Thu Dau Mot University Journal of Science
ISSN 2615 - 9635
journal homepage: ejs.tdmu.edu.vn

Researching of compost production from mixed material of cow dung, coir and domestic waste

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Article Info: *Received Jan.26th,2022, Accepted Mar. 3rd,2022, Available online Mar.15th,2022*
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https://doi.org/10.37550/tdmu.EJS/2022.01.279

ABSTRACT

Research results show that compost was created at the rate of C / N: 25/1 by mixing ingredients 2.5 grams of cow manure, 3g of organic waste, 0.01g of coir based on calculation of content. C and N in each material; With the humidity of 60% based on the calculation of the moisture content from the compost materials combined with the amount of water to add is 670ml, from which a Compost fertilizer has been produced. Determination of the optimal values for the mixratio and function has been verified on experimental crops. Research also shows that the use of probiotics in composting will shorten the compost time, limit the odor escaping from the compost.

Keywords: *compost, compost ingredients, rate of C /N of compost*

1. Introduction

With the development of the economy, the world in general and Vietnam in particular are also facing many problems of environmental pollution. In recent years, Binh Duong is one of the southern provinces leading in the development of technology, along with the speed of economic development, the trend of urbanization is getting stronger, the population is increasing day by day rapidly increasing the amount of domestic waste (Nguyen Van Phuoc, 2012). The purpose of the article is to find out how to turn waste into a useful product – high quality compost for using in farming (Ho Chi Minh University – Science and Technology – Environmental Engineering, 2011). Materials are used in this study to produce compost are domestic waste, coir and cow dung

(Truong Thi Anh Tuyet, Ly Van Son, Ha Huy Hoang, 2012). This is one of the useful solutions to overcome the pollution caused by domestic waste.

The article "Researching of Compost production from mixed materials of Cow dung, coir and domestic waste" gave the results of the optimal value of the mixing ratio and moisture function for the production of compost with the above waste materials.

2. Method of studying

2.1. Methods of investigation, data collection and processing

– Collecting documents and previous research data related to the issue of this studying

– Field surveying on the amount of organic waste generated in households in the studying area, Chanh Nghia ward.

– Use excel software to handle the experimental data.

2.2. Experimental method of production

Compost products are produced from the main materials are organic household waste, coconut fiber and cow dung

2.2.1. Prepare materials:

Organic waste is collected at the household whose address is 104/6 Town 1, Chanh Nghia Ward, Thu Dau Mot City, Binh Duong. After sorting, take the organic part, cut it into pieces about 2cm. (Tran Xuan Huy, 2010)

Coconut fiber: It is a kind of porous organic material. It can retain water, increase the aeration and porosity of the compost. In this study, we used coconut fiber purchased at an organic fertilizer store (Study carried out at the Central Coir Research Institute CCRI, 2006).

Cow dung: It is the excrement of buffaloes and cows. It has high nutritional value for plants. In this experiment we used dried cow manure purchased at the organic fertilizer store (Lallawmsanga, D.J.M. Kumar, M.D. Balakumaran, M.R. Kumar, J. Jeyarathi and P.T. Kalaichelvan, 2012).

Figure 1. Compost materials: Organic waste, Coir and Cow dung

Microbial products: Use Trichoderma microbial products with 108 CFU/g. The Trichoderma produces cellulose enzymes that help break down cellulose and convert insoluble components into soluble for easy absorption by plants. Trichoderma helps prevent fungal diseases of plants (Pham Thi Thanh Thuy, Nguyen Van Viet, 2017).

