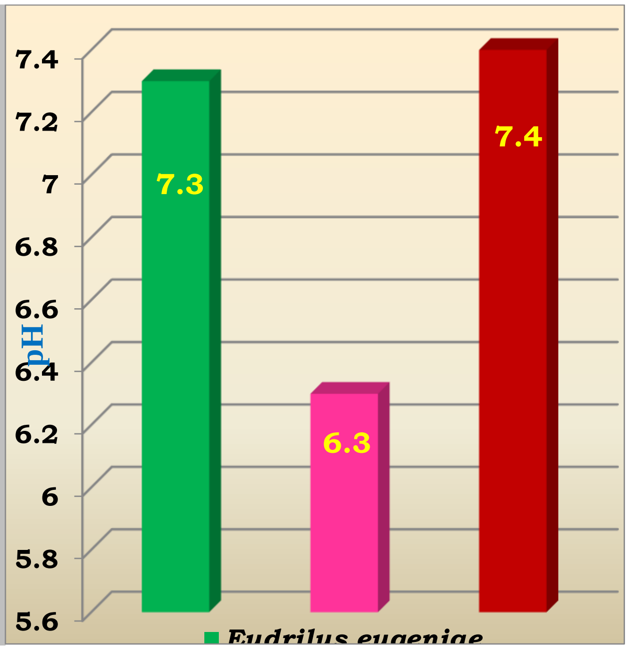
Influence of earthworm species on physical and chemical properties of the soil

Physico-Chemical Properties of Soil	Eudrilus eugeniae	Lampito mauritii	Octochaetona serrata
Tex	SL	SL	SL
LS	P	N	P
ES (dsm^{-1})	2.3	0.7	0.4
pH	7.3	6.3	7.4
N%	11.8	11.8	11.8
P%	0.48	0.52	0.58

K%	**0.75**	**1.0**	**0.90**



(Impact of earthworm species on EC (dsm^{-1}) values of the soil)



(Potential of earthworm species on pH of the soil)

3.2 MACROMINERAL PROFILE OF DIFFERENT SAMPLES OF SOIL

The soil inhabiting the *O. serrata* recorded the highest mean percentage of nitrogen content (1.13 ± 0.39) and phosphorus content (0.478 ± 0.019) whereas *L. mauritii* recorded the lowest content of nitrogen and phosphorus (1.042 ± 0.084 and 0.466 ± 0.037 respectively). The highest mean percentage of potassium content was recorded by *L. mauritii* (1.338 ± 0.261) while the *E. eugeniae* was recorded the lowest (0.826 ± 0.064).

Soil samples	**Statistics**	N% n = 5	P% n = 5	K% n = 5
Sample 1	Mean	1.106	0.468	0.826
	SD (σ)	0.04879	0.01305	0.06427
	Range	1.05 – 1.18	0.45 – 0.48	0.75 – 0.90
Sample 2	Mean	1.042	0.466	1.338
	SD (σ)	0.08468	0.03715	0.19917
	Range	0.96 – 1.18	0.42 – 0.52	0.90 – 1.40
Sample 3	Mean	1.13	0.478	1.088
	SD (σ)	0.39806	0.01924	0.19917
	Range	1.00 – 2.00	0.45 – 0.50	0.90 – 1.40

3.3 ONE WAY ANALYSIS OF VARIANCE (ANOVA) OF THE MACROMINERAL PROFILE OF SOIL SAMPLES

Macro mineral	**Source of variation**	**Sum of Squares**	**Degrees of freedom**	**Mean Square**	**F**
N%	**Between Groups**	**0.1806**	**2**	**0.0903**	**1.6125**
	Within Groups	**0.672**	**12**	**0.056**	
	Total	**0.8526**	**14**		

P%	**Between Groups**	**0.0004**	**2**	**0.0002**	**0.3333**
	Within Groups	**0.0077**	**12**	**0.0006**	
	Total	**0.0081**	**14**		
K%	**Between Groups**	**0.6555**	**2**	**0.3278**	**8.7647**
	Within Groups	**0.4421**	**12**	**0.0374**	
	Total	**1.0976**	**14**		

The calculated F value (1.6125 and 0.333) of the macro mineral profile (nitrogen and phosphorus respectively) of three different soils in habitat by earthworm species is less than the table value (3.88). As a result, the theory is accepted. So there is no discernible variation in the content of nitrogen and phosphorus present in the soil between species of earthworms. The calculated value of F (8.764) for potassium content is much more than the table value (3.88). So the theory is rejected. Hence the potassium level of the soil varies significantly across three earthworm species.

4. DISCUSSION

Threonine and glutamic acid were the two most abundant essential and non-essential amino acids in the three species of earthworms. These results are confirmed, and it is noted that glutamic acid (1.52% and 3.60% of the dry matter basis, respectively) predominated among the non-essential amino acids in earthworms and earthworm meal. [11]. The production of proteins and the supply of energy for the intestinal lining cells were both facilitated by glutamic acid. improves anti-inflammatory effects and immunological function, and helps prevent and treat ulcerative colitis and gastric ulcers [4]. In this study, threonine, when given to animal diet that boosts antibody production, yielded the greatest quantity of earthworm essential amino acid. According to species and feeding source, comparable variations were seen in the amino acid composition of earthworms and earthworm meal [12]. Dynes (2003) also verified that earthworms are excellent in protein quality (65%) and complete protein, containing all necessary amino acids. Lysine and methionine are 70-80% pure. In this investigation, glutamic acid, leucine, lysine, and arginine levels were comparable to or even higher than in fishmeal. Worms are therefore excellent probiotic feed for the fish, cattle, and poultry industries [13].

