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Impact analysis and confirmative study of physico-chemical, nutritional and biochemical parameters of vermiwash produced from different leaf litters by using two earthworm species

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Vermiwash is potential application in sustainable development for agriculture andbiotechnology. This experiment was carried out to asses the physico-chemical, nutritional and biochemical status of the vermiwash obtained using the popular composting earthworm species *Eudrillus eugeniae* (Kinb.) (Eudrilidae: Haplotaxida) and *Lampito mauritii* from three different leaf litters namely, Mango (*Mangifera indica*), Guava (*Psidium guajava*) and Sapota (*Achrus sapota*). The results showed substantial increase in the nutrient quality of the vermiwash produced with time in all of three cases. However, the vermiwash produced from guava leaf litter showed more content of electrical conductivity, magnesium, calcium, nitrite, phosphorus, carbohydrate, protein, lipid and amino acid compared with the vermiwash produced from the other two sapota and mango leaf litter by using the both earthworm species *Eudrillus eugeniae* and *Lampito mauritii* respectively. Comparison of physico-chemical, nutritional and biochemical parameters of the vermiwash produced from the present experiment with a standard commercially produced and marketed by A. L. N Farms, Thenkasi was also carried out to ascertain the quality of produced vermiwash. In the present experimental control attained the values of most of the parameters of the standard on 60^{th} day. Whereas, the vermiwash was produced by two composting earthworm species and leaf litters from three different plants in the experimental sets that attained the values of the parameters of the standard at an early days. It revealed that the quality of vermiwash can be achieved as in the standard even within 45 days with the use of these earthworms.

Key words: Vermiwash, *Eudrillus eugeniae*, *Lampito mauritii*, Nutrient analysis, Mango, Guava, Sapota.

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Introduction

Earthworms are cold blooded animals and live in a place where there is food, moisture, oxygen and favourable temperature are available. Approximately 3600 kinds of earthworms are found in the world and are represented from every soil type of the globe (Verma and Prasad, 2005). It feeds on dead organic matter present in soil that is ingested together and the later, along with the undigested food is finally egested in the form of worm castings that are rich in nitrate, available phosphorus, potassium, calcium and magnesium (Subbarao, 2002). It assimilates nutrients and energy from a wide range of ingested materials with variable efficiency, depending on the species and the nature of the ingested materials (Curry and Olaf, 2007). Vermiwash as a wonderful gift from the "farmer's friends" to boost up plant growth and yield so safely, economically and eco-friendly. It is the fluid collected by pouring water slowly through vermicompost or by washing the compost with water. It is a very nutritious input to plants since it contains a lot of minerals, micronutrients, hormones, vitamins, antibiotics, etc. in a form which is readily absorbable by plants. It is also a repository of different micro organisms which can fix atmospheric nitrogen and also increase the availability of phosphorus from the soil. It can either be applied as a foliar spray over the plants or drenched in soil. Plants treated with vermiwash are green much more resistant to pests and disease and also more vigorous in growth (Jayashree, 2006). In the light of information presented above, the present study was carried out to find out the physico-chemical, nutritional and biochemical availability in the vermiwash produced by two different composting earthworms namely *Eudrillus eugeniae* and *Lampito mauritii* when provided with the leaf litter from mango, guava and sapota trees.

Materials and methods

Collection and maintenance of experimental animals

The exotic, epigeic earthworm species *Eudrillus eugeniae* was selected for the present study. The earthworm, *Eudrillus eugeniae* was obtained from a farm in Srivilliputtur, while the earthworm, *Lampito mauritii* was collected from a field in Villuppanoor village near Srivilliputtur. The worms were transported safe along with native soil substrate in wet gunny cloth bag and introduced into separate containers having a composting bed prepared using cow dung and garden soil. This was maintained as a stock. The vermibed was kept moist by sprinkling water as and when required.

Collection and storage of cow dung

The cow dung was collected from a nearly dairy farm. This was shade dried, sieved and stored for use as the basic bedding material in vermicomposting. Most kinds of animal dung are highly attractive and nutritious food sources of earthworms.

Collection and storage of leaf litter

The leaf litter from three plants, Mango (*Mangifera indica*), Guava (*Psidium guajava*) and Sapota (*Achrus sapota*) locally from Periyapottalpatti near Sivakasi. These were then pounded and stored separately in plastic bags. Required quantities of this leaf litter were weighed out and sprinkled with water for pre-digestion. This pre-digestion leaf litter was used as the organic substrate in the present study.

Fabrication of vermiwash collection unit

The collection of vermiwash for the present study was carried out by the effective Earthen pot method (Sonia *et al*., 2007) developed in our lab. For this, the earthen pot with lid was placed over the tripod stand. A hole was made at the bottom of the pot to accommodate the nozzle of the blood transfusion tube and was fitted firmly using M-seal in order to prevent the leakage of vermiwash from the pot. The nozzle end facing inwards the pot was covered with an empty coconut shell and sponge like material to effect the filtration of vermiwash from the soil particles. The vermibed was prepared using gravel, sand, cow dung and sieved soil layered carefully one over the other. The earthworms were then introduced into the pots separately for the experimental purpose.

