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Feasibility of using Problematic Aquatic Weeds in Productive Manner by Generating Vermicompost in Coconut Triangle Area of Sri Lanka

S.H.S. Senarathne[1], H.N. Dayananda[2], A.A.A.J Atapattu[1] and S.A.S.T Raveendra[1]

Abstract

Aquatic weeds cause severe productivity loss in agriculture. These plants invade lakes, ponds, rivers, canals and agricultural fields, becoming noxious weeds. The study was conducted at the vermicomposting unit of the Coconut Research Institute, Lunuwila, in the Low country Dry Zone of North Western province of Sri Lanka from August 2012 to May 2013 to find out the feasibility of producing vermicompost from three aquatic weeds; *Salvinia molesta, Eichhornia crassipes and Lagenandra toxicaria.* Vermicompost and compost were prepared separately from aquatic weeds and *Gliricidia* and *Guinea* grass combinations. During the vermicomposting process, growth parameters of earthworms; number of earthworms, was taken in every ten days interval further, physical, chemical and biological properties of compost and vermicompost were analyzed. Experiment was carried out in a Complete Randomized Design (CRD) with eight treatment and five replicates in each treatment. *Eichhornia* and *Salvinia* recorded the highest adult earthworm number and juvenile number with the lowest mortality rate. Electrical conductivity (6.75 dSm^{-1}), organic carbon (13.21%), phosphorous (3.61%), potassium (5.03%) and calcium (6.12%) were significantly high in *Lagenandra toxicaria*, *Gliricidia* and *Guinea* grass treatment was significantly high in nitrogen content (3.93%) and low in C: N ratio (2.51), compared to aquatic weeds. *Salvinia* showed comparatively higher nitrogen content and lower C: N ratio among aquatic weeds. Both *Eichhornia* and *Lagenandra* showed significantly higher microbial activity. Vermicompost was superior in all the properties compared to compost in the same substrate. The study revealed that aquatic weeds such as *Salvinia molesta*, *Eichhornia crassipes* and *Lagenandra toxicaria* which are readily available in the coconut triangle can be successfully used to produce Vermicompost. It can be concluded that the Vermicompost produced from aquatic weeds locally could be a suitable organic fertilizer for organic coconut farming in Sri Lanka.

Key words: vermicompost, Salvinia molesta, Eichhornia crassipes, Lagenandra toxicaria and coconut palm

[1]Coconut Research Institute, Lunuwila, Sri Lanka.

[2]Faculty of Agricultural Science, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka.
Email: shsumith71@yahoo.com

Introduction

Organic manure and other agricultural organic wastes are important sources for maintenance of soil organic matter and to sustain soil productivity (Loh *et al*., 2005). It improves all soil physical, chemical and biological properties (Padmavathiamma *et al*., 2008). The compost is an excellent source of humus and plant nutrients which improves the soil biophysical properties and organic matter status, in addition to increasing crop yields (Gaur, 1994). Some basic composting methods, which have been developed, include; those that use bins, passive windrows, turned windrows, aerated static piles and in-vessel channels (composting fact sheet). According to Nataraja (2008) there are various composts such as phosphocompost, nitrogen-enriched phosphocompost, vermicompost and phosphorus-enriched vermicompost in the agricultural industry.

Vermicompost is an effective method of composting where, compost can be obtained from the shortest possible time with maximum possible nutrients. It can be simply defined as the decomposition of organic waste resources, into odor free humus like substances through the action of worms (Aira *et al*., 2002). Compared to other composting methods, vermicomposting results mass reduction of material volume, short time of processing and high levels of humus with reduced phytotoxicity (Ndegwa and Thompson, 2001). It is also an ecologically sound, economically viable and sociologically acceptable manner of producing compost (Singh 1997). It is superior to other types of compost because of its quality (Rajendran *et al*., 2008). It is a homogenous, finely divided peat like material (Edwards and Burrows, 1998), highly fragmented and porous. Limited studies on vermicompost indicate that, it increases macro pore space, ranging from 50 to 500 µm, result in improved air-water relationship in the soil, which favorably affect plant growth (Marinari *et al*., 2000). Vermicompost also have excellent structure, it improves aeration, drainage and moisture holding capacity of the soil (Edwards and Burrows, 1998). During the vermicomposting process the nutrient locked up in the organic waste are changed into simple and more readily available and absorbable forms, such as NO_3^- or NH_4^+ nitrogen, exchangeable phosphorous, soluble potassium, calcium and magnesium in worms gut (Lee, 1986 and Atiyeh *et al*., 2002). Former studies also evident that vermicompost provide all nutrients in readily available form and also enhances the uptake of nutrients by plants. Moreover, it holds nutrients over a large period and release slowly, without adverse impacts on environment (Ndegwa and Thompson, 2001). Vermicompost reduces the C: N ratio and retains more nitrogen than the traditional methods of preparing compost (Gandhi *et al.,* 1997). However, numerous organic materials can be used to produce vermicompost.

