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Optimization of Compost Maturity of Coffee Waste Mixed with Agricultural Wastes and Evaluation of Their Effect on Growth of Lettuce (Lactuca Sativa)

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Abstract
Coffee pulp and husk are the main by-products generated by the coffee processing plants and are disposed into arable land and surface water causing environmental pollution. Therefore, the major objectives of the present study were to optimize compost from coffee husk as organic fertilizer for cultivation of lettuce and to determine physico- chemical properties of compost during the decomposition periods. Coffee husk + Cow dung, Coffee husk + Poultry manure and Coffee husk + Desmodium triflorum in 3:1 (v/v) ratio were used to prepare the compost. The physicochemical parameters were determined for all the treatments during the composting periods. Temperature value at 0 day of composting was 28°C and then rose to thermophilic phase on 15, 30, 45 and 60 days. Finally at 90 days Temperature was at 35°C for each coffee husk and supplemented materials respectively. The pH values at day 0 were between 8 and 9, and finally at 60, 75 and 90 days were between 8 and 8.5 for each coffee husk and supplemented materials. The organic carbon and nitrogen content of the compost mixes: coffee husk + Desmodium triflorum, Coffee husk + Cow dung and Coffee husk + Poultry manure were 529.02, 500.05, 517.92 and 0.05, 0.1, 0.053, respectively during 0 day of composting, whereas at 90 days the values were 248.18, 265.91, 239.68 and 0.001, 0.002, 0.0002, respectively. The mature compost had natural soil odor and brown in color. Mean values of germination percentage of lettuce during the composting periods at 0, 30, 45, 60 ,75 and 90 days were 11.71, 24.53,25.83, 29.02, 46.47 and 56.37 respectively, whereas mean values of marketable yield of lettuce were 27.27, 28.87, 31.61, 35.02, 40.59 and 57.67,g/plant respectively. Addition of 10% of coffee husk compost with 90 % of top soil significantly increased seed germination and yield of lettuce indicating the suitability of bioconverted organic substrates for vegetables cultivation.
Keywords: coffee husk, cow dung, Desmodium triflorum, poultry manure, lettuce, yield

1. INTRODUCTION

Coffee production in Ethiopia is very high, due to suitable altitude, ample rainfall, optimum temperatures, and appropriate planting materials and fertile soil (Gebreselassie and Ludi, 2007). The total area covered by coffee is about 400,000 hectares, with a total production of 200,000 tones of clean coffee per annum (Gebreselassie and Ludi, 2007). The agriculture-based Ethiopian economy is highly dependent on production of Coffee. It contributes more than 65% of the country's foreign currency (Gole et al., 2002). Mafusire et al. (2010) reported that Ethiopia was the world's 5th largest coffee producer after Brazil, Vietnam, Indonesia and Colombia. It ranked first in producing coffee among twenty five countries of African continents and is the primary centre of origin and genetic diversity of the Arabica coffee plant.

Coffee is wildly grown in wildly in forests particularly in the south-western region of Ethiopia (Mekuria et al., 2004). About 70% of coffee exported from Ethiopia is sun-dried and rest is wet processed (FDRE, 2006). Coffee wastes are one of the most abundantly available agro-industrial wastes, produced during pulping operation of the coffee cherries to obtain coffee beans in many coffee-producing areas of Ethiopia. It is estimated that for every 2 tones coffee cherries processing, about one ton coffee waste is generated (Adams and Dougan, 1981). Coffee bean represents 55.4% of the fruit on dry weight basis and the rest is considered to be the byproducts or residues. At different stages from harvesting to consumption, several residues viz. coffee pulp or husk, leaves and spent-ground more than two million tons of waste generated (Murthy and Manonmani, 2008)..

In most coffee producing and processing areas of Ethiopia the husk does not have much commercial or other industrial advantage other than, becoming the major polluting agent of rivers and lakes. Municipalities where coffee processing industries are found should improve the environmental performance of the coffee industries by pioneering various initiatives (Pandey and Soccol, 2000). In spite of the toxic components, coffee husk and pulp are very much rich in organic components and could be used as substrates after bioprocessing to produce enzymes, aroma compounds, edible mushroom plant hormones, organic fertilizer and feeds (Soccol, 2001).

Bioconversion of coffee husks principally involves composting. Composting is commonly used as a means of managing municipal solid waste in various corners of the world, the current economic growth, and industrialization necessitate the search for different method to exploit the huge waste biomass. It is now time for Ethiopian cities to think about biological waste treatment system like composting (Degefe, et al., 2012). In general, under optimal conditions, composting proceed through three phases; 1) Mesophilic (moderate-temperature phase), 2) Thermophilic, (high-temperature phase), 3) maturation phase (cooling). Of the many elements required for microbial decomposition, carbon and nitrogen are the most important. According to Rebollido (2008) another essential ingredient for successful composting is oxygen. Substrates for composting comes from very diverse sources: grass clippings, leaves, hedge cuttings, food remains, fruits and vegetable wastes, wastes from the food industry, residues from the fermentation industry, solid and liquid manure from animal houses, wastes from the forests, wood and paper industries, rumen contents from slaughtered cattle and sewage sludge from wastewater treatment plants (Kutzner, 1986).