Experimental Set up

The grown up/ mature earthworms of equal length and weight from the stock of *Eudrillus eugeniae* and *Lampito mauritii* were selected and introduced separately into their respective experimental pots for its collection of vermiwash as follows. Seven earthen pots were taken separately (A1, A2, A3, B1, B2, B3 and C). The pods A1, A2 and A3 were for *Eudrillus eugeniae* in the number of fifty each. The pots B1, B2 and B3 were for *Lampito mauritii* in the number of fifty each. The pot C was the control without earthworm and leaf litter.

Collection of vermiwash

One hundred milligram of different leaf litter mango, guava and sapota after pre-digestion were added in A1, A2, A3 and B1, B2, B3 respectively and water was sprinkled with regular intervals in all pots to maintain the moisture content of 75-85 % RH and temperature at 25ºC. The water after percolation through the compost and burrows of the earthworms get collected amidst gravel bed. The vermiwash was collected at the base due to gravitational force. The roller in the blood transfusion tube was adjusted and the vermiwash was collected in fifteen day interval. Thus collections were made on the initial day (0 day) and on the 15^{th}, 30^{th}, 45^{th} and 60^{th} days respectively. The vermiwash were collected in the bottle placed at the bottom and analysed for the nutrient composition. The extract of the compost in the pot without earthworms and leaf litter was also collected simultaneously and considered as control. There collections were made on the same day and were treated as replicates in the present study. The vermiwash produced and marketed by A.L.N Farms, Thenkasi was obtained and used as a standard.

Physico-chemical analysis

The physico-chemical analyses of all the collected samples were carried out to get as idea about their nutrient status. For this, the vermiwash samples were diluted ten times and various parameters like as pH, Electrical conductivity, Alkalinity, Total hardness, Chloride and Salinity were studied in the every collected samples for the present study following standard procedures of APHA (American Public Health Association) (1975).

Nutritional analysis

The following nutritional parameters were studied in the samples of vermiwash collected following standard methodology. Walkey and Black method was used to estimate the Organic carbon described by Jackson (1973). Azoditization colorimetric method was used to estimate the Nitrite nitrogen (No2-N) and Vogels method was used to estimate the Phosphorus described by Ramarao *et al*., 1985.

Biochemical analysis

The following biochemical parameters were studied for the present study. Anthrone method was used to estimate the Carbohydrate of test samples. The total soluble protein was estimated by Lowry's *et al*., 1951. The estimation of

total lipids in the test samples was measured following the method of Modified Bragdon (1951). The quantitative estimation of Amino acid was measured using the Ninhydrin method followed by Plummer, 1982.

Statistical analysis

The results obtained in the present study were subjected to statistical analysis to ascertain their credibility. The standard deviation statistical tool was employed for the analysis of the data obtained in the present investigation.

Results

Vermiwash was a collection of excretory products and excess secretions of earthworms along with micronutrients from soil and digested organic matter or molecules. As the main substrates presented in the waste is of rich source of micro and macronutrients. Resultant complex materials can easily broken by secretary enzymes of earthworms. The physico-chemical, nutritional and biochemical parameters were observed in the present study include pH, EC, TH, magnesium, calcium, chloride, salinity, alkalinity, organic carbon, nitrite nitrogen, phosphorus, carbon : nitrogen, carbohydrate, protein, lipid and amino acid in the vermiwash produced from three types of leaf litter by using two types of earthworm species during a period of 60 days. In the control the pH value was 7.86 which decreased to 7.29, the EC value was 0.90 which increased to 1.73, values of the total hardness was 2.43 which greatly increased to 10.94, the initial magnesium and calcium content was 1.03 and 1.40 which increased to 4.99 and 5.95, the chloride and salinity content was 5.23 and 7.90 which decreased to 3.39 and 5.17, the alkalinity composition was 7.80 which increased to 9.23, the level of organic carbon was 6.83 which greatly reduced to 4.27, nitrite nitrogen and phosphorus content was 0.16 and 0.30 which increased to 1.42 and 0.57, the C:N ratio was 42.69 which greatly reduced to 3.0, the biochemical content of carbohydrate, protein, lipid and amino acid was 0.25, 0.62, 1.27 and 2.03 which increased to 2.94, 12.97, 10.61 and 12.64 respectively by the action of *Eudrillus eugeniae*. In the control the pH value was 7.86 which decreased to 7.47, the EC value was 0.90 which increased to 1.61, values of the total hardness was 2.43 which increased to 10.42, the initial magnesium and calcium content was 1.03 and 1.40 which increased to 4.75 and 5.67, the chloride and salinity content was 5.23 and 7.90 which decreased to 3.43 and 5.36, the alkalinity composition was 7.80 which increased to 8.99, organic carbon was 6.83 which reduced to 4.49, nitrite nitrogen and phosphorus initial level was 0.16 and 0.30 which increased to 1.13 and 0.52, the C:N ratio was 42.69 which greatly reduced to 4.40, the biochemical composition of

carbohydrate, protein, lipid and amino acid was 0.25, 0.62, 1.27 and 2.03 which increased to 2.45, 9.43, 9.94 and 11.90 respectively by the action of *Lampito mauritii* with the three different organic matter.

Table 1. Physicochemical, nutritional and biochemical parameters of vermiwash produced from mango leaf litter waste using *Eudrillus eugeniae* during a period of 60 days.