2.2.2. To compost

Use 6 compost bins, type of styrofoam box with size: length × width × height = 40cm × 30cm × 30cm. The compost bin has a separate wire mesh to collect leachate into the two bottom plastic bottles to lead the leachate to the outside. The bin is perforated with small holes to help with ventilation. Calculation of the content and volume of mixed materials in the case studies

– The composting period is 20 days

– The ratio of mixing C:N is:

The first composting bin has a C:N ratio of 20:1

The second composting bin has a C:N ratio of 25:1

The third composting bin has a C:N ratio of 30:1

Incubation bins 4, 5, 6 have a C:N ratio of 25:1 (different humidity)

Condition of composting block: PH = 7-7.5 ; Temperature from 250C to 300C

Humidity 60% (for compost bins 1, 2, 3, 5)

Humidity 50% (for compost bin 4)

Humidity 70% (for compost bin 6)

2.2.3. Experimental layout

a/ Experimental production of compost with different C:N mixing ratios

– Experiment 1 (Ex 1): composting with a C:N ratio of 20:1:

Mixing materials: 0.5kg of organic waste, 2.5kg of cow manure, 0.01kg of coir, microbial products, add 890ml of water

– Experiment 2 (Ex 2): composting with the ratio of C:N is 25:1

Mixing materials: 3kg of organic waste, 2.5kg of cow dung, 0.01kg of coir, microbial products, add 670ml of water.

– Experiment 3 (Ex 3): compost with the ratio C:N is 30:1

Mixing materials: 9kg of organic waste, 2.5kg of cow dung, 0.01kg of coir, microbial products.

Check the initial condition of the incubator: PH : 7, Temperature: 300C, Humidity 60%

b/ Experimental arrangement to evaluate the effect of compost on plants at different C:N ratios

The effectiveness of the bio organic compost was evaluated on the bean plants.

Planting green peas on the composted products in the experiments. Each type of fertilizer will be planted with 5 samples.

– Prepare 15 labeled plastic cups.

– Add the manure of each compost bin in the experiment, mix it with soil, and plant green beans. The ratio of soil and compost mix is 1: 0.5

Place them where sunlight hits, water and monitor.

– Experiment 4 (Ex 4): growing plants with compost at a C:N ratio of 20:1

– Experiment 5 (Ex 5): growing plants with compost at a C:N ratio of 25:1

– Experiment 6 (Ex 6): growing plants with compost at a C:N ratio of 35:1

Measure the size of the beans within 10 days

Calculate the average height of the bean trees in Experiment 4, 5, 6:

Compare the growth ability of plants to assess the quality of fertilizers in Ex 1, Ex 2, Ex 3.

c/ Experimental arrangement to produce compost with optimum C/N value, at different humidity

Humidity is an essential for the operation of VSV. The optimum moisture of the composting process is 50-60% (Nguyen Van Phuoc, 2012). According to research by authors Phan Thi Thanh Thuy and Nguyen Van Viet, in the experiment, Trichoderma microbial products were added at 44.5% -63.67% moisture for the best quality manure

Based on these bases, composting with different moisture levels to choose the best quality of manure:

– Experiment 7 (Ex7): composting with low moisture:

Mixing materials: 3kg of organic waste, 2.5kg of cow dung and 0.01kg of coir.

– Experiment 8 (Ex8): composting with average moisture:

Mixing materials: 3kg of organic waste, 2.5kg of cow dung, 0.01kg of coir, microbial products and 670ml of water.

– Experiment 9 (Ex9): composting with high humidity:

Mixing materials: 3kg of organic waste, 2.5kg of cow dung, 0.01kg of coir, microbial products and 1100ml of water.

Take the mixed sample and measure the moisture by drying method at 1050C until the weight is constant:

Ex7 has a humidity of 51.8%

Ex8 has a humidity of 61.3%

Ex9 has a humidity of 70%

Condition of composting block: Temperature = 300C, PH = 7

d/ Experimental arrangement to evaluate the quality of the compost on plants at different humidity levels

Planting green peas on the composted products in the experiments. Each type of compost will be planted with 5 samples.

Prepare 15 labeled plastic cups. Add manure from each compost bin in the experiment, mix it with soil, and add green beans. The ratio of soil and compost mix is 1: 0.5

Place where sunlight hits, water and monitor.