Bioconversion of agricultural wastes has been proved to be the best substrate for cultivation of various types of vegetables (Ashworth and Harrison, 1983). Major vegetables cultivated in Ethiopia include lettuce, potatoes, green beans, okra, melons, white and red onions, shallots, cabbages, leeks, beetroots, carrots, green chillies and tomatoes (Tekle et al., 2011). Lettuce (Lactuca sativa L.) is a member of the Asteraceae family. A lettuce salad before dinner is a common healthy habit. Lettuce is considered an annual and a polymorphic vegetable which is a source of vitamin C and beta-carotene (Seaman, 2011). In Jimma zone, Oromia Regional state, many of the farmers are using inorganic fertilizer such as DAP and Urea but the utilization of coffee husk compost for vegetables cultivation is uncommon. However, Berecha et al. (2011) demonstrated the suitability of coffee pulp compost for tomato seedlings production. In their study amendment of top soil with coffee pulp composted with grass improved physico-chemical properties of the amended soil and enhanced yield of tomato. This approach has dual purpose since it greatly assists in management of agricultural wastes and in boosting of productivity of vegetables. Therefore the objective of the study was to initiate the possibility of using coffee husk for cultivation of lettuce after bioconversion of this waste through composting processes.

2. MATERIALS AND METHODS

2.1 Descriptions of the study area

Lath house experiments were conducted at College of Agriculture and Veterinary Medicine, Jimma University. Jimma town is located 353 km south west of Addis Ababa. The town's geographical coordinates are 7°41' N latitude and 36° 50'E longitude. The town is found in an area of average altitude of 1780 m above sea level. The annual rainfall ranges from 1138 mm to 1690 mm. Maximum precipitation occurs during the three months period, June to August, with minimum rainfall in December and January. Abundant rainfall makes this region one of the high rainfall areas of the Ethiopian highland, conducive for agricultural production.

2.2 Composting materials and seed collection

The coffee husk samples were collected from Jimma zone, Yebu district, Oromia Regional State. The supplementary materials such as residues for Desmodium triflorum, cow dung and poultry manure were collected from Jimma zone. Seed of Romaine lettuce variety were collected from local market of Jimma using sterile polyethylene bags.

2.3 Composting coffee waste with other supplements

Composting was carried out under a shade tree at College of Agriculture and Veterinary Medicine, Jimma University. The coffee husks were moistened for three days before heap formation. Coffee husk were composted with different main substrate combinations (coffee husk (75%) + Cow dung (25%) (v/v), Coffee husk (75%) + Poultry manure (25%) (v/v) and Coffee husk (75%) + Desmodium triflorum residue (25%) (v/v). For the layering, coffee husk (v/v) which is difficult to decompose was laid by sprinkling with water. Thereafter, cow dung (v/v) added to the heap. These layers were repeated until the heap reached 1 m to 1.5 m high and 2m wide. The same procedures were followed for coffee husk + poultry manure, and coffee husk + Desmodium triflorum. The heaps were covered with plastic sheet to prevent water loss and rain fall. Turning was done every two weeks; the heaps were mixed and piled (Gautam et al., 2010). Full decomposition was accomplished into 3 months.

2.4 Physico-chemical properties of compost

2.4.1 Temperature

The temperature of the compost was measured using a thermometer with a 1 m long probe. The temperature measurement was done starting at initial and at three days interval until full compost maturity stage. Temperature was measured as close to the centre of the composting material as possible. As temperature could vary within the material, the temperature was measured from a variety of locations (Undersander et al., 1993).

2.4.2 pH

The pH measurement of the compost was done at the beginning of compost preparation and subsequently repeated weekly until full maturity stage. Ten gram of compost was weighed and transferred into a 50 ml capacity beaker. Ten ml of distilled water was added and stirred thoroughly. The suspension left to stand for at least 30 minutes and stirred for two or three times. The pH was determined by a glass electrode using a digital pH meter (Undersander et al., 1993).

2.4.3 Nitrogen

The samples were taken at initial stage and at 15 days interval until the maturity stage of compost from three types of composts with different supplements. Nitrogen in the sample was estimated by following the micro kjeldhal method as (Jackson, 1973). Dried sample (0.5 g) was digested using 10ml of concentrated H2S04 in presence of 0.3 g of catalytic mixture containing potassium sulfite, copper sulphate and selenium powder in the ratio 50:10:1 in the micro Kjeldhal digestion unit. The digested samples were diluted with distilled water and distilled after the addition of sufficient quantities of 40 % NaOH to make the sample alkaline in the micro Kjeldhal distillation unit. The ammonia evolved was trapped in percent of boric acid mixed indicator solution and titrated against 0.05 N H2S04. The Nitrogen content was calculated from the volume of acid consumed.

$$\% N = \frac{\text{Titrated value} \times \text{N of H2SO4} \times 0.014 \times \text{Dilution factors}}{\text{Weight of the plant sample (g)} \times 100}$$

2.4.4 Organic carbon

The samples were taken at initial stage and at each turning until the maturity stage of compost from three types of composts with different supplements. The organic carbon in the compost samples was estimated by taking 5g of dried samples in a pre-weighed silica crucible. The samples were kept in a muffle furnace at a temperature of 105°C for 4 hours. The crucibles were later transferred to desiccators, cooled and immediately weighed to a constant weight (ash weight). The total presence of organic matter was calculated by taking difference of dry weight of samples and ash weight of the sample. Then organic carbon was calculated by dividing the percent organic matter by the factors 1.724 (Jackson, 1973).