Parameters	Control					Mango leaf litter				
	0 day	15th day	30th day	45th day	60th day	0 day	15th day	30th day	45th day	60th day
pH	7.86± 0.05	7.83± 0.05	7.80± 0.01	7.76± 0.05	7.71± 0.01	7.86± 0.05	7.76± 0.05	7.66± 0.05	7.53± 0.05	7.42± 0.01
EC (mhos/cm^3)	0.90± 0.01	0.96± 0.05	1.06± 0.05	1.10± 0.01	1.12± 0.01	0.90± 0.01	1.13± 0.05	1.33± 0.09	1.60± 0.01	1.64± 0.05
TH (mg/l)	2.43± 0.05	2.93± 0.05	3.33± 0.05	3.90± 0.01	4.23± 0.01	2.40± 0.01	4.46± 0.12	5.96± 0.05	8.70± 0.01	10.20 ±0.05
Magnesium (mg/l)	1.03± 0.05	1.26± 0.05	1.30± 0.08	1.50± 0.01	1.59± 0.01	1.10± 0.01	1.93± 0.12	2.56± 0.12	3.90± 0.01	4.92± 0.01
Calcium (mg/l)	1.40± 0.01	1.66± 0.05	2.03± 0.05	2.40± 0.01	2.64± 0.05	1.30± 0.01	2.53± 0.05	3.40± 0.08	4.80± 0.01	5.28± 0.01
Chloride (mg/l)	5.23± 0.05	4.93± 0.05	4.73± 0.05	4.50± 0.01	4.39± 0.01	5.26± 0.05	4.83± 0.05	4.23± 0.05	3.70± 0.01	3.47± 0.01
Salinity (g/l)	7.90± 0.01	7.53± 0.05	7.23± 0.05	6.93± 0.05	6.64± 0.05	7.90± 0.01	7.06± 0.05	6.23± 0.05	5.63± 0.05	5.24± 0.01
Alkalinity (mg/l)	7.80± 0.01	8.03± 0.05	8.13± 0.05	8.40± 0.01	8.63± 0.01	7.80± 0.01	8.13± 0.05	8.33± 0.05	8.83± 0.05	8.94± 0.05
Organic carbon (%)	6.83± 0.05	6.56± 0.05	6.46± 0.05	6.23± 0.05	6.18± 0.01	6.70± 0.01	6.23± 0.05	5.43± 0.05	4.80± 0.01	4.38± 0.01
Nitrite (%)	0.16± 0.01	0.19± 0.01	0.23± 0.06	0.26± 0.01	0.29± 0.06	0.15± 0.06	0.32± 0.06	0.61± 0.01	0.91± 0.01	1.20± 0.06
Phosphorus (%)	0.30± 0.01	0.33± 0.01	0.35± 0.01	0.38± 0.01	0.41± 0.05	0.30± 0.01	0.37± 0.01	0.42± 0.01	0.46± 0.01	0.51± 0.01
C: N (%)	42.69± 3.29	34.53± 3.18	28.08± 0.08	23.96± 0.18	21.31± 0.08	44.67± 0.01	19.47 ± 0.05	8.90± 0.06	5.27± 0.01	3.65± 0.01
Carbohydrate (%)	0.25± 0.01	0.41± 0.01	0.64± 0.05	0.87± 0.01	0.93± 0.01	0.20± 0.06	0.78± 0.05	1.34± 0.01	2.50± 0.01	2.68± 0.05
Protein (%)	0.62± 0.01	1.03± 0.01	1.69± 0.01	2.50± 0.01	2.91± 0.01	0.83± 0.29	2.31± 0.01	4.76± 0.01	7.50± 0.01	8.99± 0.05
Lipid (%)	1.27± 0.06	1.87± 0.01	2.29± 0.01	2.87± 0.01	3.94± 0.01	1.36± 0.01	3.89± 0.01	6.23± 0.01	9.58± 0.01	10.02 ±0.05
Amino acid (%)	2.03± 0.01	2.98± 0.01	3.64± 0.01	4.21± 0.05	4.92± 0.01	2.03± 0.01	3.91± 0.05	7.01± 0.05	10.78 ±0.01	12.03 ±0.05

Each value is the average of 3 to 5 observations ± SD.

Table 2. Physicochemical, nutritional and biochemical parameters of vermiwash produced from guava leaf litter waste using *Eudrillus eugeniae* during a period of 60 days.

