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Bioconversion of perennial weeds of *Chromolaena odorata* (L.) R.M. King & H. Rob., *Sida rhombifolia* L., and *Lantana camara* L. by vermicomposting process

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ABSTRACT

Bioconversion of weeds through vermicomposting is getting momentum in sustainable organic farming, whilst mitigating negative impacts on the environment. The present study was conducted to find out the effect of three perennial weed species and the different ratio between weed to cow dung on the efficacy of Eisenia fetida and the physicochemical properties of vermicompost produced. The experiment was set up as a two-factor factorial completely randomized design with three replicates and 100% of cow dung was maintained as the control experiment. Factor one of the experiment was the weed species (Three weed species; Chromolaena odorata, Sida rhombifolia and Lantana camara) and factor two was the different ratio between weed and cow dung when preparing substrate by weight (four ratios; 100% weed, 75% weed + 25% cow dung, 50% weed + 50% cow dung, 25% weed + 75% cow dung). The results revealed that the interaction effect between weed species and the ratio of weed to cow dung on live biomass of earthworms (P<0.001), weight (P<0.001) and total dissolved solids (P<0.05) of the vermicompost was significantly different. The salinity and electrical conductivity of the vermicompost was significantly different among the main factors of weed species (P<0.01) and the ratio of weed to cow dung (P<0.01). The pH value of the vermicompost was significantly different only among the weed species (P<0.01). A significant difference was found between treatment combinations for the colour (P<0.01) of the vermicompost. However, the odour of the vermicompost harvested in different treatment combinations was not significantly different. The treatment combination of 50% Lantana camara and 50% cow dung performed better than the control for the growth and reproduction of earthworms. However, none of the treatment combinations performed better than the control for the weight of vermicompost. Furthermore, the pH of the vermicompost was not significantly different from the control. The treatment combination of 25% Chromolaena odorata and 75% cow dung was significantly different from the control on electrical conductivity, total dissolved solids and salinity of the vermicompost. According to the results of the experiment, the treatment combination of 50% cow dung and 50% Lantana camara L. by weight showed the highest efficacy on Eisenia fetida. Therefore, it can be concluded that the bioconversion of perennial weeds of Chromolaena odorata, Sida rhombifolia and Lantana camara were possible and 50% cow dung and 50% Lantana camara L. by weight produced the best quality vermicompost. Furthermore, it can be suggested that the perennial weed species of Lantana camara could be used to produce vermicompost effectively than the other weed species used in the study. Bioconversion of weed substrate without mixing of cow dung was not successful. Better performances of Eisenia fetida can expect by feeding partially degraded weed substrate.

Keywords: *Chromolaena odorata*, Earthworms, *Lantana camara*, *Sida rhombifolia*, Vermicompost

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INTRODUCTION

The process of converting organic waste into high-quality compost that consists of worm cast, with the aids of surface-dwelling earthworms is referred to as vermicomposting (Ismail, 2005; Devi and Prakash, 2015). The final product of vermicomposting is a finely divided peat-like compound that has excellent structure, aeration, porosity, drainage and water holding capacity (Ismail, 2005; Edwards *et al.*, 2011). Different digestive enzymes secreted by earthworms at different stages during the vermicomposting process break the macromolecules in the substrates (Usmani *et al.*, 2019). The unique advantage of vermicomposting is the persistence of agricultural activities by building and sustaining soil conditions and fertility (Rameshwar and Argaw, 2016). Moreover, it enhances the growth and yield of different field crops, vegetables, flowers and fruit crops (Nagavallemma *et al.*, 2004). Vermicompost is a significant component of organic farming due to its easy preparation, tremendous properties and harmless nature to the environment (Ramnarain *et al*., 2019).

The main biological agents of vermicomposting are microorganisms and earthworms. Microorganisms play a role in both composting and vermicomposting, whereas earthworms are the main biological agents of the vermicomposting process. Earthworms are considered as ecosystem engineers (Jones *et al.*, 1997; Barot *et al.*, 2007). They perform a substantial role in decomposition activities due to their symbiotic relationship with bacteria (Manaf *et al.*, 2009). Rameshwar and Argaw (2016) stated that the production and use of vermicompost is an economical and eco-friendly method in agriculture. In fact, it is low skilled required process. The efficiency of the vermicomposting process depends on the earthworm species and the substrate material used as feeding stock (Gajalakshmi *et al.*, 2001). Amongst, *Eisenia fetida* which belongs to the epigeic group of earthworms can be considered as a leading and effective earthworm species in the vermicomposting process.