Aquatic weeds are considered as a huge threat all over the world for reducing the potential in fisheries industry, deteriorating drinking water quality, disturbing the free water flow and spreading mosquito and snail bone human and animal diseases (Gupta, 1987). Both natural and artificial water bodies in Sri Lanka have also become infected with the aquatic weeds and are common in coconut triangle area water bodies. These aquatic weed biomasses are used as mulch around the coconut palms. Chemical and mechanical control measures have been used to control water weeds, but they are only effective on small infestations. Eradication of the weed has been rare because of its rapid growth rate and higher multiplication ability. Majid (1986) has clearly mentioned that aquatic weeds cannot be totally eradicated by chemical, mechanical or biological methods. These problematic weeds can be used to productive manner like composting. Several workers (Sluyters, 1979; Majid, 1986; Mukhopadhyay and Hussain, 1990; Gajalakshmi *et al*., 2001; Sannigrahi *et al*., 2002) have reported that the good quality compost can be prepared from water hyacinth, the most dreaded aquatic weed. Vermicompost from water hyacinth have positive impact on growth and flowering of *Crossandra undulaefolia* and different species of vegetables (Gajalakshmi and Abbasi, 2002). According to Giriraj *et al*., (2005) vermicompost can be prepared from *Eichhornia crassipes*

Table 1. Quantities of biomass and cow dung using for compost and vermicompost preparation

Treatments	*Gliricidia* and Guinea Grass	*Salvinia*	*Eihhornia*	*Lagenandra*	Fresh cow dung (kg)	Water (liter)	Earth worms	Total weight (kg)
T_1	2kg	-	-	-	1	1	50	3
T_2	-	2kg	-	-	1	1	50	3
T_3	-	-	2kg	-	1	1	50	3
T_4	-	-	-	2kg	1	1	50	3
T_5	2kg	-	-	-	1	1	-	3
T_6	-	2kg	-	-	1	1	-	3
T_7	-	-	2kg	-	1	1	-	3
T_8	-	-	-	2kg	1	1	-	3

(water hyacinth) and *Salvinia molesta*. Gajalakshmi *et al*., 2001 found out that water hyacinth loss its reproductive ability either by vegetatively or sexually after it has passed through the earthworms gut. Hence, the spread of weed can be avoided by this means. The objective of this study was to evaluate the feasibility of producing vermicompost from problematic aquatic weeds namely *Salvinia molesta*, *Lagenandra toxicaria* and *Eichhornia crassipes*. Vermicompost produced locally by using aquatic weeds could be a suitable source of organic fertilizer for organic coconut farming in Sri Lanka.

Materials and Methods

This experiment was carried out at the vermicomposting unit of the Coconut Research Institute, Lunuwila, in the Low country Dry Zone of North Western province of Sri Lanka from August 2012 to May 2013. Aquatic weeds such as *Salvinia molesta, Lagenandra toxicaria and Eichhonia crasipes* were brought from a nearby water body, *Gliricidia* and *Guinea* grass were collected from a nearby site and cattle dung was brought from the dairy unit of the Coconut Research Institute. The aquatic weeds, *Gliricidia* and *Guinea* grass which were withered under shade, for two days to bring down the moisture content were used in every treatment. Slurry of cow dung was prepared by mixing cattle dung and water in 1:1 proportion (Nataraja, 2008). Experiment was carried out in a Complete Randomized Design (CRD) with eight treatment and five replicates in each treatment. Selected treatment combinations were shown in Table 1. Compost and vermicompost were prepared in black plastic pots with a volume of 8 dm^3. Vermibeds were prepared ten days prior to the introduction of the aquatic weeds into vermicomposting pots. Vermibeds were prepared as described by Rajendran *et al*., (2008). A plastic net was laid at the bottom of the pot to avoid the moving of earthworms from the pot at the initial stage. Three species of earthworms namely *Perionyx escavatus, Eisenia foetida and Eudrilus euginiae* were extracted from the vermicomposting units' and vermi culturing tanks at Coconut Research Institute. These species were well known species in vermicomposting (Pattnaik and Reddy, 2010; Samaranayake and Wijekoon, 2010). Vermibeds were watered every day, to maintain the moisture levels at 40% - 60% (Rajendran *et al*., 2008). Over watering was avoided. Withered materials (*Salvinia molesta, Lagenandra toxicaria and Eichhonia crasipes*, *Gliricidia* leaves and *Guinea* grass) were cut into small pieces (3 - 5 cm) as done by Sannigrahi *et al.,* 2002. Known quantities of aquatic weeds (Table 1), *Gliricidia* and grass cuttings were weighed, and mixed well with cow dung slurry, to get the different treatment combinations and placed them in the respective pots. In vermicomposting pots material was applied on to the vermibeds.

After introducing treatments, vermicomposting and composting pots were aerated by mixing in every ten days. It was done by manual screening of the treatment substrates and earthworms by emptying the pots separately into a polythene sheet. After that material was mixed and pots were refilled, separated worms were added again. The same practice was given for the compost pots. Uniform moisture level (60%) was maintained in all treatments (Nataraja, 2008) by watering them adequately by sprinkling the water at frequent intervals (Pattnaik and Reddy, 2010). The respective treatment combinations were followed separately for compost and vermicompost production. Watering was ceased three days before the harvesting, to separate worms from the compost (Nataraja, 2008). Harvesting was done after 45 days of introducing the treatments into vermicomposting and composting pots. In vermicomposted treatments, the pot contents were separately emptied into a polythene sheet and the material was carefully screened for earthworms. The composting and vermicomposting treatments were separately packed in polythene bags, labeled and kept in the laboratory for further analysis.

Nutrient analysis of vermin-compost

Prepared vermicompost were air dried and sieved using a 2mm sieve, and 200g samples were obtained from each treatment. The following parameters were measured in each sample. The pH of samples was recorded by a digital pH meter. The EC was measured using the conductivity meter (Conductance Bridge – Griffin). Determination of total Oxidizable Organic Carbon / Matter were measured by modified Wet digestion-Walkley-Black method (1934). The total nitrogen was determined by using the kjeldahl method described by Jackson, 1973. The total P and K contents by calorimetric method (Anderson and Ingram, 1993) and flame photometric method (Simard, 1993), respectively.