	Control					Guava leaf litter				
Parameters	0 day	15th day	30th day	45th day	60th day	0 day	15th day	30th day	45th day	60th day
pH	7.86± 0.05	7.83± 0.05	7.80± 0.01	7.76± 0.05	7.71± 0.01	7.86± 0.05	7.56± 0.05	7.46± 0.05	7.36± 0.05	7.29± 0.05
EC (mhos/cm^3)	0.90± 0.01	0.96± 0.05	1.06± 0.05	1.10± 0.01	1.12± 0.01	0.90± 0.01	1.30± 0.08	1.40± 0.08	1.70± 0.01	1.73± 0.05
TH (mg/l)	2.43± 0.05	2.93± 0.05	3.33± 0.05	3.90± 0.01	4.23± 0.01	2.40± 0.01	4.73± 0.05	6.13± 0.05	9.20± 0.01	10.94± 0.01
Magnesium (mg/l)	1.03± 0.05	1.26± 0.05	1.30± 0.08	1.50± 0.01	1.59± 0.01	1.10± 0.01	2.06± 0.05	2.80± 0.08	4.30± 0.01	4.99± 0.01
Calcium (mg/l)	1.40± 0.01	1.66± 0.05	2.03± 0.05	2.40± 0.01	2.64± 0.05	1.30± 0.01	2.66± 0.05	3.33± 0.12	4.90± 0.01	5.95± 0.05
Chloride (mg/l)	5.23± 0.05	4.93± 0.05	4.73± 0.05	4.50± 0.01	4.39± 0.01	5.30± 0.01	4.73± 0.05	4.36± 0.05	3.63± 0.05	3.39± 0.01
Salinity (g/l)	7.90± 0.01	7.53± 0.05	7.23± 0.05	6.93± 0.05	6.64± 0.05	7.86± 0.05	7.03± 0.05	6.06± 0.05	5.23± 0.05	5.17± 0.01
Alkalinity (mg/l)	7.80± 0.01	8.03± 0.05	8.13± 0.05	8.40± 0.01	8.63± 0.01	7.80± 0.01	8.33± 0.05	8.56± 0.05	9.00± 0.05	9.23± 0.05
Organic carbon (%)	6.83± 0.05	6.56± 0.05	6.46± 0.05	6.23± 0.05	6.18± 0.01	6.76± 0.05	5.96± 0.05	5.23± 0.05	4.46± 0.05	4.27±0 .01
Nitrite (%)	0.16± 0.01	0.19± 0.01	0.23± 0.06	0.26± 0.01	0.29± 0.06	0.15± 0.06	0.41± 0.01	0.84± 0.01	1.11± 0.01	1.42± 0.01
Phosphorus (%)	0.30± 0.01	0.33± 0.01	0.35± 0.01	0.38± 0.01	0.41± 0.05	0.30± 0.01	0.37± 0.01	0.45± 0.01	0.50± 0.01	0.57± 0.01
C: N (%)	42.69± 3.29	34.53± 3.18	28.08± 0.08	23.96± 0.18	21.31± 0.08	45.06± 0.31	14.54± 0.05	6.23± 0.05	4.02± 0.04	3.00± 0.01
Carbohydrate (%)	0.25± 0.01	0.41± 0.01	0.64± 0.05	0.87± 0.01	0.93± 0.01	0.20± 0.06	0.93± 0.01	1.81± 0.01	2.87± 0.01	2.94± 0.05
Protein (%)	0.62± 0.01	1.03± 0.01	1.69± 0.01	2.50± 0.01	2.91± 0.01	0.62± 0.01	4.30± 0.05	7.99± 0.01	11.87± 0.01	12.97± 0.05
Lipid (%)	1.27± 0.06	1.87± 0.01	2.29± 0.01	2.87± 0.01	3.94± 0.01	1.36± 0.01	4.64± 0.01	7.34± 0.01	10.13± 0.01	10.61± 0.05
Amino acid (%)	2.03± 0.01	2.98± 0.01	3.64± 0.01	4.21± 0.05	4.92± 0.01	2.03± 0.01	4.32± 0.01	8.10± 0.01	11.40± 0.05	12.64± 0.05

Each value is the average of 3 to 5 observations ± SD

Table 3. Physicochemical, nutritional and biochemical parameters of vermiwash produced from sapota leaf litter waste using *Eudrillus eugeniae* during a period of 60 days.

Parameters	Control					Sapota leaf litter				
	0 day	15th day	30th day	45th day	60th day	0 day	15th day	30th day	45th day	60th day
pH	7.86± 0.05	7.83± 0.05	7.80± 0.01	7.76± 0.05	7.71± 0.01	7.86± 0.05	7.66± 0.05	7.53± 0.05	7.43± 0.05	7.37± 0.05
EC (mhos/cm^3)	0.90± 0.01	0.96± 0.05	1.06± 0.05	1.10± 0.01	1.12± 0.01	0.90± 0.01	1.23± 0.05	1.36± 0.05	1.56± 0.05	1.59± 0.05
TH (mg/l)	2.43± 0.05	2.93± 0.05	3.33± 0.05	3.90± 0.01	4.23± 0.01	2.46± 0.05	4.53± 0.05	6.06± 0.05	9.03± 0.05	10.51± 0.01
Magnesium (mg/l)	1.03± 0.05	1.26± 0.05	1.30± 0.08	1.50± 0.01	1.59± 0.01	1.06± 0.05	2.06± 0.05	2.83± 0.05	4.23± 0.05	4.95± 0.01
Calcium (mg/l)	1.40± 0.01	1.66± 0.05	2.03± 0.05	2.40± 0.01	2.64± 0.05	1.40± 0.01	2.46± 0.05	3.23± 0.05	4.80± 0.01	5.56± 0.05
Chloride (mg/l)	5.23± 0.05	4.93± 0.05	4.73± 0.05	4.50± 0.01	4.39± 0.01	5.30± 0.01	4.86± 0.05	4.43± 0.05	3.66± 0.05	3.43± 0.01
Salinity (g/l)	7.90± 0.01	7.53± 0.05	7.23± 0.05	6.93± 0.05	6.64± 0.05	7.90± 0.01	7.06± 0.05	6.16± 0.05	5.56± 0.05	5.21± 0.01
Alkalinity (mg/l)	7.80± 0.01	8.03± 0.05	8.13± 0.05	8.40± 0.01	8.63± 0.01	7.83± 0.05	8.23± 0.05	8.43± 0.05	8.93± 0.05	9.01± 0.01
Organic carbon (%)	6.83± 0.05	6.56± 0.05	6.46± 0.05	6.23± 0.05	6.18± 0.01	6.80± 0.01	6.06± 0.05	5.43± 0.05	4.73± 0.05	4.31± 0.01
Nitrite (%)	0.16± 0.01	0.19± 0.01	0.23± 0.06	0.26± 0.01	0.29± 0.06	0.15± 0.06	0.39± 0.06	0.62± 0.01	0.99± 0.01	1.31± 0.01
Phosphorus (%)	0.30± 0.01	0.33± 0.01	0.35± 0.01	0.38± 0.01	0.41± 0.05	0.30± 0.01	0.34± 0.01	0.40± 0.01	0.48± 0.01	0.54± 0.01
C: N (%)	42.69± 3.29	34.53± 3.18	28.08± 0.08	23.96± 0.18	21.31± 0.08	45.33± 0.01	15.54± 0.05	8.76± 0.05	4.78± 0.11	3.29± 0.01
Carbohydrate (%)	0.25± 0.01	0.41± 0.01	0.64± 0.05	0.87± 0.01	0.93± 0.01	0.25± 0.01	0.90± 0.05	1.67± 0.01	2.62± 0.01	2.81± 0.05
Protein (%)	0.62± 0.01	1.03± 0.01	1.69± 0.01	2.50± 0.01	2.91± 0.01	0.62± 0.01	2.98± 0.01	5.94± 0.01	9.37± 0.01	10.03± 0.05
Lipid (%)	1.27± 0.06	1.87± 0.01	2.29± 0.01	2.87± 0.01	3.94± 0.01	1.32± 0.06	3.92± 0.01	6.61± 0.01	9.86± 0.01	10.30± 0.05
Amino acid (%)	2.03± 0.01	2.98± 0.01	3.64± 0.01	4.21± 0.05	4.92± 0.01	2.03± 0.01	4.01± 0.01	7.24± 0.01	10.93± 0.01	12.33± 0.01