Vermicomposting can be used as an alternative technology for the sustainable management of weeds. In general, weeds disrupt agricultural activities by competing for useful natural resources with the main crops, providing aids to spread pests and diseases, decreasing harvest yield and making agronomic practices difficult. Thus, weed management is an important aspect of agricultural activities to achieve sustainable yield. Many weed species are tested for suitability of decomposition by earthworms including, *Eichhornia crassipes* (Gajalakshmi *et al.*, 2001), *Colocasiae sculanta* (Kurien and Ramasamy, 2006), *Parthenium hysterophorus* (Yadav and Garg, 2011), *Hydrilla verticillta* (Jain *et al.*, 2018) and *Lantana camara* (Hussain *et al.*, 2016; Devi and Khwairakpam, 2019).

In Sri Lanka *Chromolaena odorata* L., *Sida rhombifolia* L. and *Lantana camara* L. are considered as noxious weeds that interrupt agricultural activities due to their quick and abundant growth. Siam weed, *Chromolaena odorata* (L.) R.M. King and H. Rob. (= *Eupatorium odoratum)* is a perennial shrub that belongs to the family Asteraceae. The plant is native to the America from the southern USA to Northern Argentina (Gautier, 1992). It already spread in South-East Asia, the Indian subcontinent, East Timor, Philippines, Papua New Guinea, several Pacific islands, and central, western, and southern Africa (Mondal and Ray, 2017). In Sri Lanka, it was introduced as an ornamental plant to Peradeniya, in 1884, and naturalized by the 1930s (Grierson, 1980). *Chromolaena odorata* disturbs commercial and subsistence agriculture including crops and plantation, grazing lands, and silviculture (Zachariades *et al.*, 2009), thus it can be considered as a notorious weed that is prevalent throughout the world. *Sida rhombifolia* L. which is known as arrow-leaf sida belongs to the family Malvaceae. It is widely distributed in Australia, India, and Sri Lanka, specifically in open grassy extents in tropical to warm temperate areas (Rahman *et al.*, 2011). *Sida rhombifolia* grows best in non-disturbed areas, although, it can be found in cultivated lands (Chauhan and Johnson, 2008).

Lantana camara belongs to the family Verbenaceae and it has been considered as one of the ten most harmful weeds globally (Devi and Khwairakpam, 2019). It is native to the Central, South America, and Caribbean islands with 35˚ N and 35˚ S geographical distribution (Day *et al.*, 2003). The presence of *Lantana camara* in the forests and agricultural fields is a severe threat, and effective management of this weed is the main task for the policymakers and scientific community (Suthar and Sharma, 2013).

These three weed species show invasive leading behavior. Hence, the management of these weeds is a major challenge in Sri Lanka, especially in arable lands and national parks.

The various methods including chemical, mechanical, cultural, and biological have been used to control weeds. However, these methods do not provide effective solutions for perennial weed management. Therefore, bioconversion of weeds using the vermicomposting process can be considered as an alternative approach for managing noxious weeds.

The present study was conducted to find out the effect of three perennial weed species and different proportions of three weed species and cow dung on efficacy of *Eisenia fetida* and the physicochemical properties of vermicompost.

MATERIALS AND METHODS

The present study was conducted at the Department of Crop Science, Faculty of Agriculture, University of Ruhuna, from November 2020 to March 2021. Three perennial weeds species of *Chromolaena odorata*, *Sida rhombifolia* and *Lantana camara* were (Plate 1) collected from the lands of the farm of the Faculty of Agriculture located in Mapalana, Kamburupitiya. The area is located in the low country wet zone (Weerasinghe *et al.*, 2000) receives an annual rainfall of about 2500 mm. The annual average air temperature is 22 - 30℃, and relative humidity is about 80%. The red earthworm species of *Eisenia fetida* (Plate 2) was collected near the cattle shed of the faculty farm. Before commencing the experiment, the required amount of *Eisenia fetida* was multiplied in plastic containers with 10 L of capacity. During the multiplication process, cow dung which is collected from the faculty farm, was used as culture media (Devi and Khwairakpam, 2019). In addition to cow dung, finely chopped fruit and vegetable peels were added to enhance the growth and reproduction of earthworms. Water was added when necessary, during the multiplication process. Drainage holes were made to remove excess water in each container. Containers were covered by nets to give protection from the external damages and kept under the shade condition for two months. The ambient temperature of the shade house was between 25 - 29℃ during the process.

Weed plant materials were allowed to wither for five to seven days in a shaded place to release volatile compounds and excess water. Then, wilted weed substrates were chopped into small pieces of 1-2 cm manually.