– Experiment 10 (Ex10): growing plants with low-moisture compost

– Experiment 11 (Ex11): growing plants with medium-moisture compost

– Experiment 12 (Ex12): growing plants with high-moisture compost

Measure the size of the beans within 10 days

Calculate the average height of trees in Experiment 10, 11,12:

Compare the growth ability of plants to assess the quality of manure in Ex7, Ex8, Ex9.

3. Results and discussion

3.1. Results of calculation about C/N ratio

The C:N ratio is the most important parameter in the composting process. In fact, determining the ratio of C:N is quite difficult for households. According to the textbook on solid waste management and treatment of Prof. Dr. Nguyen Van Phuoc, 2012, the most optimal C:N ratio is 25:1. Based on this to calculate the appropriate mixing ratio (Nguyen Van Phuoc, 2012).

TABLE 1. Data on percentage of Nitrogen, ratio of C:N and moisture constant for each type of material

Composition	% N(dry)	C:N Ratio	Moisture (%)
Organic waste	2.7	34.8	70
Coir	0.3	80	20
Cow dung	1.7	18	30

Calculation of Nitrogen and Carbon content in each type of raw material results as follows:

For 1kg of organic waste, the Nitrogen content is 0.0081kg, the Carbon content is 0.0282kg

Similarly, for 1kg of cow manure, the Nitrogen content is 0.0119 kg, the Carbon content is 0.2142kg

For 1kg of coir, the Nitrogen content is 0.0024kg, the Carbon content is 0.192kg

Mix these 3 ingredients according to the hypothetical method in 3 cases:

Case 1: Take the weight of cow dung is 1 kg and the weight of coir is 1kg

Case 2: Take the weight of cow manure is 1 kg and the volume of organic waste is 1kg

Case 3: Take the weight of coir is 1 kg and the volume of organic waste is 1kg

The results of calculation for the ratio of C:N at the lowest level of 20:1. The first case and the second case both result that the weight of the 3rd material is negative. Therefore, these two cases are eliminated. The third case gives reasonable results with the weight of coir is 1kg, the weight of organic waste is 1kg and the weight of cow dung is 11kg. However, with this rate, it does not have much meaning in environmental treatment because of the relatively large amount of organic waste that is disposed of daily in households. Through many times of calculating and processing data, the author has come up with a table of data. In this table, the data of the mixed materials to ensure the necessary C:N ratios for the study are as follows:

TABLE 2. Mass of C and N in compost material with C:N ratio of 20:1

Material name	Mass of C and N (g)	
	C	N
Cow dung	535.5	29.75
Coir	1.92	0.024
Organic waste	140.94	4.05

TABLE 3. Mass of C and N in compost material with C:N ratio of 25:1

Material name	Mass of C and N (g)	
	C	N
Cow dung	535.5	29.75
Coir	1.92	0.024
Organic waste	845.64	24.3

TABLE 4. Mass of C and N in compost material with C:N ratio of 30:1

Material name	Mass of C and N (g)	
	C	N
Cow dung	535.5	29.75
Coir	1.92	0.024
Organic waste	2536.92	72.9

From there can calculate the weight of composting material as follows:

TABLE 5. Weight of composting materials

C:N Ratio	Material weight (kg)		
	Cow dung	Organic waste	Coir
20:1	2.5	0.5	0.01
25:1	2.5	3	0.01
30:1	2.5	9	0.01

3.2. Resulting in optimal moisture selection in compost materials and the amount of water to be added to the compost bins

3.2.1. Results of the calculation of moisture in composting materials

TABLE 6. Humidity of compost mass

ϕ_1 (Organic waste)	ϕ_2 (Cow dung)	ϕ_3 (Coir)
70%	30%	20%

3.2.2. Calculate the amount of water to add to the compost bins

Initial moisture content of the composting mass:

$\phi = (\phi_1 * m_1 + \phi_2 * m_2 + \phi_3 * m_3) : m$

The initial moisture content of the composting mass in the Ex1 is:

$\phi_{01} = (0.7*0.5 + 0.3*2.5 + 0.2*0.01) : 3.01 \approx 36.6\%$

The initial moisture content of the composting mass in the Ex2 is:

$\phi_{02} = (0.7*3 + 0.3*2.5 + 0.2*0.01) : 5.51 \approx 51.8\%$

The initial moisture content of the composting mass in the Ex3 is:

$\phi_{03} = (0.7*9 + 0.3*2.5 + 0.2*0.01) : 11.51 \approx 61.3\%$

So the amount of water to add to the Ex1 is:

$\phi_{01} = (\phi_1 * m_1 + \phi_2 * m_2 + \phi_3 * m_3 + m_{H2O}) : m = 0.613 = (1.102 + m_{H2O}) : 3.01$

$\Rightarrow m_{H2O} = (0.613* 3.01) – 1.102 = 0.743(kg)$, $D_{H2O} = 1000\ kg/m^3$

$\Rightarrow V_{H2O} = m_{H2O} : D = 0.743 :1000 = 0.000743(m^3)=743ml$

So the volume of water that needs to be added to achieve 61.3% humidity in the Ex1 is 743ml

Similarly calculate the volume of water to be added to achieve 61.3% humidity in the Ex2 is 454ml

The initial humidity of the Ex3 is 61.3%, so no need to add water.

In the Ex7, initial humidity is 51.8% so no need to add water

Similarly calculate the volume of water to be added to achieve 61.3% humidity in the Ex8 is 454ml

The volume of water that needs to be added to achieve 70% humidity in the Ex9 is 1005ml

3.3. Results of assessing the quality of compost on the bean plants at different C/N ratios

After 10 days of experimental planting on bean plants (all peas are germinated), the results of the bean height in 3 experiments were as follows:

TABLE 7. Average height of the bean plant in the Ex4, Ex5, Ex6

Day	Average height of the green beens (cm)		
	Ex4	Ex5	Ex6
1	0	0	0
2	0	0	0
3	0.41	0.5	0.4
4	1.25	1.7	1.9
5	3.15	3.8	4.3
6	4.15	5.35	5.1
7	5.1	7.3	5.75
8	5. 5	8.35	6.3
9	6.5	10.3	6.95
10	7.21	11.7	7.4