Growth measurement of worms

Number of earthworms

Fifty (50) earthworms were initially introduced into each vermibed. Number of earthworms in each vermibed was recounted and recorded, after ten days when introducing treatments. Thereafter, numbers of earthworms in T_1, T_2, T_3, and T_4 treatments were counted in every ten days.

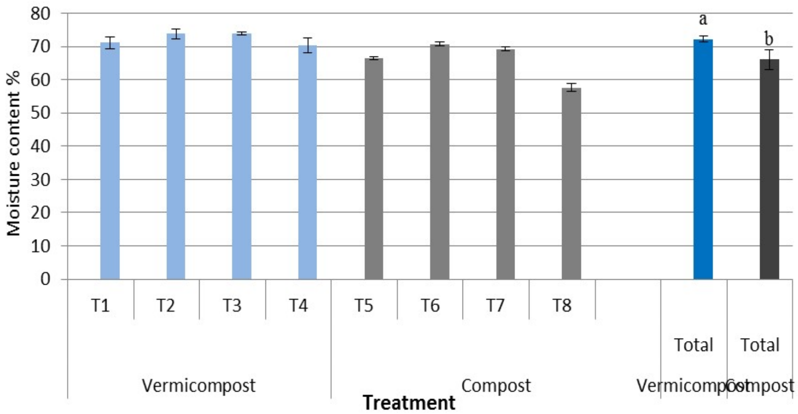
Statistical Analysis

One-way analysis of variance (ANOVA) was computed using SAS (version No.9.00 - 2002) to test the level of significance of difference between vermicompost produced by three species of aquatic weeds and *Gliricidia*. Also to analyze compost and vermicompost samples with respect to nutrient parameters. Mean comparison was done using Tukey's Studentized Range (HSD) Test.

Results and Discussion

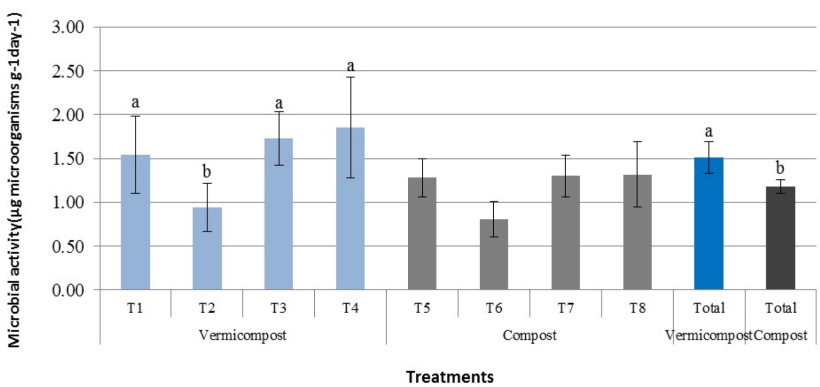
Moisture content:

Moisture content was significantly ($P<0.05$) different between vermicompost and compost treatments. Though it was not significantly differ in vermicompost treatments, moisture content was always above 70% (Figure 1). This can be due to the higher absorption capacity of vermi castings, and may also be due to digestion rate by microbial population indicating the higher rate of degradation of waste by earthworms. In here moisture content ranged from 55% - 75%. With the optimum moisture content the rate of mineralization and degradation becomes faster (Singh *et al.*, 2005). According to (Liang *et al.*, 2003) the 40% - 60% moisture content is optimum for maximum microbial activity whereas, 50% of moisture content is the minimum level for rapid rise in microbial activity.



T_1 – *Gliricidia* + grass (Vermicompost)	T_5 – *Gliricidi*a + grass (compost)
T_2 – *Salvinia molesta* (Vermicompost)	T_6 – *Salvinia molesta* (compost)
T_3 – *Eichhornia cras*sipes (Vermicompost)	T_7 – *Eichhornia crassipes* (compost)
T_4 – *Lagenandra toxicaria* (Vermicompost)	T_8 – *Lagenandra toxicaria* (compost)

Figure 1. Variation of moisture content among treatments



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T_4 – *Lagenandra toxicaria* (Vermicompost)	T_8 – *Lagenandra toxicaria* (compost)

Figure 2. Microbial activity in vermicomposting and composting treatments

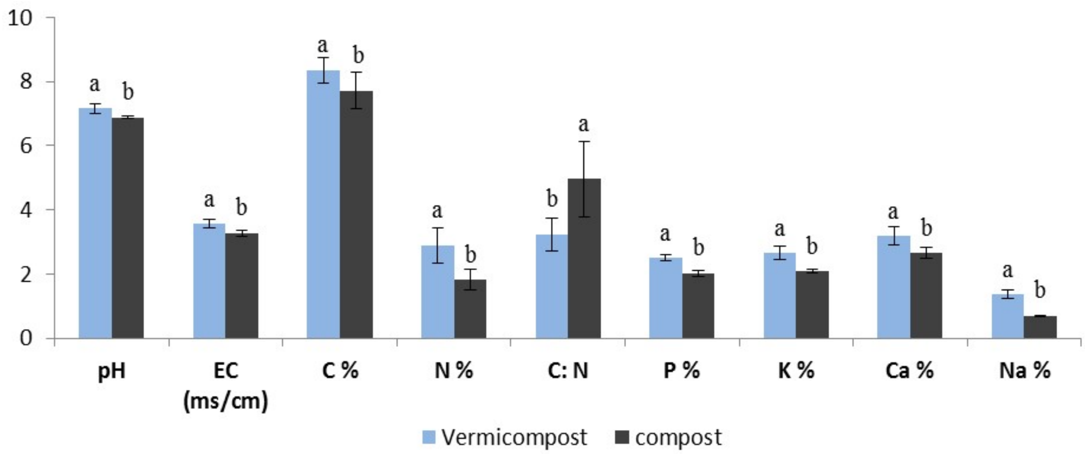

Figure 3. Chemical properties of Vermicompost and compost made by *Salvinia molesta*