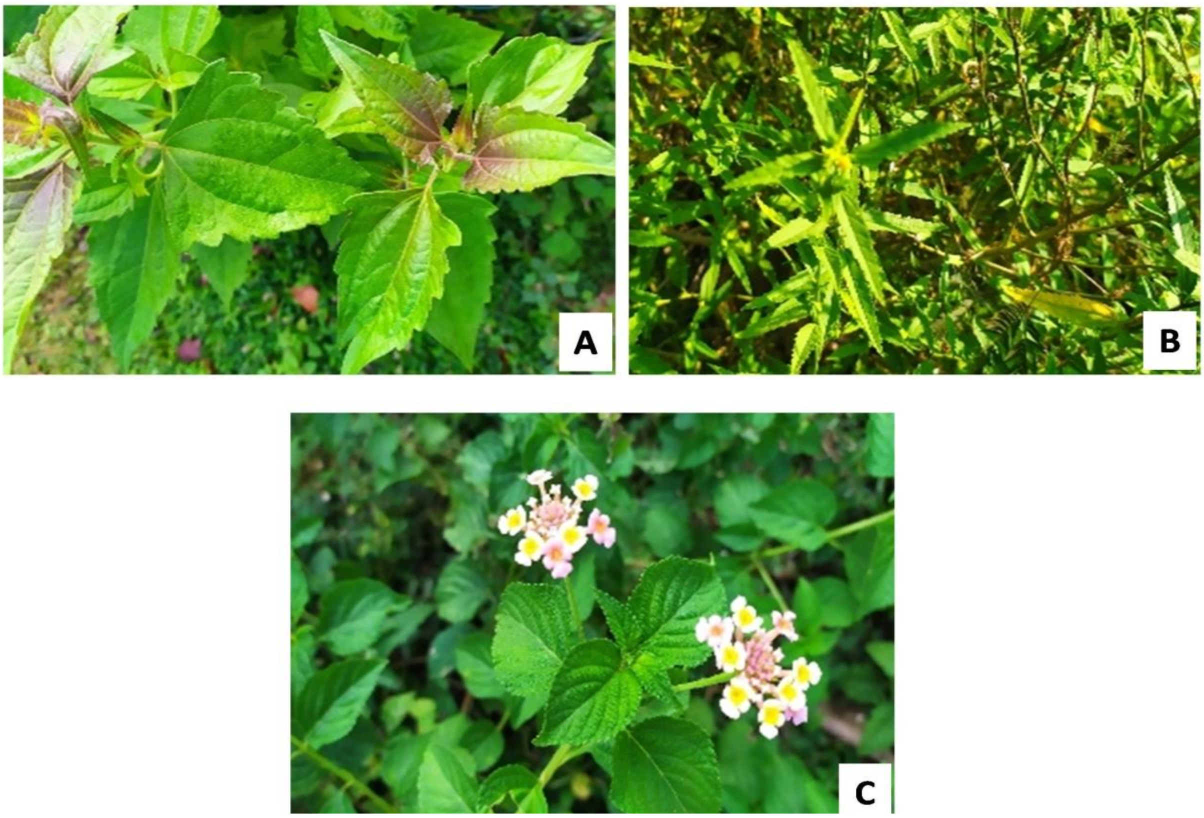

Plate1: Three weed species used in the study (A) *Chromolaena odorata* (B) *Sida rhombifolia*(C) *Lantana camara*

Plate 2: The *Eisenia fetida* earthworm species

Experimental Design and treatment combinations

The experiment was conducted in plastic pots having a capacity of 10 L with small drainage holes at the bottom. Two-factor factorial completely randomized design was used to set up the experiment with triplicates. Treatment combinations were allocated randomly within the experiment. Factor one of the experiments had three levels (Three weed species; *Chromolaena odorata*, *Sida rhombifolia* and *Lantana camara*) and the factor two had four levels as different ratio between weed and cow dung by weight (four ratios; only 100% weed, 75% weed + 25% cow dung, 50% weed + 50% cow dung, 25% weed + 75% cow dung). The bedding material of 100g was added for the bottom of 36 reactors and approximately 12g of *Eisenia fetida* was added to the bedding material of each reactor. Four different proportions of cow dung and plant materials (Table 1) were added to all reactors up to 500 g and covered using nets. As a control experiment, 100% of cow dung was maintained in triplicates in addition to the 12 treatment combinations. The ambient temperature was in between 25℃ to 29℃ during the process. Vermicompost was harvested 75 days after the establishment. Harvested vermicompost samples were sieved using a 2 mm sieve and then air-dried.