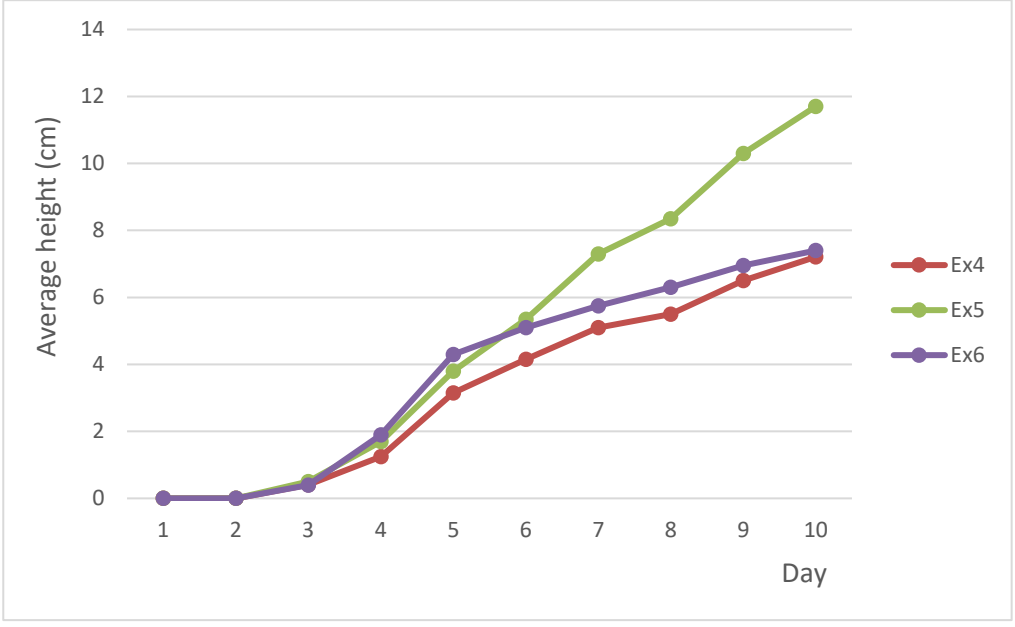

Figure 2. Growth chart of the bean plants in the experiments: Ex4, Ex5, Ex6.

From the chart, we can see that the rate of germination is 100%. Quality manure can be used. However, the growth in height of the plants is varied. In Ex5 (composting with the C:N ratio is 25:1) we see the best growth.

3.4. Results of the assessment of compost quality at the optimum C:N value (C:N=25:1) with different humidity.

After 10 days of performing on 3 experiments (Ex7, Ex8. Ex9), the author obtained the following results:

TABLE 8. Evolution of height change of composting mass during 10 days of the experiment

Day	Height of composting mass (cm)		
	Ex4	Ex5	Ex6
1	15	15	15
2	13.5	13	14
3	12	11	13
4	11.5	9	11
5	9	7.5	9.5
6	8	6	9
7	7.5	5	8
8	6	4.5	7
9	5.5	4	5.5
10	4	4	4

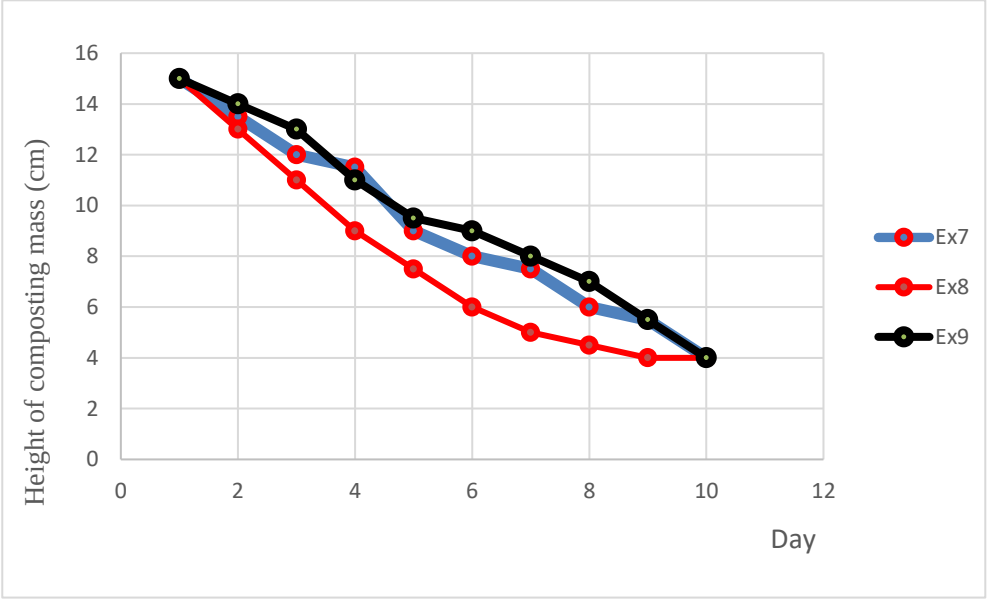

Figure 3. Variation chart of the decrease in height of the composting mass in the experiments Ex7, Ex8, Ex9.

From the chart, we can see in the Ex8 the volume of composting mass decreases faster than in the Ex7 and Ex9. This proves that medium humidity is most suitable for composting.