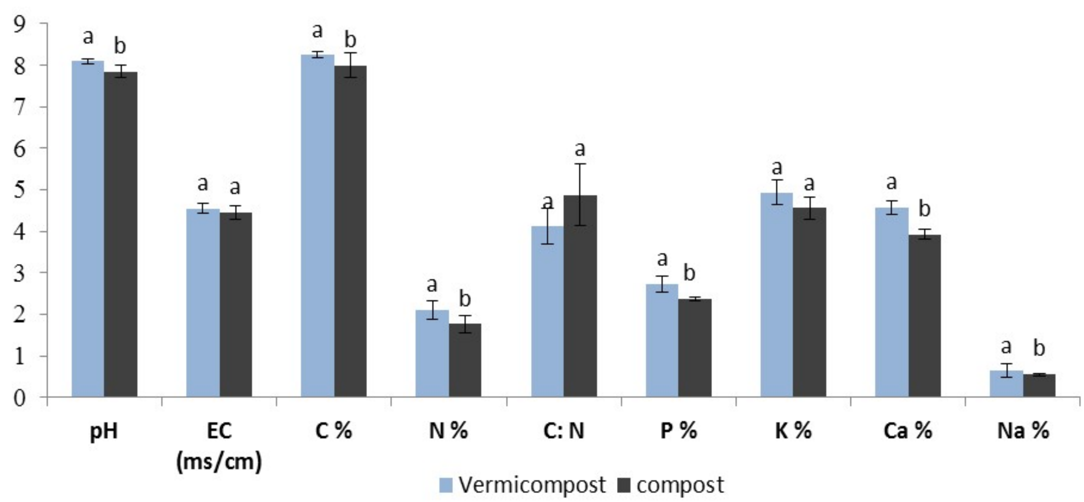

Figure 4. Chemical properties of Vermicompost and compost made by *Eichhornia crassipes*

Microbial activity

Microbial activities of treatments fluctuate with the method of composting and the material of composting. The individual effects of method and material is significant ($P<0.05$) whereas, the interaction effect is non-significant. In vermicomposting treatments the microbial activity is significantly ($P<0.05$) higher compared to composting treatments (Figure 2). Vermicompost is microbial active than parent material, due to humification and increased decomposition (Edwards *et al*., 1998; Edwards and Bohlen, 1996). It contains large particulate surface areas that provide many micro sites for microbial activity (Shi-wei and Fu-Zhen, 1991).

Several authors have also mentioned that earthworms can significantly effect on the microbial community (Coleman, 1985, Parmelee *et al.*, 1998). Regarding vermicomposting treatments, a significantly ($P<0.05$) lower microbial activity can be found in T_2 treatment (*Salvinia molesta*) whereas; other treatments do not show any significant difference with each other but higher in microbial activity.

Chemical properties of vermi-compost and compost:

Chemical properties of vermicompost and compost were significantly affected by the method of composting and the material used. Chemical properties such as pH, electrical conductivity (EC), organic carbon, nitrogen, phosphorous, potassium, calcium and magnesium were significantly higher in vermicomposting treatments compared to composting treatments whereas C: N ratio was significantly lower.

Vermicomposting treatments of all three aquatic weeds show significantly ($P<0.01$) higher pH values than the composting treatments (Figure 3, 4 and 5). In all the vermicomposting treatments, the pH values were approximately 7. A graphical illustration of the results was given in the figure 5**.** Considering vermicomposting treatments T_3 (*Eichhonia crasipes*) is significantly ($P<0.01$) higher in pH value with 8.09 than T_1, T_2, T_4. NH_4^+ ions that reduce the pool of H^+ and the activity of calciferous glands in earthworms containing carbonic anhydrase that catalyzes the fixation of CO_2 as $CaCO_3$ thus, preventing the reduction of pH (Pattnaik and Reddy, 2010).

Electrical conductivity of vermicomposting was significantly ($P<0.05$) higher than conventional composting method. This could be probably due to the higher degradation of organic matter, releasing minerals such as exchangeable Ca, Mg, K and P in available forms in vermicompost. Percentage of Organic carbon was significantly ($P<0.05$) higher in Vermicompost than the normal compost. This can be due to the addition of carbon from earthworms by excreta and death of worms. These observation also indicate that the process of composting is completed (Tripathy and Bharadwaj, 2004). organic carbon in the present study was consistence with the results of Tripathy and Bharadwaj, 2004 and Reddy and Okhura, 2004 but it is contradictory with most of the earlier workers (Pattnaik and Reddy, 2010; Nataraja, 2008; Suthar, 2007).