Table 1: Treatment Combinations in the Study

Weed species (Factor 1)	Cow dung and weed ratio (Weight basis) Factor 2			Treatment combination
	Cow dung %	Weed substrate %	Symbol	
Chromolaena odorata	75	25	W1P1	T_1
	50	50	W1P2	T_2
	25	75	W1P3	T_3
	0	100	W1P4	T_4
Sida rhombifolia	75	25	W2P1	T_5
	50	50	W2P2	T_6
	25	75	W2P3	T_7
	0	100	W2P4	T_8
Lantana camara	75	25	W3P1	T_9
	50	50	W3P2	T_{10}
	25	75	W3P3	T_{11}
	0	100	W3P4	T_{12}

Remarks: As a control experiment, three replicates of 100% cow dung was maintained in addition to the treatment combinations

Measurements

The live biomass of earthworms, weight, pH, electrical conductivity (EC), total dissolved solid (TDS), and salinity of the vermicompost were measured as quantitative parameters. The colour and the odour of the vermicompost were recorded as qualitative measurements. The qualitative parameters of vermicompost were evaluated using scoring criteria (Table 2). The earthworms were separated manually and zoomass of earthworms in each reactor was measured after harvesting of vermicompost.

The air-dried weight of vermicompost was recorded in each reactor. Then, the air-dried vermicompost from each reactor (5 g) was dissolved in 25 ml of distilled water to produce an aqueous solution of vermicompost. Then, the samples were allowed to settle for 10 minutes and the pH of each sample was measured using EXTECH pH meter and EC, TDS, and salinity of each sample were measured using Walk LAB Conductivity, TDS, and Salinity meter. Average values of each measurement were taken for treatment combinations from three replicates.

Table 2: Scoring criteria for the qualitative parameters of the vermicompost harvest

Scale	Colour	Smell
1	Light brown	Extremely bad odour
2	Brown	Moderately bad odour
3	Dark brown	Bad odour
4	Grayish black	Odourless
5	Black	Earthy smell

Statistical analysis

The statistical analysis was done at 5% probability level by means of one way ANOVA using SAS software for the quantitative data. The Duncan Multiple Range Test at the probability of 5% was used to compare means. Mean separation comparison of treatments with the control was performed using Dunnett's test. Qualitative data analysis was done using the Kruskal-Wallis test with the aid of SPSS software. Descriptive data were presented using charts and graphs.

RESULTS AND DISCUSSION

Vermicomposting experiments depend on the production of earthworms, which is a significant and integrated aspect of the vermicomposting process (Ananthavalli *et al.,* 2019). There was a significant interaction ($p<0.001$) between weed species and the ratio of weed and cow dung on the live biomass of earthworms. According to Figure 1, *Lantana camara* with the combination of 50% with50% of cow dung was the most suitable weed species and the ratio for growth and reproduction of earthworms. Numerous organic materials determine the efficacy of vermicompost and some of the materials have been already examined for the growth and reproduction of earthworms (Nagavallemma *et al.,* 2004). The population of compost worms can be expected to be doubled every 60 - 90 days when there is adequate food, well-aerated bedding with 70 - 90% of moisture content, temperature between 15 - 30℃ and initial stocking densities between 2.5 - 5 kgm^{-2} (Munroe, 2007). Najar and Khan (2010) found that earthworm biomass increment might be due to the consumption of substrates enriched with nutrients, resulting in enhancement of the reproduction capability of earthworms. Also, the nature of bulking material like cow dung determine the growth and reproduction of earthworms (Negi and Suthar, 2013; Sharma and Garg, 2018).

Eisenia fetida has superior adaptation to various organic feeds and they can tolerate a wide range of abiotic environmental conditions (Devi and Khwairakpam, 2019). Moreover, the earthworm population is governed by food and its quantity, and the higher nitrogen ratios caused to enhance rapid growth and cocoon production of earthworms (Gajalakshmi and Abbasi, 2004). Therefore, in the present study, the highest live biomass change observed in thereactor which contains 50% of *Lantana camara* and 50% of cow dung may be attributed to the higher availability of nutrients during the vermicomposting process and it may enhanced the growth and reproduction of the earthworms.