Each value is the average of 3 to 5 observations ± SD

Table 4. Physicochemical, nutritional and biochemical parameters of vermiwash produced from mango leaf litter waste using *Lampito mauritii* during a period of 60 days.

Parameters	Control					Mango leaf litter				
	0 day	15th day	30th day	45th day	60th day	0 day	15th day	30th day	45th day	60th day
pH	7.86± 0.05	7.83± 0.05	7.80± 0.01	7.76± 0.05	7.71± 0.01	7.83± 0.05	7.74± 0.05	7.63± 0.05	7.56± 0.05	7.49± 0.01
EC (mhos/cm^3)	0.90± 0.01	0.96± 0.05	1.06± 0.05	1.10± 0.01	1.12± 0.01	0.90± 0.01	1.21± 0.01	1.37± 0.01	1.50± 0.01	1.55± 0.01
TH (mg/l)	2.43± 0.05	2.93± 0.05	3.33± 0.05	3.90± 0.01	4.23± 0.01	2.50± 0.01	4.33± 0.05	6.16± 0.09	8.40± 0.01	10.01± 0.01
Magnesium (mg/l)	1.03± 0.05	1.26± 0.05	1.30± 0.08	1.50± 0.01	1.59± 0.01	1.10± 0.01	1.93± 0.05	2.86± 0.05	4.00± 0.01	4.63± 0.01
Calcium (mg/l)	1.40± 0.01	1.66± 0.05	2.03± 0.05	2.40± 0.01	2.64± 0.05	1.40± 0.01	2.40± 0.01	3.30± 0.08	4.40± 0.01	5.38± 0.01
Chloride (mg/l)	5.23± 0.05	4.93± 0.05	4.73± 0.05	4.50± 0.01	4.39± 0.01	5.33± 0.05	4.86± 0.05	4.53± 0.05	3.90± 0.01	3.61± 0.01
Salinity (g/l)	7.90± 0.01	7.53± 0.05	7.23± 0.05	6.93± 0.05	6.64± 0.05	7.86± 0.05	7.26± 0.05	6.76± 0.05	6.03± 0.05	5.87± 0.05
Alkalinity (mg/l)	7.80± 0.01	8.03± 0.05	8.13± 0.05	8.40± 0.01	8.63± 0.01	7.80± 0.01	8.13± 0.05	8.46± 0.05	8.83± 0.05	8.99± 0.01
Organic carbon (%)	6.83± 0.05	6.56± 0.05	6.46± 0.05	6.23± 0.05	6.18± 0.01	6.80± 0.01	6.31± 0.05	5.47± 0.01	4.93± 0.05	4.60± 0.01
Nitrite (%)	0.16± 0.01	0.19± 0.01	0.23± 0.06	0.26± 0.01	0.29± 0.06	0.14± 0.01	0.31± 0.05	0.58± 0.01	0.88± 0.01	1.10± 0.01
Phosphorus (%)	0.30± 0.01	0.33± 0.01	0.35± 0.01	0.38± 0.01	0.41± 0.05	0.30± 0.01	0.35± 0.01	0.40± 0.05	0.44± 0.01	0.49± 0.01
C: N (%)	42.69± 3.29	34.53± 3.18	28.08± 0.08	23.96± 0.18	21.31± 0.08	48.57± 5.34	20.35± 0.18	9.43± 0.05	5.60± 0.05	4.82± 0.05
Carbohydrate (%)	0.25± 0.01	0.41± 0.01	0.64± 0.05	0.87± 0.01	0.93± 0.01	0.29± 0.05	0.72± 0.01	1.29± 0.01	1.87± 0.01	2.29± 0.05
Protein (%)	0.62± 0.01	1.03± 0.01	1.69± 0.01	2.50± 0.01	2.91± 0.01	0.62± 0.01	1.82± 0.05	3.47± 0.01	5.63± 0.01	7.04± 0.05
Lipid (%)	1.27± 0.06	1.87± 0.01	2.29± 0.01	2.87± 0.01	3.94± 0.01	1.40± 0.06	3.41± 0.01	6.53± 0.05	8.76± 0.01	9.02± 0.01
Amino acid (%)	2.03± 0.01	2.98± 0.01	3.64± 0.01	4.21± 0.05	4.92± 0.01	2.03± 0.01	3.10± 0.01	7.00± 0.05	10.00±0. 05	11.16± 0.05