2.5 Lathe house experiment

Soil was collected from the agricultural field of College of Agriculture and Veterinary Medicine, Jimma University and was air dried. The soil was sieved using a 2 mm screen to remove soil clumps and roots before use. Three liter capacity pots were used for the experiments. The compost was added to topsoil at rates of 10 % (v/v) at 0, 30, 45, 60, 75, and 90 days of composting periods. Non- amended soil was used as control. A total of eleven treatments were tested in randomized complete block design with three replications. Fifty seeds of lettuce of Romaine variety were seeded to each pot. Six pots per treatment and a total of sixty six pots were used to assess the effect of coffee husk composted with other ingredients at different time points on yield of lettuce. Watering was done using a hose with fine Nozzles and pots were watered independently. Numbers of seed germinated were determined starting from first germination day and continued until 15 days and was calculated using the following formula:

% Germination = (Number of seeds germinated / Number of seeds sown) ×100

After 15 days of germination five seedlings were maintained for 5 days and after acclimatization thinning was done to maintain one seedling per pot. Finally a fresh weight of plant per pot was assessed at maturity (60 days after sowing). First plants were removed from soil and washed off any of loose soil, next plants were gently blotted with soft paper towel to remove any free surface moisture and weighed immediately.

Compost types and treatments

Compost types

1. Compost A= Desmodium triflorum + Coffee Husk (3: 1 (v/v)) ratio
2. Compost B= poultry manure +Coffee Husk (3: 1 (v/v)) ratio
3. Compost C= cow dung +Coffee Husk (3: 1 (v/v)) ratio

The treatments were:

1. 90% top soil + 10% compost A (v/v)
2. 90% top soil+ 10% compost B (v/v)
3. 90% top soil+ 10% compost C (v/v)
4. 90% top soil+ 5% compost A + 5% compost B (v/v)
5. 90% top soil+ 5% compost A + 5% compost C (v/v)
6. 90% top soil+ 5% compost B + 5% compost C (v/v)
7. 90% top soil+ 3.3 % compost A + 3.3 % compost B + 3.3% compost C (v/v)
8. Top soil alone
9. Compost A only
10. Compost B only
11. Compost C only

3. Data analysis

The collected data collected were analyzed using one way analysis (ANOVA) and SAS for window version 9.2 to test the differences among treatments. Fisher's protected least significant difference test was used to separate the means of significant effects.

4. Result

4.1 Mean values of temperature

Different values of temperature were recorded during compost preparation to maturity for coffee husk plus cow dung, coffee husk plus poultry manure and coffee husk plus *Desmodium triflorum* (Table 3). The mean values of temperature for coffee husk plus poultry manure combination at 0 composting period was 28°C. However, at 15 and 30 days it was between 52.5°C and 51.5°C, while at 45 and 60 days it was between 61.5°C and 52°C. Finally, as the composting period extended to days 75 and 90 the mean values of the temperature were between 42.5°C and 36°C. however for coffee husk plus cow dung and coffee husk plus *Desmodium triflorum* combinations were 28°C, 64.5°C, 58.5°C, 60°C, 57°C, 43.5°C and 38°C; 28°C, 57.5°C, 54°C, 47°C, 44°C, 35°C and 31.5°C at 0, 15, 30, 45, 60, 75, 90 days of composting periods respectively (figure 1).

4.2 Mean values of pH

The mean values of pH for coffee husk plus cow dung, coffee husk plus Desmodium triflorum and coffee husk plus poultry manure were 8.95, 8.71, 8.44, 8.3 and 8.2; 8.75, 9.28, 9.25, 8.55,8.52 and 8.19, 8.71, 8.5, 7.96, 8.56 and 8.36, respectively during composting periods of 5,30, ,60,75, and 90 days respectively (figure 2).