The growth and reproduction of the earthworms in some reactors have not been supported in the current study. Correspondingly, 100% of *Chromolaena odorata* was the worst weed species affected badly on the growth and reproduction of earthworms. Earthworms' growth parameters are affected by organic waste palatability for earthworms that are directly related to the chemical composition of the organic substances (Najar and Khan, 2013; Sharma and Garg, 2019) and survival, growth rate and reproductive capacity of the earthworms (Sharma and Garg, 2019). On one hand, the reason for the poor performance of earthworms may be due to toxic materials and the chemical composition of the weed substrates, which caused to diminish earthworm's growth and reproduction. On the other hand, it may be due to the prevention of air entering to the bottom of the reactors due to the sticky nature of the weed substrates. Therefore, increment of the wilting period of the weed materials can be done for further release of toxic compounds. Gunadi *et al*. (2002) suggested that pre-composting of wastes can be used to reduce most of the chemicals incompatible for earthworms. Further reduction of the size of weed materials is also possible since bioconversion is easy and rapid when the size of the substrate material is small

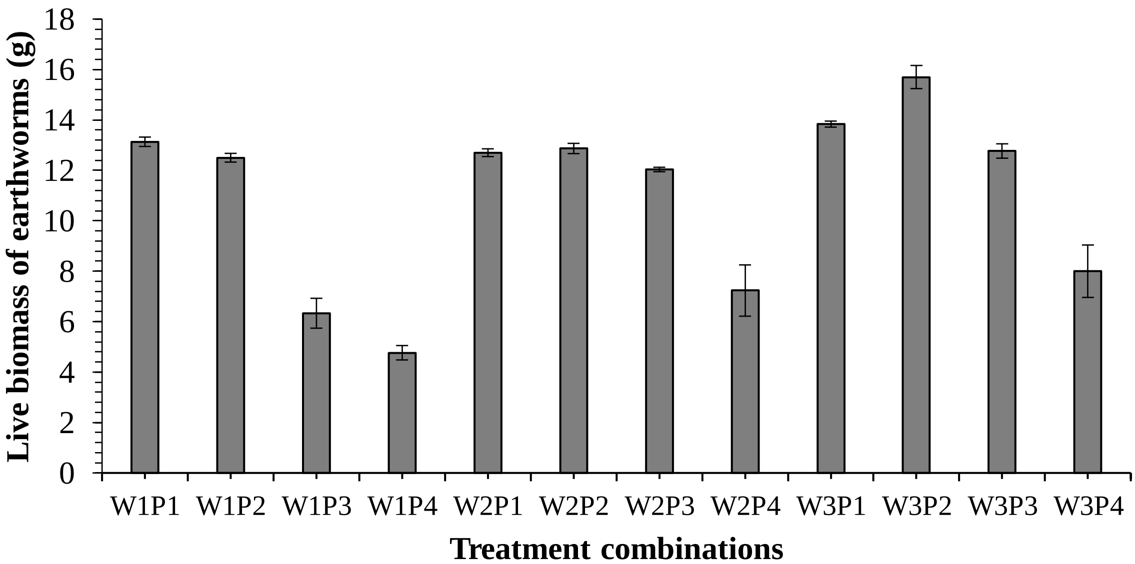

Figure 1: Mean live biomass of earthworms in different treatment combinations ($p<0.001$). The standard error of the mean is indicated by error bars.

There was a significant interaction ($p<0.001$) between species of weed and ratio of weed and cow dung on the weight of vermicompost harvested (Table 3). The highest yield of vermicompost was obtained from the reactor that contained 25% of *Lantana camara* and 75% of cow dung. Cow dung may easily be decomposed by earthworms than plant materials.

Vermicompost production is affected by several factors including, initial population, types, reproductive and metabolic activities of the earthworms, physicochemical, nutrient composition and amount of the substrates and time duration for the vermicomposting process (Sharma and Garg, 2017). Das and Deka (2021) found a significant increment of the vermicompost production after the addition of cow dung in their study related to the vermicomposting of harvested waste biomass of potato crops. According to Sinha *et al.* (2002) earthworms feed easily on cow dung like partially decomposed materials which are primarily degraded by microorganisms. Hence the addition of cow dung is advantageous for the production of vermicompost.

Besides, rapid bioconversion of the substrate was observed in the treatment combinations where high proportion of cow dung was presented. Therefore, it can be suggested that the rate of the bioconversion process may be enhanced by cow dung.