Significantly higher ($P<0.05$) nitrogen content was observed in Vermicompost compared to normal compost. This is corroborated with the finding of earlier workers (Patnaik and Reddy, 2010; Tripathy and Bharadwaj, 2004). The enhancement in nitrogen vermicompost was probably due to mineralization of organic matter containing proteins (Bansal and Kapoor, 2000, Kaushik and Garg, 2003) and conversion of ammonium-nitrogen into nitrate (Suthar and Singh, 2008). Earthworms can rapidly increase the nitrogen levels of the substrate, during digestion in their gut, adding their nitrogenous excretory products, mucus, body fluid, enzymes and even through the decaying dead tissues of worms in vermicomposting subsystem (Suthar, 2007).

Considering the C: N ratio, it was significantly ($P<0.05$) lower in vermicompost (5: 1) compared to normal compost. However, it was not lower up to a satisfactory level to make nutrients readily available for plants. The C: N ratio of the substrate material reflects the organic waste mineralization and stabilization during

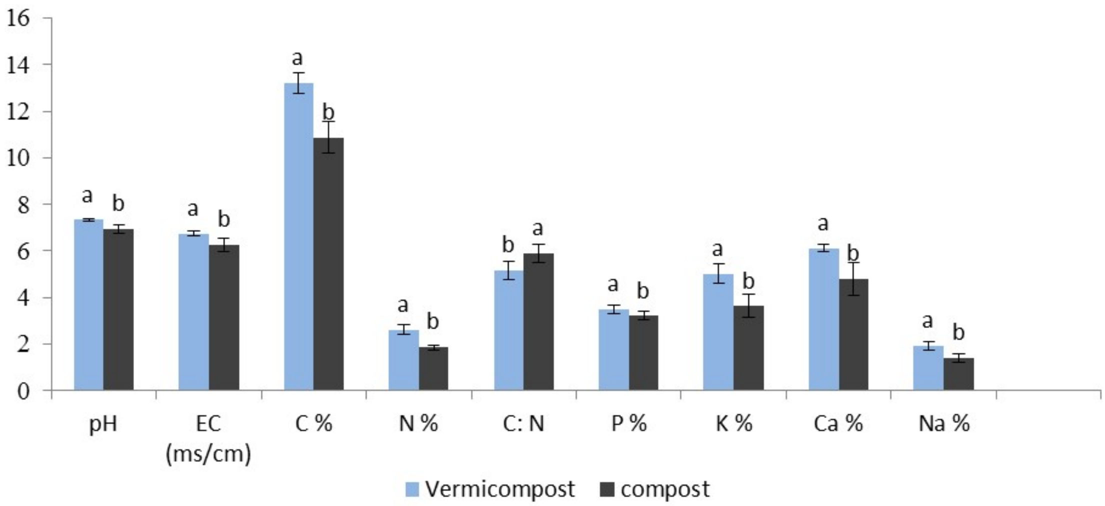

Figure 5. Chemical properties of vermicompost and compost made by *Lagenandra toxicaria*

the process of composting or vermincomposting. Higher C: N ratio indicates slow degradation of substrate (Haug, 1993). The loss of carbon through microbial respiration and mineralization process of composting or vermicomposting. through microbial respiration and mineralization and simultaneously addition of nitrogen by worms in the form of mucus and nitrogenous excreta materials lowered the C: N ratio in vermicompost (Suthar, 2007, Pattnaik and Reddy, 2010).

Total phosphorous content is significantly ($P<0.05$) higher in vermicomposting treatments (2.31% -3.51%) compared to composting treatments (1.87% - 3.31%). This is consistence with the findings of Nataraja, 2008. During vermicomposting the worms converts the insoluble phosphorous into soluble forms with the help of phosphorous solubilizing microorganisms through phosphate present in the gut, making it more available to plants (Suthar, 2007; Suthar and Singh, 2008). Further release of phosphorous may be by phosphorous solubilizing microorganisms in casts (Suthar, 2007). This is confirmed by the higher levels of EC in vermicomposting treatments compared to composting treatments.

Method of composting has found to be significant ($P<0.05$) on potassium content by vermicomposting having higher potassium content compared to composting (Figures 3, 4 and 5). The present findings are consistant with Pattnaik and Reddy, 2010 and Delgado *et al.*, 1995. This is probbly because of physical decomposition of substrate due to biological grinding during passege through the gut, which may have caused it increased (Suthar,2007). The microorganisms present in the worms gut probably converted *insoluble potassium into the soluble form by producing microbial enzymes* (Kaviraj and Sharma, 2003). Method of composting has found to be significant ($P<0.05$) on calcium content by vermicomposting having higher calcium content compared to composting. This can be attributable to the catalytic activity of carbonic anhydrase present in calciferous glands of earthworms generating $CaCO_3$ on the fixation of CO_2 (Padmavathiamma *et al*., 2008).

Variation of chemical properties among Vermicompost

In all the vermicomposting treatments, the pH values were approximately 7. Usually in the finished product of compost pH value ranges from 7.1 – 7.5 (Gupta, 2004). A graphical illustration of the results was given in the figure 6. Considering vermicomposting treatments T_3 (*Eichhonia crasipes*) is significantly ($P<0.01$) higher in pH value with 8.09 than T_1, T_2, T_4. Electrical conductivity in vermicompost varied between 3.28 – 6.75 dS/m in the present study.