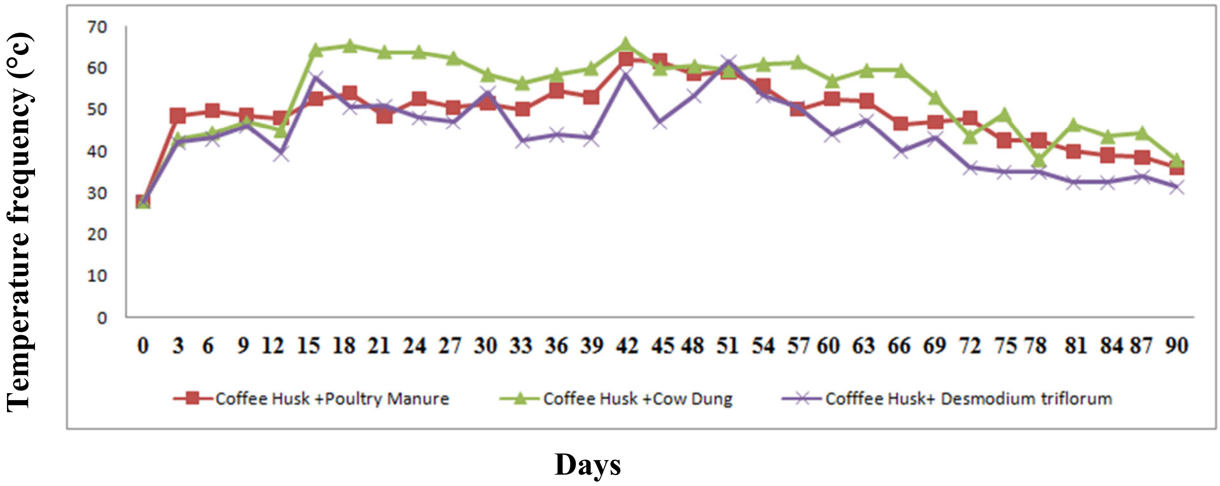

Figure 1 : Mean values of temperature for composting substrates.

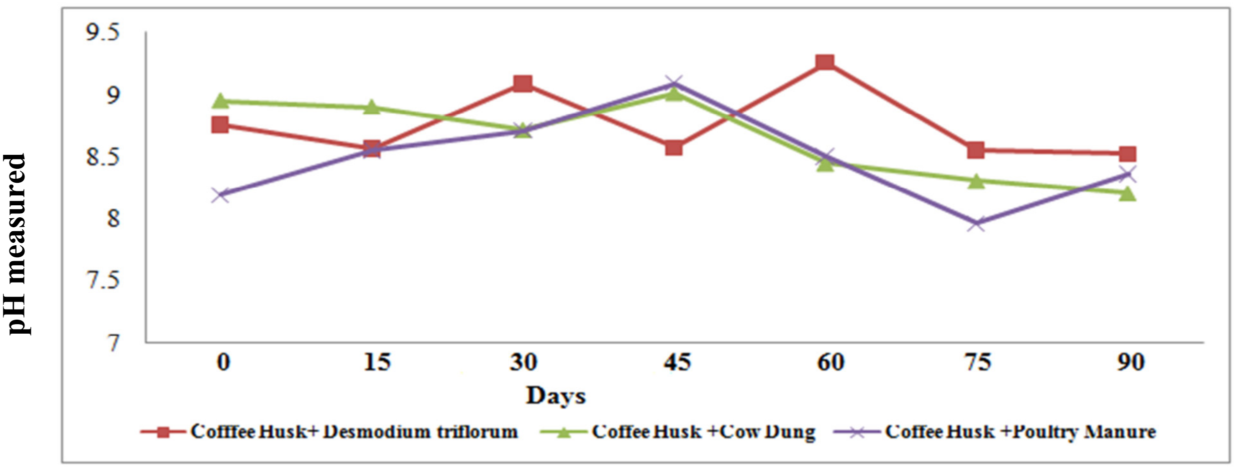

Figure 2 : Mean values of pH for composting substrates

4.3 Nitrogen and organic carbon content

The higher carbon content was recorded at the beginning of the composting for all compost types ranging from 500.1- 529 without any significant difference among themselves (Table 1). For all cases there was purposive decrease with the lowest at 90 days of incubation for all the compost, ranging from 239.6 (coffee husk + poultry manure), 248.1 (coffee husk + *Desmodium triflorum*) to that of days 265.9 (coffee husk + cow dung), except with coffee husk + *Desmodium triflorum* which should an increase in carbon after 45 days.

Table 1: Carbon content (%) of coffee husk and its combinations at each composting period.

Day	Cofffee Husk+ *Desmodium triflorum*	Coffee Husk + Cow Dung	Coffee Husk + Poultry Manure
0	529.0	500.1	517.9
15	507.2	499.7	508.0
30	426.4	478.3	468.8
45	372.2	392.2	390.6
60	389.9	383.7	389.9
75	256.7	290.9	383.7
90	248.1	265.9	239.6

Nitrogen content also decreased as composting period extended in all of coffee husk and supplemented material compost. Nitrogen content were 0.05, 0.1, 0.05 and 0.001, 0.002 and 0.0002 for coffee husk plus *Desmodium triflorum* , coffee husk plus cow dung and coffee husk plus poultry manure and at composting periods 0 and 90 days respectively (Table 2).

Table 2. Nitrogen content (%) of coffee husk and its combinations at each composting period.

Day	Cofffee Husk+ *Desmodium triflorum*	Coffee Husk +Cow Dung	Coffee Husk +Poultry Manure
0	0.05	0.1	0.053
15	0.02	0.012	0.011
30	0.006	0.011	0.009
45	0.004	0.009	0.007
60	0.003	0.005	0.003
75	0.002	0.003	0.002
90	0.001	0.002	0.0002

4.4 Physical properties of mature compost

At the beginning odor of compost was unpleasant but at maturity changed to soil planter smell which is pleasant odor. The color of mature composts showed black to brown color for compost mixes of coffee husk plus cow dung, coffee husk plus poultry manure and coffee husk plus *Desmodium triflorum* (Figure 3).