The studies carried out by Dedeke *et al.,* (2010) in the epigeic species observed that the concentration of both essential amino acids (lysine, histidine and phenylalanine) and the non-essential amino acids (serine, tyrosine and alanine) were similar to that of present study [9]. According to the nutritional comparison study, P. excavatus might be a good protein source for substituting fishmeal in fish feed. The protein content of this earthworm variety was determined to be within the limits of the protein demand (35 - 50%) for aquaculture diets. They imply that P. excavatus could potentially be employed as fresh meal for fish and as a feed element in fish feed.The pH and EC values of E. eugeniae vermicompost were greater (7.75 and 0.70 dsm-1) than those of L. mauritii (7.68 and 0.50 dsm-1). The macronutrients N, P, and K (1.27%, 0.65%, and 1.05%, respectively) were likewise greater in E. eugeniae than in L. mauritii (1.06%, 0.50%, and 0.86%). These findings are corroborated by Priya and Santhi (2014) [10]. The pH value of E. eugeniae and O. serrata was discovered to be neutral and coincided with that of Jairajpuri, (1993); Edwards and Bohlen, (1996) indicated that the majority varieties of earthworms prefer soils with pH values that are neutral [14,15]. Because earthworms are dependent on the hydrogen ion concentration, pH is a critical component in determining their dispersal (Chalasani et al., 1998). [16]. pH and pH-related parameters affect the distribution and number of earthworms in soil (Staaf, 1987) [17]. pH has a considerable positive association with the seasonal prevalence of juvenile and youthful adults (Reddy and Pasha, 1993). [18].

Most researchers believe that earthworm castings include more liquid-stable aggregates than surrounding soil and that their activity influences both water drainage from soil and soil moisture holding capacity, both of which are key variables in plant production [19]. Macronutrients like N and P were found to be higher in detritivorous species in *Octochaetona serrata* in the present study. Former laboratory research comparing L. terrestris and L. rubellus castings to the geophagous species A. caliginosa and Octolacion cyaneum discovered that both species' casts contained more nutrients than the soil. Furthermore, the detritivorous castings included larger quantities of C, N, P, and S rather than the geophagous deposits.

Earthworms have soil-beneficial effects, and many researchers have sought to show that these impacts boost plant development and agricultural yields. The conductivity of electricity is a soil characteristic that directly measures salinity and indirectly shows the overall concentration of soluble salts. Following the application of solitary compost or in conjunction with chemical fertiliser to rice and wheat crops, a general rise in the EC of normal soil was noted. Although the soil's EC rose in many treatments, the real values did not exceed the crucial level of 4.0ds m-1. The EC of the current research samples was determined to be 0.4-2.3 dsm1, which corroborated the previous findings. (Niklasch and Joergensen, 2001) discovered that when different types of organic materials were treated to acidic and alkaline soils, the EC rose [19].

Chemical fertiliser proven to be superior in terms of control. After wheat, this trend improved much more. The highest amount (2.34 m mol L-1) was found in wheat after harvest, whereas the lowest value (0.55 m mol L-1) was found in control. Potash can be found in a variety of forms, including freely accessible or water soluble, exchangeable, and fixed as part of a clay micelle. All of the shapes are in harmony with one another. A modification in one form inevitably causes equivalent changes in other forms. When acid or acid-forming substances are given to the soil in the form of compost, they alter potassium availability. The effect is beneficial, resulting in increased K availability to plants. The hydrogen ions generated by organic molecules are swapped with K on the exchange site or released from the clay micelle's fixed site. As a result, the general condition of the soil in terms of potassium availability improves. Other scientists' research supported the aforesaid notion. Our potassium content levels are comparable to the above data.It has been proposed that earthworms can affect the increased generation of plant growth-regulating chemicals by supporting significantly greater microbial activity in biological material and soils. It has been convincingly proven that some earthworm species are specialised to dwell in organic matter that decays and may convert it into tiny particle materials rich in accessible nutrients, with significant economic possibilities as plant growth medium or soil supplements.

CONCLUSION

Quantitative data is provided by the nutritional analysis of earthworms to substantiate the claim that these three species can meet their own daily protein and other trace element needs. Worms are currently largely used as an experimental feed source for aquacultured animals. Worms have a lot of promise as a food with high nutritional content and as recyclers of garbage. It is just a matter of time until many aquaculturists and feed manufacturers realise the financial benefits of raising worms as a cheap source of protein in light of the rising costs of conventional protein sources, such as fishmeal and soybean meal. By shredding leftovers and promoting microbial decomposition, earthworms improve soil fertility and physical soil characteristics like soil aggregation and infiltration.

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