Table 3: Weight of vermicompost according to the treatment combinations with standard error of the means

Weed species (W)	Cow dung: weed ratio by weight (R)		Weight of vermicompost (g)
	Cow dung %	**Weed substrate %**	
Chromolaena odorata	75	25	77. 57^{a}±2.80
	50	50	42.00^{c}±2.75
	25	75	24.33^{e}±1.33
	0	100	13.83^{gf}±2.93
Sida rhombifolia	75	25	41.23^{c}±0.75
	50	50	32.93^{d}±3.49
	25	75	19.63^{ef}±3.19
	0	100	12.00^{gf}±2.96
Lantana camara	75	25	84.27^{a}±6.40
	50	50	52.40^{b}±8.21
	25	75	26.60^{de}±9.99
	0	100	10.93^{g}±2.48
P value (W x R)		< 0.001	
CV%		13.048	

Remarks: CV%- Coefficient of variance. Mean values followed by the same letters are not significantly different at α =0.05

Earthworms are very sensitive to hydrogen ions concentration in the substrates (Singh and Prakash, 20E09). The interaction effect between weed species and the ratio of weed and cow dung was not significantly different for the pH of the vermicompost. The pH of the harvested vermicompost was significantly different among the weed species ($p<0.01$), but not significantly different among the ratio of weed and cow dung (Table 4). The highest pH was observed in *Sida rhombifolia* and it was significantly different from the pH of the vermicompost produced using *Chromolaena odorata* and *Lantana camara*. The pH value was near neutral at the end of the vermicomposting process.

Similar trend was observed in previous studies with different proportions of *Lantana camara* (Garg and Gupta, 2011; Porkodi and Amruththa, 2014; Devi and Khwairakpam, 2019). However, the findings of the current study are conflicting with the findings of Yadav and Garg (2019) who reported pH towards the acidic state in their studies with different types of organic matter. The pH of the vermicompost depends on the acidic content of the substrate materials (Hanc and Chadimova, 2014) and the different intermediate compounds of the substrates (Singh and Kalamdhad, 2016). Therefore, the pH of the vermicompost may vary according to the substrate used for the vermicomposting.

Table 4: pH values of the vermicompost prepared from different weed species with standard error of the means

Weed species	**pH value**
Chromolaena odorata	$6.87^{b}\pm0.21$
Sida rhombifolia	$7.53^{a}\pm0.67$
Lantana camara	$7.05^{b}\pm0.44$
P value	P<0.01
CV%	7.127754

Remarks: CV%- Coefficient of variance. Mean values followed by the same letters are not significantly different at α =0.05

The interaction effect between species of weed and ratio of weed and cow dung was not significantly different for EC of the vermicompost. However, it was significantly different among weed species ($p<0.01$) and the ratio of weed and cow dung ($p<0.01$) (Table 5). The final EC were in the range of 5.33 – 7.52 mS/cm.

The formation of soluble salts during the degradation process of organic matter clues to the liberation of Calcium, total Phosphorus, and Potassium which are known as exchangeable minerals into the vermi-reactors affecting to intensify the EC value of vermicompost (Yadav and Garg, 2019). Devi and Khwairakpam (2019) suggested that the vermicompost reactors with high concentrations of mineral including Calcium, Phosphorus and Potassium havedirect association between the proportional increments of EC in the vermicompost.

The EC values of the vermicompost which was produced using *Chromolaena odorata* was significantly different from vermicompost produced from *Sida rhombifolia* and *Lantana camara*. Furthermore, EC depends on the cow dung concentration and when cow dung concentration was increased the EC values were gradually decreased. Therefore, it can be suggested that the EC value of the vermicompost is determined by both of the factors which used in the study.

Table 5: Electrical conductivity (EC; mS/cm) of the vermicompost according to the treatment combinations with standard error of the means

Treatment	**EC (mS/cm)**
Chromolaena odorata	$7.51^{a}\pm1.47$
Sida rhombifolia	$6.13^{b}\pm1.76$
Lantana camara	$5.99^{b}\pm1.06$
Weed species (P value)	**P<0.01**
Ratio 1	$7.52^{a}\pm1.63$
Ratio 2	$6.74^{a}\pm0.61$
Ratio 3	$6.55^{a}\pm1.58$
Ratio 4	$5.33^{b}\pm1.47$
Ratio (P value)	**P<0.01**
CV%	**17.15620**

Remarks: CV%- Coefficient of variance. Mean values followed by the same letters are not significantly different at α =0.05

The salinity of the vermicompost was not significantly influenced by the interaction between weed species and the ratio of weed and cow dung. However, the salinity of the vermicompost was significantly different among weed species (p<0.01) and weed to cow dung ratio (p<0.01) (Table 6). The vermicompost, which was produced using *Chromolaena odorata* was recorded the highest salinity among the other two weed species. The salinity value was reduced when the cow dung percentage of the reactor was reduced. Salinity indicates the amount of salts dissolved in a suspension. Therefore, *Chromolaena odorata* was responsible for the high amount of salts during the vermicomposting process, and the highest cow dung ratio was represented the higher salt content in vermicompost. Besides, EC reveals the salinity of the vermicomposting substrates (Choudhary *et al.*, 2019) and a similar trend between EC and salinity of the vermicompost can be identified in the present study.