Each value is the average of 3 to 5 observations ± SD

Table 5. Physicochemical, nutritional and biochemical parameters of vermiwash produced from guava leaf litter waste using *Lampito mauritii* during a period of 60 days.

Parameters	Control					Guava leaf litter				
	0 day	15th day	30th day	45th day	60th day	0 day	15th day	30th day	45th day	60th day
pH	7.86± 0.05	7.83± 0.05	7.80± 0.01	7.76± 0.05	7.71± 0.01	7.86± 0.05	7.79± 0.05	7.68± 0.05	7.63± 0.05	7.53± 0.01
EC (mhos/cm^3)	0.90± 0.01	0.96± 0.05	1.06± 0.05	1.10± 0.01	1.12± 0.01	0.90± 0.01	1.23± 0.01	1.41± 0.01	1.56± 0.05	1.61± 0.01
TH (mg/l)	2.43± 0.05	2.93± 0.05	3.33± 0.05	3.90± 0.01	4.23± 0.01	2.43± 0.05	4.33± 0.05	6.13± 0.09	8.50± 0.01	10.35± 0.01
Magnesium (mg/l)	1.03± 0.05	1.26± 0.05	1.30± 0.08	1.50± 0.01	1.59± 0.01	1.03± 0.05	1.73± 0.05	2.80± 0.08	3.90± 0.01	4.71± 0.01
Calcium (mg/l)	1.40± 0.01	1.66± 0.05	2.03± 0.05	2.40± 0.01	2.64± 0.05	1.40± 0.01	2.60± 0.01	3.33± 0.05	4.60± 0.01	5.64± 0.01
Chloride (mg/l)	5.23± 0.05	4.93± 0.05	4.73± 0.05	4.50± 0.01	4.39± 0.01	5.26± 0.05	4.76± 0.05	4.26± 0.05	3.76± 0.05	3.43± 0.01
Salinity (g/l)	7.90± 0.01	7.53± 0.05	7.23± 0.05	6.93± 0.05	6.64± 0.05	7.83± 0.05	6.99± 0.05	6.23± 0.05	5.70± 0.01	5.36± 0.01
Alkalinity (mg/l)	7.80± 0.01	8.03± 0.05	8.13± 0.05	8.40± 0.01	8.63± 0.01	7.80± 0.01	8.13± 0.05	8.53± 0.05	8.70± 0.01	8.90± 0.01
Organic carbon (%)	6.83± 0.05	6.56± 0.05	6.46± 0.05	6.23± 0.05	6.18± 0.01	6.73± 0.05	6.03± 0.01	5.43± 0.05	4.76± 0.05	4.49± 0.01
Nitrite (%)	0.16± 0.01	0.19± 0.01	0.23± 0.06	0.26± 0.01	0.29± 0.06	0.15± 0.06	0.38± 0.01	0.79± 0.05	0.92± 0.01	1.13± 0.05
Phosphorus (%)	0.30± 0.01	0.33± 0.01	0.35± 0.01	0.38± 0.01	0.41± 0.05	0.30± 0.01	0.36± 0.05	0.42± 0.01	0.46± 0.01	0.52± 0.01
C: N (%)	42.69± 3.29	34.53± 3.18	28.08± 0.08	23.96± 0.18	21.31± 0.08	44.87± 0.31	15.87± 0.12	6.87± 0.05	5.17± 0.12	4.40± 0.08
Carbohydrate (%)	0.25± 0.01	0.41± 0.01	0.64± 0.05	0.87± 0.01	0.93± 0.01	0.20± 0.06	0.83± 0.01	1.69± 0.01	2.25± 0.01	2.45± 0.05
Protein (%)	0.62± 0.01	1.03± 0.01	1.69± 0.01	2.50± 0.01	2.91± 0.01	0.62± 0.01	2.16± 0.01	4.35± 0.05	6.87± 0.01	9.43± 0.05
Lipid (%)	1.27± 0.06	1.87± 0.01	2.29± 0.01	2.87± 0.01	3.94± 0.01	1.36± 0.01	3.91± 0.01	6.82± 0.01	9.45± 0.01	9.94± 0.05
Amino acid (%)	2.03± 0.01	2.98± 0.01	3.64± 0.01	4.21± 0.05	4.92± 0.01	2.03± 0.01	4.02± 0.06	7.82± 0.01	10.62± 0.01	11.90± 0.05

Each value is the average of 3 to 5 observations ± SD

Table 6. Physicochemical, nutritional and biochemical parameters of vermiwash produced from sapota leaf litter waste using *Lampito mauritii* during a period of 60 days.