Coffee Husk + Cow dung Coffee Husk + Poultry manure Coffee Husk + *D. triflorum*

Figure 3. Mature Coffee husk compost after 3 months

4.5 Percentage Germination

The pattern of seed germination was showed that, in general low percentage germination ranging from 6.99- 18.48 without any significant difference amongst the compost types (Table 3). There was low germination percentage at the beginnings of the composting. There was no significant ($p > 0.05$) variation among treatments in case of germination percentage of lettuce seed on 0 day. However, highly significant ($p < 0.05$) difference among treatments was observed in terms of germination percentage on 30, 45, 60, 75 and 90 days. However , there appeared to be a progressive increase in germination starting from 30 days (with 2-5 times increase 0 compared to the beginning of the experiment , except (CH+ CD only) treatment with a drastic decrease in % germination from 16.55% up to 9.03 % at 30 day of composting . also there was an increase by the treatment

(CH + CD + TS) in % of germination by 7.03 % at compost time 45 days , while at composting period 60 there was progressive increase by all the treatments except for, CH + CD + PM + TS , CH + CD only , CH + DES + TS , CH + DES only and CH+ PM only . although there appeared to be an increase by (2 times) at compost time 75 days except a decrease in % germination from 23.93 up to 7.42. finally a continues increase obtained by all the treatment , except a decrease in % germination by the treatment CH + CD only from 48.66 to 36.46 at compost time 90 days . The highest (65.9 %) value of seed germination observed with the treatment of 10% coffee husk + cow dung + poultry manure+90% top soil at three month aged compost.

Table 3. Effect of different coffee husk treatments on lettuce seed germination at each composting period

Treatments	Composting Period					
	0	30	45	60	75	90
CH + CD + DES + TS	14.66a	30.13ab	24.56ab	31.30ab	54.51ab	63.70a
CH + CD + PM + DES + TS	15.30a	40.03a	26.06ab	36.13a	62.66a	63.13a
CH + CD + PM + TS	7.33a	23.23bc	27.23ab	25.46abcd	64.45a	65.90a
CH + CD + TS	6.99a	36.66ab	29.63ab	33.63ab	60.81a	61.46a
CH + CD ONLY	16.55a	9.03d	16.23b	14.83de	48.66b	36.46b
CH + DES + TS	14.85a	40.80a	42.00a	28.46abc	57.18ab	65.63a
CH + DES ONLY	18.48a	15.56cd	21.40b	10.96e	19.51c	27.23b
CH + PM + TS	8.33a	42.46a	20.90b	30.26abc	55.90ab	57.50a
CH + PM +DES + TS	9.02a	37.50a	24.83ab	29.10abc	56.03ab	64.00a
CH + PM ONLY	9.97a	15.13cd	27.30ab	23.93bcd	7.42d	53.83a
Control	7.29a	28.70abc	9.66b	20.03cde	24.03c	31.30b
CV	47.9					
LSD	12..3					
Significance	P<0.05(significant)					

Mean values of percentage of seed germinated. Means in the same column with the same letter are not significantly different at $p < 0.05$.

Where:- CH + CD + DES + TS=*10 %* coffee husk plus cow dung plus *Desmodium triflorum* plus 90 % top soil, CH + CD + PM + DES + TS=10 % coffee husk plus cow dung plus poultry manure plus *Desmodium triflorum* plus 90 % top soil, CH + CD + PM + TS=10 % coffee husk plus cow dung plus poultry manure plus 90 % top soil, CH + CD + TS=*10 %* coffee husk plus cow dung plus 90 % top soil, CH + CD only=100 % coffee husk plus cow dung, CH + DES + TS=10 % of coffee husk plus *Desmodium triflorum* plus 90 % top soil, CH + DES only=100% coffee husk plus *Desmodium triflorum,* CH + PM + TS=10 % coffee husk plus poultry manure plus 90 % top soil, CH + PM +DES + TS=,10 % coffee husk plus poultry manure plus *Desmodium triflorum* plus 90 % top soil, CH + PM only=100% coffee husk plus poultry manure

4.6 Marketable yield

Highly significant (p<0.05) difference in fresh biomass of lettuce was recorded among treatments at all periods of incubation (Table 4). A continuous increase in lettuce biomass was recorded for the tested treatments by application of 0, 30,45,60,75 and 90 days old coffee husk composts. The treatment with the highest(63.4g/plant) marketable yield at 0 day was 10% coffee husk + cow dung + poultry manure + *Desmodium Triflorum* + 90% top soil and the treatment with lowest value was obtained from 100% coffee husk + *Desmodium triflorum*, followed by highest(65.1g/plant) at 30 days. the highest marketable yield was obtained from 10% coffee husk + cow dung + 90 % top soil (65.7g/plant, 78.2g/plant and 79.6 g/plant) at composting periods of 45, 60 and 75 respectively. Similarly the highest (105.42g/plant) fresh biomass of lettuce (32.3g/plant) was obtained by application of 10% coffee husk + cow dung + 90% top soil treatment compared to control.

Table 4: Effect of different coffee husk treatments on lettuce yield at each composting period.