Table 6: Salinity (ppt) of the vermicompost according to the treatment combinations with standard error of the means

Treatment	Salinity (ppt)
Chromolaena odorata	5.79^{a}±1.34
Sida rhombifolia	4.18^{b}±1.24
Lantana camara	4.01^{b}±0.43
Weed species (P value)	**P< 0.01**
Ratio 1	5.24^{a}±1.24
Ratio 2	5.13^{a}±1.32
Ratio 3	4.48^{ab}±1.21
Ratio 4	3.71^{b}±1.04
Ratio (P value)	**P<0.01**
CV%	18.32853

Remarks: CV%- Coefficient of variance. Mean values followed by the same letters are not significantly different at α =0.05

TDS indicates total organic and inorganic substances which present in a suspension (Thirumalini and Joseph, 2009). In the present study, there was a significant interaction (P<0.05) between species of weed and the ratio of weed and cow dung on TDS of the vermicompost (Table 7). Therefore, the treatment combination of 25% *Chromolaena odorata* and 75% cow dung may be responsible for the highest availability of organic and inorganic compounds of the vermicompost.

Table 7: TDS (ppt) on vermicompost harvest in different treatment combinations with standard error of the means

Weed species (W)	**Cow dung: weed ratio by weight (R)**		**TDS (ppt)**
	Cow dung %	**Weed substrate %**	
Chromolaena odorata	75	25	$4.38^{a}\pm0.93$
	50	50	$3.52^{abc}\pm0.08$
	25	75	$4.23^{ab}\pm0.49$
	0	100	$3.33b^{c}\pm0.25$
Sida rhombifolia	75	25	$3.55^{abc}\pm0.20$
	50	50	$3.59^{abc}\pm0.24$
	25	75	$3.03^{c}\pm0.86$
	0	100	$1.79^{d}\pm0.43$
Lantana camara	75	25	$2.84^{c}\pm0.30$
	50	50	$3.05^{c}\pm0.15$
	25	75	$2.90^{c}\pm0.60$
	0	100	$2.88^{c}\pm0.14$
P value (W x R)		$P<0.05$	
CV%		15.14654	

Remarks: CV%- Coefficient of variance. Mean values followed by the same letters are not significantly different at $\alpha = 0.05$

Compared to the control treatment with the combinations, 50% of *Lantana camara* and 50% cow dung recorded the highest live biomass, which was significantly different from the control experiment (Table 8). Therefore, the growth and reproduction of earthworms may improve in the combination of 50% of *Lantana camara* and 50% cow dung than the control experiment. The weight of vermicompost of all treatment combinations was significantly different from the control treatment of the experiment (Table 8). Therefore, it can be suggested that partial degradation may enhance the production of vermicompost than directly vermicomposting of the materials. The pH of the vermicompost was not significantly different among the control treatment and the treatment combinations (Table 8). Therefore, pH variation may be only due to the three weed species used for the study. Furthermore, there was significant different between the treatment combination of 25% *Chromolaena odorata* and 75% cow dung and the control experiment on EC, TDS and salinity of the vermicompost (Table 8). Salinity increases with the breakdown and release of mineral ions from the substrate material and it is directly related to TDS of the substrate material, whilst EC reflects only the conductive ions (Choudhary *et al.*, 2019). Therefore, the treatment combination of 25% *Chromolaena odorata* and 75% cow dung may be attributed to the higher availability of exchangeable ions, organic and inorganic substances and salts than the 100% of cow dung.

Table 8: Mean comparison of the treatment combinations with control experiment for the live biomass of earthworms