Parameters	Control					Sapota leaf litter				
	0 day	15th day	30th day	45th day	60th day	0 day	15th day	30th day	45th day	60th day
pH	7.86± 0.05	7.83± 0.05	7.80± 0.01	7.76± 0.05	7.71± 0.01	7.86± 0.05	7.78± 0.05	7.66± 0.05	7.53± 0.05	7.47± 0.01
EC (mhos/cm^3)	0.90± 0.01	0.96± 0.05	1.06± 0.05	1.10± 0.01	1.12± 0.01	0.90± 0.01	1.10± 0.01	1.32± 0.01	1.50± 0.01	1.56± 0.01
TH (mg/l)	2.43± 0.05	2.93± 0.05	3.33± 0.05	3.90± 0.01	4.23± 0.01	2.50± 0.01	4.56± 0.09	6.43± 0.05	8.60± 0.01	10.42± 0.01
Magnesium (mg/l)	1.03± 0.05	1.26± 0.05	1.30± 0.08	1.50± 0.01	1.59± 0.01	1.10± 0.01	1.96± 0.05	3.03± 0.05	4.10± 0.01	4.75± 0.01
Calcium (mg/l)	1.40± 0.01	1.66± 0.05	2.03± 0.05	2.40± 0.01	2.64± 0.05	1.40± 0.01	2.60± 0.14	3.40± 0.08	4.50± 0.01	5.67± 0.01
Chloride (mg/l)	5.23± 0.05	4.93± 0.05	4.73± 0.05	4.50± 0.01	4.39± 0.01	5.30± 0.01	4.83± 0.05	4.33± 0.05	3.80± 0.01	3.57± 0.01
Salinity (g/l)	7.90± 0.01	7.53± 0.05	7.23± 0.05	6.93± 0.05	6.64± 0.05	7.90± 0.01	7.03± 0.05	6.43± 0.05	5.76± 0.05	5.52± 0.01
Alkalinity (mg/l)	7.80± 0.01	8.03± 0.05	8.13± 0.05	8.40± 0.01	8.63± 0.01	7.83± 0.05	8.26± 0.05	8.63± 0.05	8.76± 0.05	8.94± 0.01
Organic carbon (%)	6.83± 0.05	6.56± 0.05	6.46± 0.05	6.23± 0.05	6.18± 0.01	6.83± 0.05	6.07± 0.05	5.62± 0.01	4.96± 0.05	4.63± 0.05
Nitrite (%)	0.16± 0.01	0.19± 0.01	0.23± 0.06	0.26± 0.01	0.29± 0.06	0.15± 0.06	0.36± 0.01	0.62± 0.05	0.87± 0.01	1.06± 0.01
Phosphorus (%)	0.30± 0.01	0.33± 0.01	0.35± 0.01	0.38± 0.01	0.41± 0.05	0.30± 0.01	0.35± 0.01	0.41± 0.01	0.45± 0.01	0.51± 0.01
C: N (%)	42.69± 3.29	34.53± 3.18	28.08± 0.08	23.96± 0.18	21.31± 0.08	45.53± 0.31	16.86± 0.15	9.06± 0.05	5.70± 0.13	4.89± 0.06
Carbohydrate (%)	0.25± 0.01	0.41± 0.01	0.64± 0.05	0.87± 0.01	0.93± 0.01	0.25± 0.01	0.79± 0.01	1.46± 0.06	2.12± 0.01	2.33± 0.06
Protein (%)	0.62± 0.01	1.03± 0.01	1.69± 0.01	2.50± 0.01	2.91± 0.01	0.62± 0.01	2.09± 0.05	4.12± 0.01	6.25± 0.01	8.86± 0.05
Lipid (%)	1.27± 0.06	1.87± 0.01	2.29± 0.01	2.87± 0.01	3.94± 0.01	1.32± 0.06	3.61± 0.01	6.71± 0.05	9.17± 0.01	9.49± 0.05
Amino acid (%)	2.03± 0.01	2.98± 0.01	3.64± 0.01	4.21± 0.05	4.92± 0.01	2.03± 0.01	3.94± 0.05	7.59± 0.01	10.31± 0.01	11.51± 0.01

Each value is the average of 3 to 5 observations ± SD

Table 7. Comparison of physicochemical, nutritional and biochemical parameters of vermiwash produced in this experiment with a commercial standard during a period of 60 days.

Parameters	Standard	Control	*Eudrillus eugeniae*			*Lampito mauritii*		
			Mango	Guava	Sapota	Mango	Guava	Sapota
pH	7.61±0.05	60 day	45 day	15 day	30 day	45 day	60 day	45 day
EC (mhos/cm^3)	1.72±0.01	60 day	60 day	45 day	60 day	60 day	60 day	60 day
TH (mg/l)	9.24±0.05	60 day	45 day	45 day	45 day	45 day	45 day	45 day
Magnesium (mg/l)	4.23±0.05	60 day	45 day	45 day	30 day	30 day	45 day	45 day
Calcium (mg/l)	4.92±0.05	60 day	45 day	45 day	45 day	45 day	45 day	45 day
Chloride (mg/l)	3.91±0.01	60 day	45 day	45 day	45 day	45 day	45 day	45 day
Salinity (g/l)	6.09±0.05	60 day	45 day	30 day	45 day	45 day	45 day	45 day
Alkalinity (mg/l)	8.74±0.05	60 day	30 day	30 day	30 day	30 day	45 day	30 day
Organic carbon (%)	4.74±0.05	60 day	60 day	45 day	60 day	60 day	30 day	60 day
Nitrite (%)	0.97±0.01	60 day	45 day	30 day	30 day	45 day	45 day	45 day
Phosphorus (%)	0.48±0.01	60 day	45 day	30 day	30 day	45 day	45 day	45 day
C: N (%)	4.05±0.05	60 day	60 day	45 day	60 day	60 day	60 day	60 day
Carbohydrate (%)	2.60±0.01	60 day	45 day	30 day	30 day	60 day	60 day	60 day
Protein (%)	9.35±0.01	60 day	60 day	30 day	30 day	60 day	45 day	60 day
Lipid (%)	8.79±0.01	60 day	30 day	30 day	30 day	45 day	30 day	30 day
Amino acid (%)	11.42±0.01	60 day	45 day	45 day	45 day	60 day	45 day	45 day