Treatments	Composting Period/day					
	0	30	45	60	75	90
CH + CD + DES + TS	29.3^{de}	$_{39}$bc	26.2^{d}	28.1^{c}	41.7^{e}	57.5^{cd}
CH + CD + PM + DES + TS	63.4^{a}	65.1^{a}	36.3^{cd}	34.3^{c}	54.8^{bc}	58.4^{cd}
CH + CD + PM + TS	33.1^{cd}	44.9^{b}	32.9^{cd}	39.9^{bc}	53.1^{cd}	66.8^{bc}
CH + CD + TS	10.5^{f}	41.5^{bc}	65.7^{a}	78.2^{a}	79.6^{a}	105.4^{a}
CH + CD ONLY	1.03^{g}	32.1^{cd}	45.9^{bc}	40.1^{bc}	47.6^{cde}	61.6^{cd}
CH + DES + TS	29.4^{e}	25.1^{d}	5.5^{e}	10.2^{d}	9.9^{f}	42.6^{de}
CH + DES ONLY	0^{g}	0.93^{e}	1.3^{e}	1.1^{d}	0.45^{f}	0^{f}
CH + PM + TS	41.2^{c}	48.3^{b}	53.8^{ab}	52.4^{b}	58.9^{b}	71.9^{c}
CH + PM +DES + TS	53.2^{b}	38.3^{bc}	41.8^{bc}	35.1^{c}	55b^{c}	82.6^{b}
CH + PM ONLY	14.5^{f}	7.43^{e}	7.2^{e}	28^{c}	43.3^{de}	55.3^{cd}
Control	24.4^{e}	43.2^{b}	1.1^{e}	0.5^{d}	1.95^{f}	32.3^{ed}
CV	50.8					
LSD	12.3					
Significance	P<0.05(Significant)					

Mean values of yield of lettuce growth. Means in the same column with the same letter are not significantly different at $p < 0.05$.

Where:- CH + CD + DES + TS=*10 %* coffee husk plus cow dung plus *Desmodium triflorum* plus 90 % top soil, CH + CD + PM + DES + TS=10 % coffee husk plus cow dung plus poultry manure plus *Desmodium triflorum* plus 90 % top soil, CH + CD + PM + TS=10 % coffee husk plus cow dung plus poultry manure plus 90 % top soil, CH + CD + TS=*10 %* coffee husk plus cow dung plus 90 % top soil, CH + CD only=100 % coffee husk plus cow dung, CH + DES + TS=10 % of coffee husk plus *Desmodium triflorum* plus 90 % top soil, CH + DES only=100% coffee husk plus *Desmodium triflorum,* CH + PM + TS=10 % coffee husk plus poultry manure plus 90 % top soil, CH + PM +DES + TS=,10 % coffee husk plus poultry manure plus *Desmodium triflorum* plus 90 % top soil, CH + PM only=100% coffee husk plus poultry manure

Lettuce seedlings grown in different composting substrates with coffee husk at various composting periods gave better marketable yield compared to the control (without compost) (Figure 4 A-D).