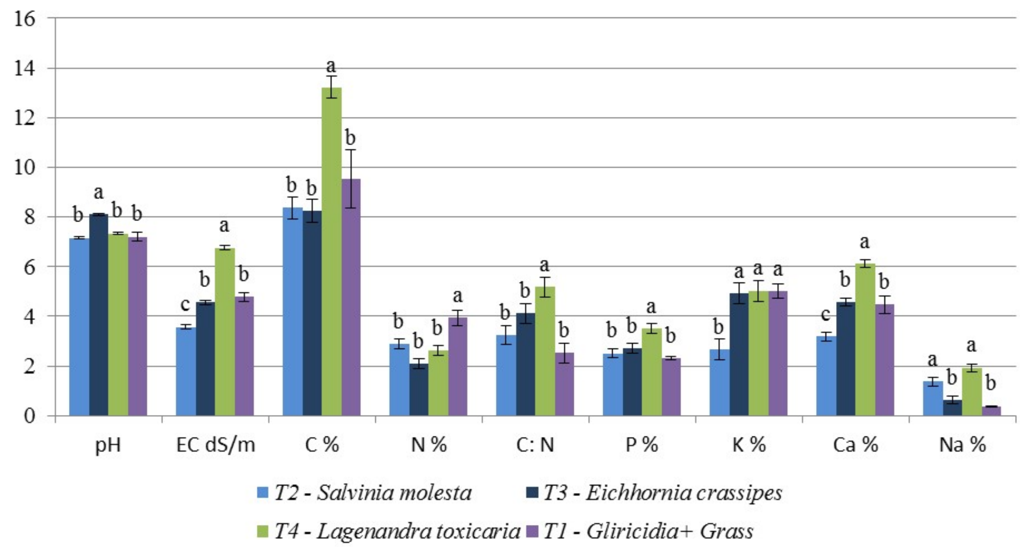

Figure 6. Variation of chemical properties in vermicompost with respect to substrate

The significantly highest ($P<0.05$) electrical conductivity was observed in T_4 with 6.75 dS/m (*Lagenandra toxicaria*). Whereas, the significantly lowest value for EC was observed in T_2 (*Salvinia molesta*) with 3.57 dS/m. T_4 (*Lagenandra toxicaria*) shows significantly ($P<0.05$) higher organic carbon percentage of 13.21%. T_1, T_2 and T_3 does not show any significance with having organic carbon contents of 9.54%, 8.37% and 8.24% respectively. Anyhow, the significantly ($P<0.05$) highest nitrogen content from vermicomposting treatments was recorded in T_1 (*Gliricidia* + grass) with 3.93% followed by T_2, T_4, T_3 with 2.89%, 2.61%, 2.09% respectively. Regarding the aquatic weeds, T_1 with *Salvinia* showed higher nitrogen content although, the results are not significant whereas, T_3 with *Eichhonia* substrate records the lowest. T_1 *(Gliricidia* and grass) was found to be significantly lower ($P<0.05$) in the C: N ratio followed by T_2 (*Salvinia*), T_3 (*Eichhonia*) and T_4 (*Lagenandra*) (Figure 6).

Significantly ($P<0.05$) higher phosphorous percentage was found in T_4 (*Lagenandra toxicaria*). In contrast, lowest phosphorous content was found in treatments with T1 (*Gliricidia* and grass). Regarding vermicomposting treatments significantly ($P<0.05$) higher potassium contents were found in T_4, T_1 and in T_3 with 5.03%, 5.01% and 4.93% respectively compared to T_2. Anyhow, there was no significance between T_1, T_3 and T_4. T_2 was found with significantly ($P<0.05$) low potassium content of 2.38%. Regarding vermicomposting treatments T4 has the highest calcium content with 6.12% whereas, T_2 (3.18%) was found to be signifiantly lower in calcium content.

Chemical properties of vermicompost highly varies according to the used substrate Earlier researcher has also mentioned that the qualities of vermicompost made from aquatic weeds obviously depend on the chemical composition of aquatic plants and quality of the water bodies in which they grow and this may be the reason for variation in composition of vermicompost with respect to aquatic weed (Anonymous, 1976). Vermicomposting treatments with *Gliricidia* (T_1) shows higher nitrogen content by being a legume and having a good ability in nitrogen fixing (Elevitch and Francis, 2006). To the compatible agricultural use, the total level of nitrogen should not be less than 0.6 percent (Zucconi and Bertoldi, 1991). Anyhow, in all the vermicomposting treatments the total nitrogen level was between 2% - 4%, this suggests vermicompost made by all three aquatic weeds are suitable to use as a fertilizer. Significance in nitrogen content was observed in *Salvinia molesta* with 2.89% due to this, lowest C: N ratio (2.51) was also obtained by *Salvinia* suggesting of its higher nitrogen level. This was probably due to the high nitrogen content in *Gliricidia* leaves as being a legume. the higher C: N ratio in T_4 (*Lagenandra toxicaria*) may be a result of containing higher organic carbon content (13.21%) and also less nitrogen content (5.17%) as compared to rest of the treatments (Nataraja, 2008).

Growth parameters of earthworms

The variation of the earthworm number, mortality rate and number of juveniles at the harvesting time, varied with respect to time and material of vermicomposting (Figure 7). An increment of earthworms was observed in all the treatments except in T_1 (*Gliricidia* + grass treatment). A drastic reduction found in first ten days in T_1 (*Gliricidia* + grass treatment) thereafter, it was also gradually increased. The maximum numbers of earthworms were seen at 40 days after vermicomposting in all treatments and a gradual decrement was seen afterwards. The maximum quantity of earthworms have being maintained in T_2 and T_3 (*Salvinia molesta* and *Eichhonia crasipes*) throughout the vermicomposting period.

Mortality rate of earthworms

Mortality was seen in some treatments after the initial introduction of 50 earthworms into each replicate. Mortality rate of earthworms with respect to time, in different treatments are shown in the Figure 8.