Discussion

The analysed physico-chemical, nutritional and biochemical, total sixteen parameters of the vermiwash produced from different leaf litters by these two composting earthworms experimented in the present study form and index of the quality of vermiwash produced, enabling the analysis of the nutrient status at different time intervals. In the present experiment, the level of analysed all parameters were comparatively mere in all the experiment with earthworm species of *E. eugeniae*. Alkalinity, nitrite nitrogen and protein levels were comparatively more in all the experiment with earthworm species of *L. mauritii*. All this can be considered to indicate the perfect blend of the nutrients to be present in the vermiwash produced by the action of *E. eugeniae*.

Therefore, it would be comparatively very effective if the production of vermiwash is carried out with *E. eugeniae*. The nutrient increase in the product is due to the fact that *E. eugeniae* has greater potential in the mineralization of waste and even capable of working on every strong pollutants like paper mill sludge (Umamaheshwari and Vijayalakshmi, 2003) and petrochemical sludge (Rajeshbanu *et al*., 2005). The quality of vermiwash produced with the use of leaf litter from three different plants namely mango, guava and sapota clearly show that the vermiwash potential of the earthworm species *E. eugeniae* and *L. mauritii* are largely influenced by the food quality. As a result the role of earthworms in the vermiwash production also depends on the nature of organic input. We judged that the quality of nutritional status of the sixteen parameters of produced and analysed samples, in the present study was an increased with the increase in the number of days of composting. Besides, the quality also

changed with reference to the addition of leaf litter from different plants. The neutralization of the pH level of the vermiwash produced in the experiment was great with mango leaf litter followed by sapota and guava respectively. In the present experiment, the parameters such as electrical conductivity, total hardness, magnesium, calcium, alkalinity, nitrite nitrogen, phosphorus, carbohydrate, protein, lipid and amino acid level were found to be higher in all the experiment with guava leaf litter by sapota and mango respectively. The organic degradable refuse of plant and animal origin have been shown to provide a good source of nutrients to improve productivity (Padmavathiamma *et al*., 2007). The physico-chemical, nutritional and biochemical parameters observed in the present point out that the leaf litters show a marginal difference in their nutrient status initially, but they showed improvement in their quality with duration. Further, the vermiwash produced from the leaf litter of guava appeared to be the best followed by sapota and mango, various researchers have established the viability of vermitechnology for the treatment of different wastes. The earthworms maintain aerobic conditions in organic wastes through proper mixing and enhance the microbial activity to selectively digest the wastes (Kumar and Sekaran, 2004). The nutrient level was comparatively higher in the vermiwash produced by *E. eugeniae* than that of the vermiwash produced by *L. mauritii*. The earthworms in the vermifilter bed were agile and healthy and achieved good growth throughout the period of study. They were much developed at the end of the study and even after 60 days several earthworms were seen wringgling down into the sand, gravels and inhabiting in the voids. These observations prove that *E. eugeniae* is comparatively a better soil macro fauna, which helps in the degradation of the organic matter and there by help the bioconversion of waste materials into valuable vermiwash. Earlier studies on the breakdown of plant residues with contrasting chemical composition in humic tropical conditions by the earthworm, *E. eugeniae* was found to have different effects on soil nutrient supply depending on residue quality (Tian *et al*., 1995).

Comparison of physico-chemical, nutritional and biochemical parameters of the vermiwash produced from the present experiment with a standard commercially produced and marketed by A. L. N Farms, Thenkasi was also carried out to ascertain the quality of vermiwash produced. In the present experiment the control attained the values of most of the parameters of the standard on 60^{th} day and the experimental sets attained the values of the parameters of the standard at an early day. It reveals that the quality of vermiwash can be achieved as in the standard even within 45 days with the use of these earthworms. Moreover, guava leaf litter was dealt better by *E. eugeniae* while *L. mauritii* was effective with sapota and mango leaf litter in the

production of vermiwash with in 45 days. Earthworms assimilate nutrients as energy from a wide range of ingested materials with variable efficiency depends on the species and the nature of the ingested materials (Curry and Olaf, 2007). Sumathi and Isaiarasu (2009) had already reported variability in the quality of vermicompost produced by *L. mauritii* when provided with different leaf litters. In the present study also the quality of vermiwash produced improved with duration of vermicomposting but at the same time the nature of leaf litter influenced the quality of vermiwash produced. The observation in the present study thus indicate that studies exploring the possibilities of employing earthworms with different substrate could offer more scope for the promotion of organic farming and sustainable agriculture.

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