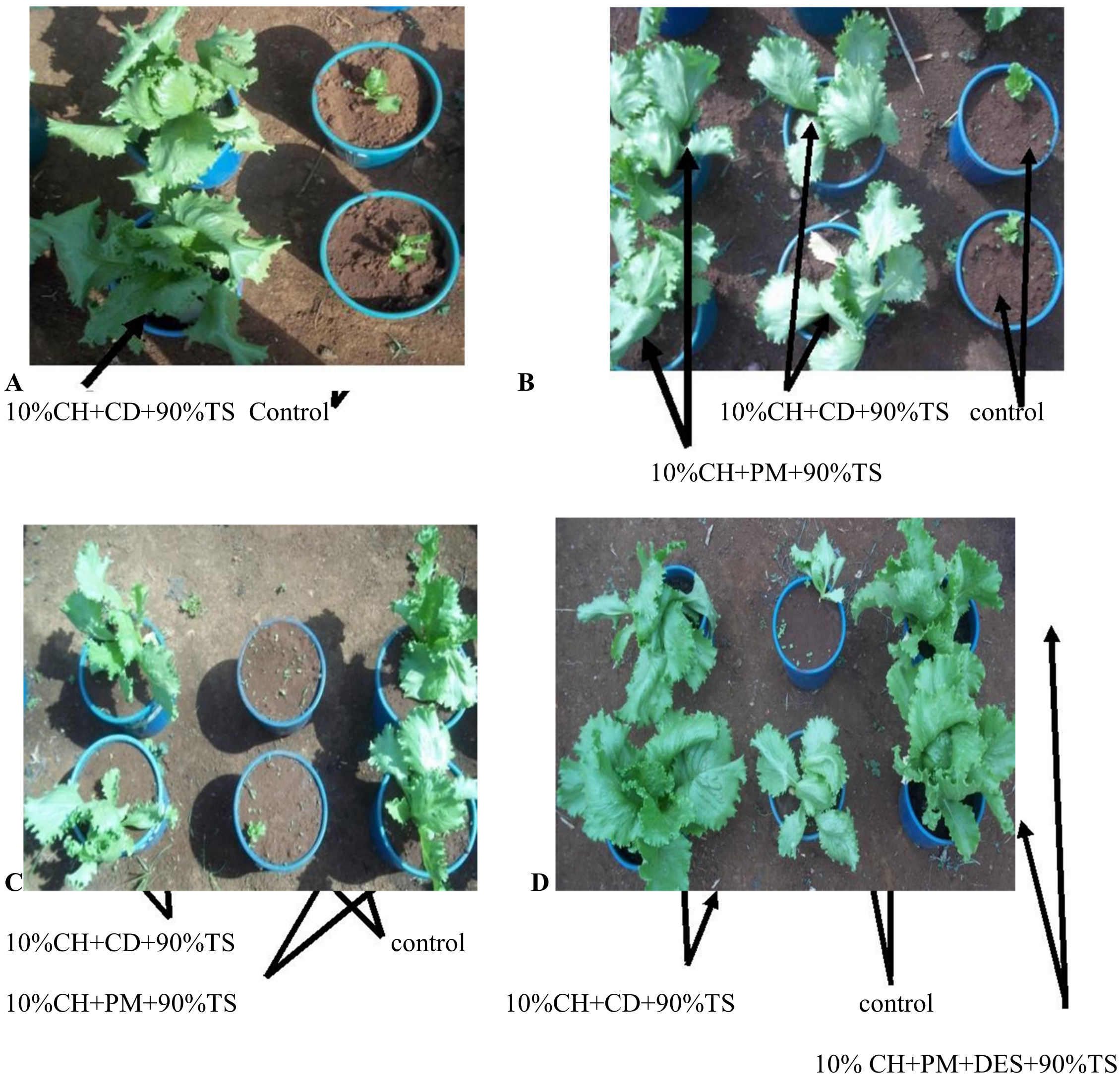

Figure 4. Lettuce seedling growth at different composting time between treatments and control
(a) marketable yield at day 45 (b) marketable yield at day 60 (c) marketable yield at day 75
(d) marketable yield at day 90
Where: - 10%CH+CD+90%TS = 10 % coffee husk plus cow dung plus 90 % top soil 10%CH+PM+90%TS= 10 % coffee husk plus poultry manure *plus* 90 % top soil, 10%CH+ PM+ DES+90%TS= 10 % coffee husk plus poultry manure plus *Desmodium triflorum* plus 90 % top soil

4.7 Non Marketable yield

Significant ($p< 0.05$) differences were observed in non marketable yield in g/plant at 0, 30, 45, 60, 75 and 90 days of composting period with mean values of 0.91 g, 0.11 g, 0.4 g, 0.43 g, 0.7 g and 0g, respectively (Table 5). Zero aged compost displayed a significant ($p< 0.05$) among treatments with regard to non marketable weight of lettuce. Highly significant ($p< 0.05$) differences were recorded with one month aged composts. There was no significant ($p< 0.05$) difference on non marketable yield of lettuce at day 45. A significant ($p< 0.05$) difference was observed among the tested treatments in terms of non marketable yield of lettuce at 60 and 75 days of composting. It was further noted that 3 month old composts have no significant difference ($p< 0.05$).

Table 5: Effect of different coffee husk treatments on nonmarketable yield of lettuce at different time of composting

Treatments	Composting periods					
	0	30	45	60	75	90
CH + CD + DES + TS	0.55^{cd}	0**cd**	0.03^{a}	0^{b}	0^{b}	0^{a}
CH + CD + PM + DES + TS	2.76^{a}	0**a**	0.48^{a}	0**b**	0**b**	0**a**
CH + CD + PM + TS	1.68^{abc}	0**abc**	0.21^{a}	0**b**	0**b**	0**a**
CH + CD + TS	0^{d}	0.66^{d}	0.31^{a}	0.05^{b}	0^{b}	0^{a}
CH + CD ONLY	0^{d}	0^{d}	1.85^{a}	4.5^{a}	7.7^{a}	0^{a}
CH + DES + TS	0.83^{bcd}	0**bcd**	0^{a}	0^{b}	0^{b}	0^{a}
CH + DES ONLY	0^{d}	0^{d}	0.05^{a}	0^{b}	0.11^{b}	0^{a}
CH + PM + TS	1.13^{bcd}	0.3^{bcd}	1.3^{a}	0.13^{b}	0^{b}	0^{a}
CH + PM +DES + TS	1.9^{ab}	0**ab**	0.05^{a}	0**b**	0**b**	0**a**
CH + PM ONLY	0.02^{d}	0**d**	0**a**	0**b**	0**b**	0**a**
Control	**1.18^{bcd}**	**0.25^{bcd}**	**0^{a}**	**0^{b}**	**0^{b}**	**0^{a}**
Significance	ns					

Mean values of non marketable yield of lettuce in (g). Means in the same columns with the same letter are not significantly different at $p < 0.05$.