Treatment combination	**Live biomass of earthworms (g)**	**Weight of vermicompost (g)**	**pH**	**EC (mS/cm)**	**TDS (ppt)**	**Salinity (ppt)**
W1P1 Vs Control	0.3333	-95.300*	-0.0400	2.8200*	1.4167*	2.7667*
W1P2 Vs Control	-0.3000	-130.867*	-0.1700	1.0817	0.5483	1.9667
W1P3 Vs Control	-6.4667*	-148.533*	-0.1733	1.5233	1.2633	1.7667
W1P4 Vs Control	-8.0333*	-159.033*	-0.2533	0.7267	0.3667	0.5333
W2P1 Vs Control	-0.1000	-131.633*	0.1967	1.1533	0.5800	0.8333
W2P2 Vs Control	0.0667	-139.933*	0.3533	1.2533	0.6267	0.9000
W2P3 Vs Control	-0.7667	-153.233*	0.4633	1.0067	0.0667	0.1000
W2P4 Vs Control	-5.5667*	-160.867*	0.9867	-2.3667	-1.1800	-1.6667
W3P1 Vs Control	1.0333	-88.600*	0.0733	0.0733	-0.1317	-0.1333
W3P2 Vs Control	2.9000*	-120.467*	0.1833	0.1667	0.0867	0.1333
W3P3 Vs Control	-0.0333	-146.267*	-0.1367	-0.5500	-0.0667	-0.3667
W3P4 Vs Control	-4.8000*	-161.933*	-0.0433	-0.1767	-0.0867	-0.1333

Remarks: Comparisons significant at the 0.05 probability level are indicated by *

The colour of the vermicompost of 12 treatment combinations were significantly different ($P<0.01$) (Plate 3) while the odour was not significantly different. Colour variation may be due to the various chemical compounds present in weed substrates.

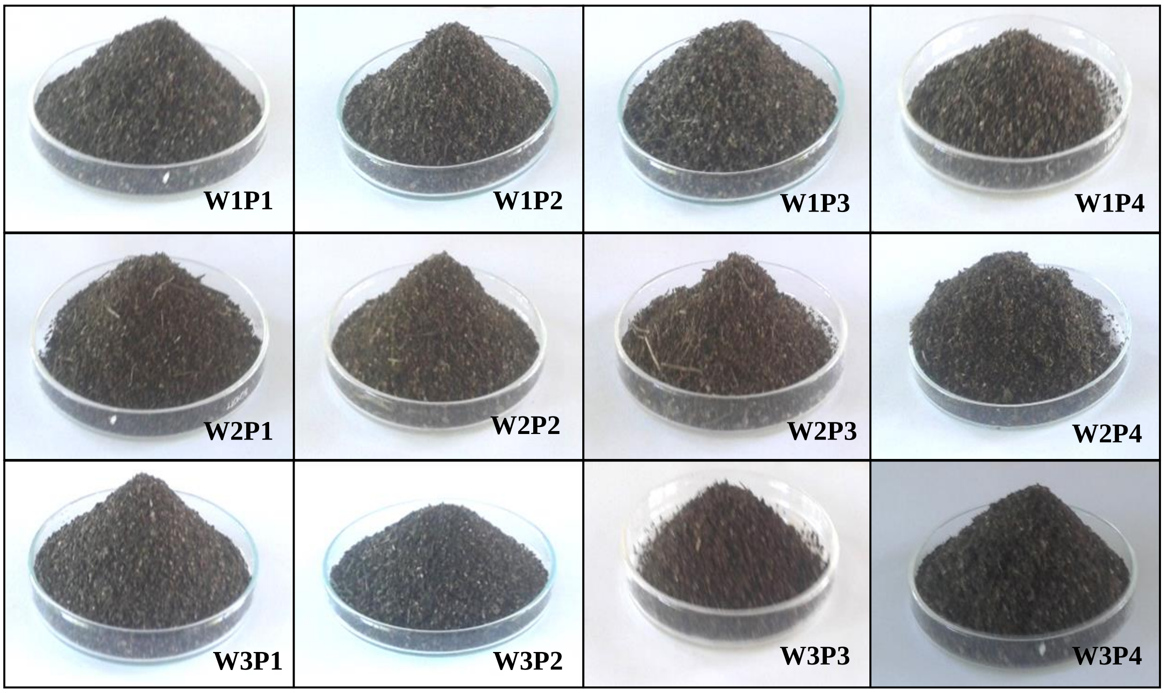

Plate 3: Vermicompost harvest from different treatment combinations

CONCLUSION

According to the findings of the present study, there was a significant interaction between weed species and the ratio of weed to cow dung on weight of earthworms, weight of vermicompost harvest, and total dissolved solids of the vermicompost. Salinity and EC of the vermicompost were significantly different among weed species and the ratio of weed to cow dung. However, pH of the vermicompost was significantly different only among weed species. The treatment combination of 50% *Lantana camara* and 50% cow dung was the most suitable ratio for enhancing the efficacy of the *Eisenia fetida.* Therefore, it can be suggested that the perennial weed species of *Lantana camara* could be used to produce vermicompost effectively than the other weed species used in the study. Furthermore, bioconversion of weed substrate without mixing of cow dung was not successful. Better performances of Eisenia fetida can expect by feeding partially degraded weed substrate.

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