According to the statistics, both the material and composting method have significant ($P<0.05$) individual and combine effect on the mortality rate. A significantly higher mortality rate was observed in T_1 (*Gliricidia*+grass) whereas, other treatments (T_2, T_3, T_4) did not show any significance. An increasing mortality rate was shown in T_1 between 10 - 25 days of vermicomposting which reduced gradually later. Increment of mortality rate was seen in all the treatments (T_1, T_2, T_3, and T_4) from day 40 up to harvesting.

No of juveniles at harvesting

The number of juveniles are significantly ($P<0.05$) higher in T_2 (*Salvinia molesta*) and T_3 (*Eichhonia crasipes*) treatments but, no significant difference between T_2 and T_3. Juvenile count in *Salvinia* treatment is 50 times higher than the juvenile count in *Giricidia* treatment whereas, it is 21 times higher than *Lagenandra* treatment (Figure 9). Meanwhile *Eichonia* treatment is 32 times higher in worm count compared to *Gliricidia* treatment and 14 times between T_1 (*Gliricidia* + grass) treatment and T_4 (*Lagenandra toxicaria*) treatment. T_4 has a 2 times higher juvenile count compared to T_1 treatment.

So the variation of adult earthworm number and juvenile counts in different treatments suggests the varied ability of growth and reproduction of earthworms in different materials. This may due to the various chemical, physical and biological conditions maintained in treatment material. Regarding the number of earthworms and juvenile count at harvesting T_1 (Gliricidia) showed a significant reduction further, a significant increment in mortality from day 10. This can be explained with the change of physical chemical and biological environment of the vermibed, with the introduction of materials. This change might have affected adversely on earthworm growth. Material-specific behavior or related to unfavorable environmental conditions maintained in the treatment might be the reasons.

During day 40 – 50 near harvesting in all the treatments number of adult earthworms has being slightly decreased further mortality rate have being increased. This could be due to the reduction of feed materials (organic matter) in pots. Considering the total adult earthworm number and juvenile count at harvesting T_2 and T_3 showed significantly higher values further also significantly lower mortality rate. This may be due to the quality of the material or may be due to the fluctuating environmental conditions (Pattnaik and Reddy, 2010). Thus indicated T_2 (*Salvinia*) and T_3 (*Eichhonia*) as better substrate for earthworms to grow and reproduce.