Where:- CH + CD + DES + TS=*10 %* coffee husk plus cow dung plus *Desmodium triflorum* plus 90 % top soil*,* CH + CD + PM + DES + TS=10 % coffee husk plus cow dung plus poultry manure plus *Desmodium triflorum* plus 90 % top soil*,* CH + CD + PM + TS=10 % coffee husk plus cow dung plus poultry manure plus 90 % top soil, CH + CD + TS=*10 %* coffee husk plus cow dung plus 90 % top soil, CH + CD only=100 % coffee husk plus cow dung, CH + DES + TS=10 % of coffee husk plus *Desmodium triflorum* plus 90 % top soil*,* CH + DES only=100% coffee husk plus *Desmodium triflorum,* CH + PM + TS=10 % coffee husk plus poultry manure plus 90 % top soil, CH + PM +DES + TS=,10 % coffee husk plus poultry manure plus *Desmodium triflorum* plus 90 % top soil*,* CH + PM only=100% coffee husk plus poultry manure

5. DISCUSSION

In this study, the temperature of the composting process started from 28 °C from all compost types, and increased as a function of time (fig 1). There was steady increase between 30-40 °C up to 15 days which was considered as a Mesophilic stage. Similar study showed a steady increase in temperature of the compost in the early stage of composting could be caused by rapid mineralization of organic carbon and nitrogen in the presence of adequate aeration and moisture which are required by microbes responsible for the breakdown of organic compounds (Finstein *et al*., 1986). However, there was drastic increase between 50-60°C up to 60 days which therefore decrease slowly. The steady decline of temperature during final phase indicates that the compost had gone through the thermophilic stage and approached maturity as supported by the results of Nogueira *et al*., (1999). Similar study also showed that the maturity of the compost is determined by its cooling phase (Kassa *et al.,* 2011).

In present study, pH values of all the three compost piles were between 8-9 (fig 2). This phenomenon may be attributed to the properties of the raw materials. In agreement with this study, Adegunloye *et al.* (2007) reported that the pH values for the composting ratios vary at the temperature regime in various composts at the beginning of composting and ranged from 7.3-7.7. Moreover, the average compost pH value between 8.0-8.5 was reported by Steger (2006).

The organic materials used in these experiments varied in nutrients composition since after composting, different concentrations of carbon and nitrogen nutrients were recorded. As composting period extended, the total carbon and nitrogen content significantly decreased in each of compost piles in this study. This was primarily caused by the decomposition during active stage of composting. In agreement with the current findings, laboratory analysis of compost confirmed that the addition of organic amendment in coffee byproducts reduced the C: N ratio and organic matter content of the compost compared to the control (Kassa *et al.,* 2011). The decrease in organic matter, organic carbon and organic nitrogen ratio from 897 to 891, 567 to 539.8 and 33.2 to 25.4, respectively was primarily caused by the decomposition during active stage of composting (Khiyami, 2008).

During the composting process, a gradual change in color of compost to brownish black observed and this indicates the maturity of the compost. The obtained results are in agreement with other studies (Diaz *et al.,* 1993; Steger, 2006) who reported a grayish-black or brownish-black color, depending on originally contained pigments. The three compost mixes were also odorless as reported by other investigators (Hauge, 1980; Alexander, 2006).

In the present study mean values of germination percentage of lettuce was very high in mature compost (3 month) compared to other composting periods. This suggests that as composting period extends the undecomposed materials (that was not favorable) for lettuce growth eliminated and the toxic chemicals in coffee husk also decrease because of decomposition. Rao (1991) indicated that the soil could be enriched with the application of organic material which tends to decompose and release relatively large amounts of nitrogen into the soil before planting crop to boost yield. In this study top soil amended with 10% of compost enhanced germination of lettuce seed. In light of this study Xu *et al.* (2005) reported that vegetables grown with organic fertilizers promoted better and resulted in a higher total yield than those grew with chemical fertilizers.

Mean values of marketable yield of lettuce was very high in mature compost in treatments 10 % coffee husk plus cow dung plus 90% top soil and 10 % coffee husk plus poultry manure plus *Desmodium triflorum* plus 90 % top soil. Similar study showed that utilization of coffee pulp compost for commercial growing media substitution at nursery has proven to be useful method to obtain suitable growth media for tomato seedling production (Berecha *et al.,* 2011). Abbasi *et al*. (2002) reported that composted coffee husk contains considerable quantities of nutrients. It was also observed that the application of mature compost had a positive effect on plant height (Akhtar *et al*., 2009).

Treatment 10% of coffee husk plus cow dung plus poultry manure plus *Desmodium triflorum* plus 90 % top soil and 10 % of coffee husk plus poultry manure plus 90% top soil were also show relatively high yield after the compost mature. Similar study showed that plants which were fertilized with composted mature cow dung gave the highest marketable yield (Uddin *et al*., 2009). *Cucumis melo* plants receiving chicken litter exhibit relatively higher marketable yield than those receiving no chicken litter (Ghanbarian *et al*., 2008). Similar results were obtained with broccoli (Ouda and Mahadeen, 2008) where cattle manure was found to increase pod yield of okra (Ogunlela *et al*., 2005). Despite its merits, compost from coffee byproducts was not widely used in nursery and field production of crops and ornamental plants in Ethiopia. This study clearly showed that the addition of coffee husk compost as biofertilizer for lettuce production had proven to be effective.

6. CONCLUSION and RECOMMENDATION

The combination of Coffee husk plus supplementing compost enhanced the temperature, aeration, moisture content and chemical composition of the organic waste materials through process of decomposition. Use of coffee husk compost after three month decomposition as organic fertilizer increased the lettuce yield. However, replacement of commercial growing media for the production of lettuce seedlings in lath house by coffee husk compost is credible. Based on the finding of this study, it is recommended that the combinations of 10% Coffee husk with Cow dung plus 90% top soil is suitable combination for the cultivation of lettuce.

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