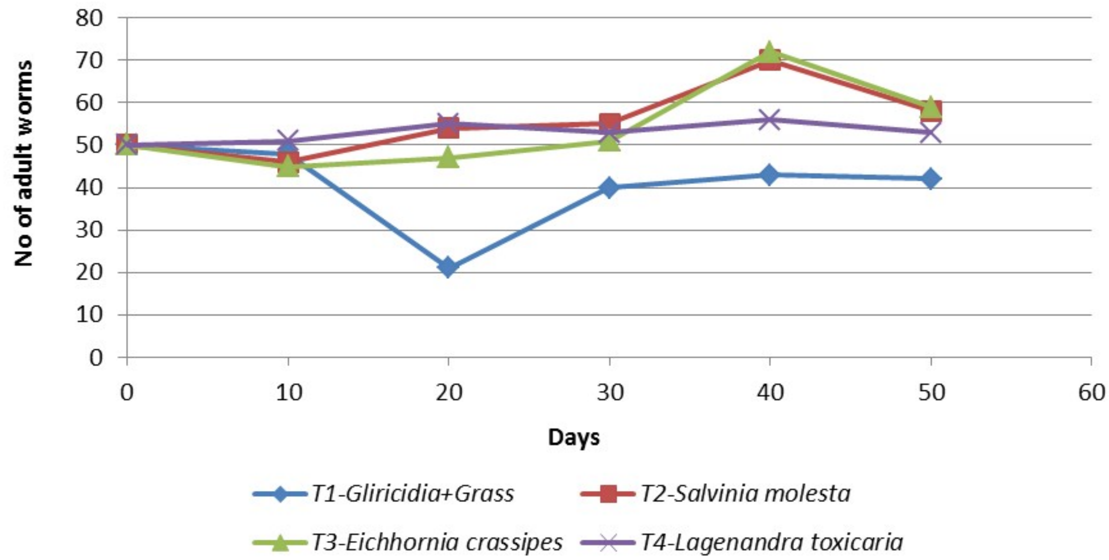

Figure 7. Variation of adult earthworm number with time of vermicomposting

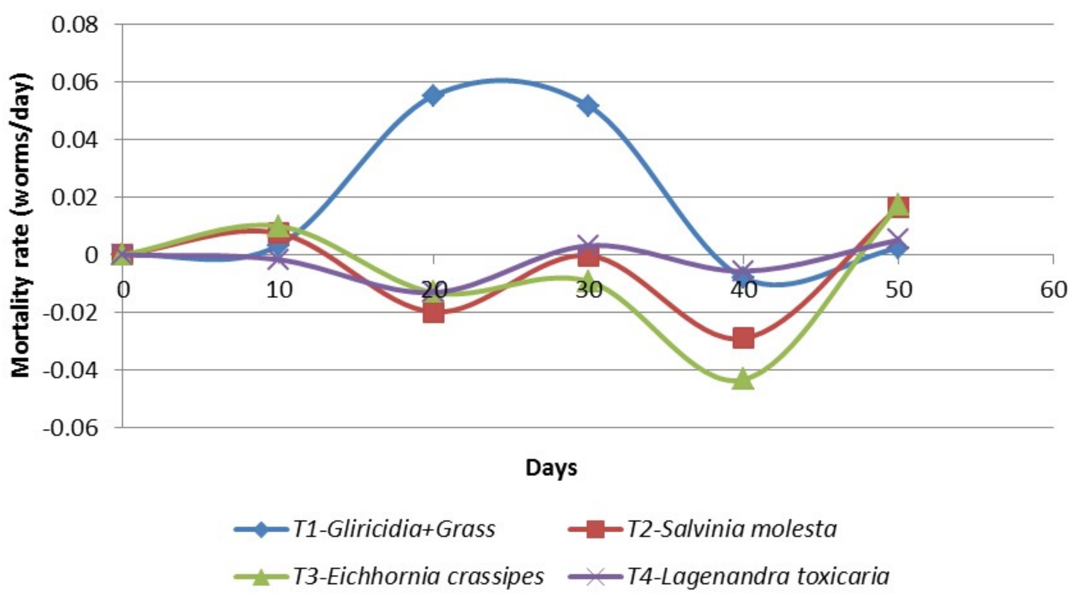

Figure 8. Change of mortality rate with time of vermicomposting

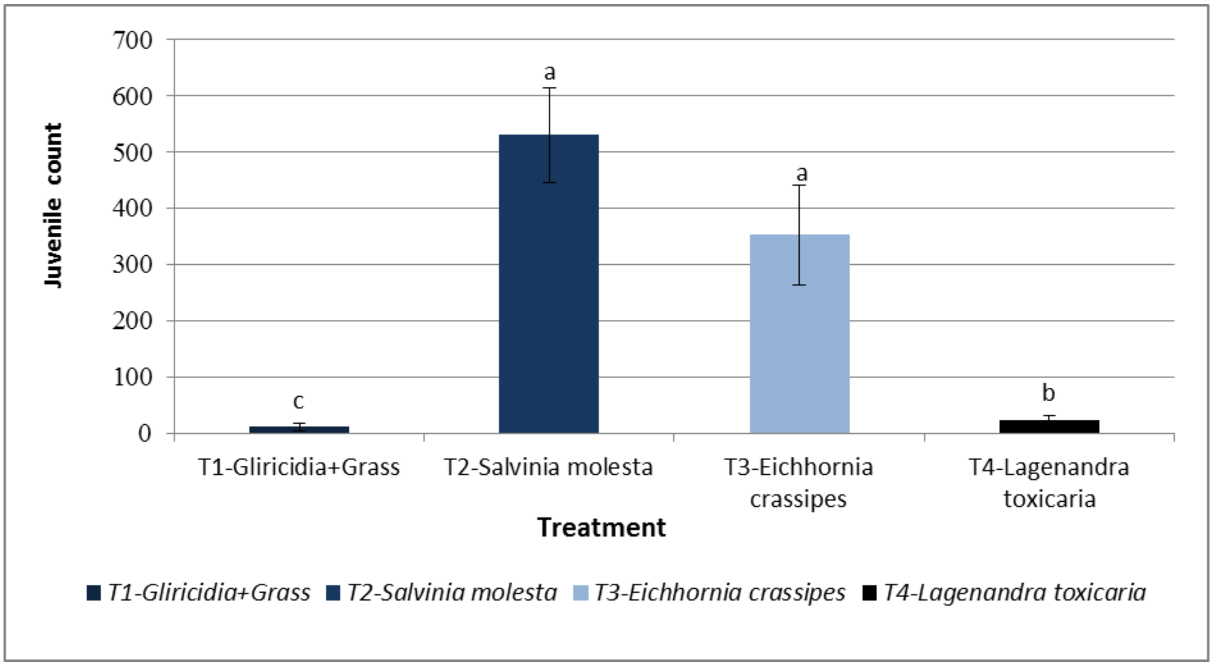

Figure 9. Count of juveniles at the time of harvesting

Due to high demand for coconut and value added products in global scale, production of the organic manure in large scale is still in a challenging situation due to the rate of production and the quality of the product. Therefore, as an alternative for the conventional compost, aquatic weeds can be used as comparatively good nutrient source for coconut. Availability of the raw materials in large quantities in coconut cultivating areas and the less technological involvement in production process may provide a better solution for small scale farming community involved in organic coconut farming. Recent global policies and strategies are directed to the sustainable agriculture through in-situ organic manure production to reduce the detrimental effects on the environment. Therefore, to address these issues it is vital to identify the potential organic nutrient sources for commercial perennial agriculture.

Conclusion

Vermicomposting of aquatic weeds is more efficient and productive as an organic fertilizer compared to conventional composting of the same substrate. Thus, the problem of aquatic weeds can be controlled by their large-scale utilization for vermicompost in an ecologically sound way. *Lagenandar toxicaria* is the most effective substrate in vermicomposting since; it inherited many favourable physical, chemical and biological properties needed for plant growth like, higher moisture holding capacity, pH, electrical conductivity, organic carbon, phosphorous, potassium, calcium and sodium in the final product. However, its performance as nitrogen rich organic manure is poor. Meanwhile among aquatic weeds *Salvinia molesta* can be used to produce vermicomposts with comparatively higher nitrogen content. The study further confirmed that *Salvinia molesta* and *Eichhornia crassipes* can successfully utilized in multiplying of earthworms since, the growth and reproduction rate of earthworms were rapid in these substrate. Therefore these materials can be used for commercial or experimental purposes in earthworm culturing used in vermitechnology. In future research, the locally available Eppawala Rock Phosphate (ERP) will be assessed to examine the feasibility of increasing the solubility with the use of vermitechnology as a low cost phosphate source for coconut.

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