Low humidity limits the growth of microorganisms but if humidity is too high, it will also slow down the decomposition process. Therefore, in the Ex7 and Ex9 the volume

loss was slower than in the Ex8. The larger the mass obtained, the slower the decomposition

3.5. Results of evaluating the quality of compost on plants at the optimal C:N ratio and at different humidity

After 15 days of experimental planting on bean trees, all split peas germinated. Growing bean trees on experimental conditions (Ex10, Ex11, Ex12) obtained the following results:

TABLE 9. Average height of green beans in the experiments Ex10, Ex11, Ex12

Day	Average height of the green beens (cm)		
	Ex10	Ex11	Ex12
1	0	0	0
2	0	0	0
3	0.45	0.5	0.4
4	1.2	1.75	1.875
5	2.5	3.8	2.95
6	4.45	5.45	4.05
7	5.2	7.4	5.3
8	5.55	8.35	6.25
9	6.2	10.4	6.9
10	6.65	11.6	7.4

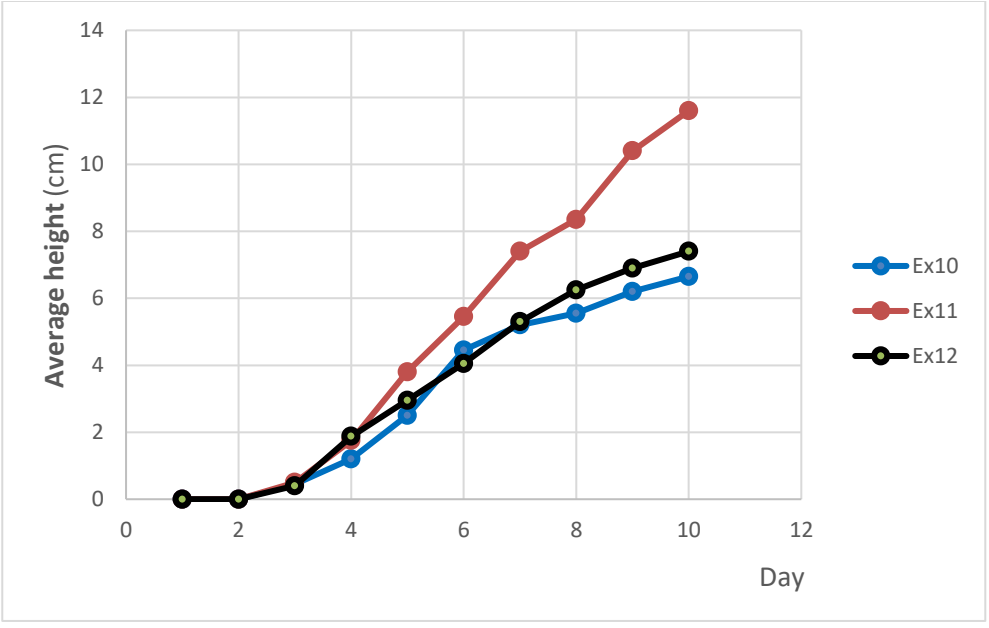

Figure 4. Growth chart of green beans in the experiments Ex10, Ex11 and Ex12

From the chart, we can see that the height of green beans in Ex11 (14cm) is the largest compared to the Ex10 and Ex12. Therefore, it can be concluded that the quality of compost at medium humidity is the best (with the optimal C:N ratio is 25:1).

4. Conclusion

– Through analysis and evaluation of the growth of green beans planted on different types of compost, the compost with the ratio of C:N = 25:1 (moisture 60%) is the best quality. This is also consistent with previous authors' research on composting conditions.

– The research has given a mixed formula to have the best quality compost, which is 2.5g Cow dung, 3g organic waste, 0.01g Coir, adding microbial products and 670ml water will have the compost with a ratio of C: N is 25:1 and 60% humidity.

– The use of microorganisms in composting will shorten the composting time, limit the odor emitted from the compost, and keep the environment cleaner.

– Research results have made it easy to mix compost materials with appropriate ratios. We can use of organic waste from households to make compost. Thereby, both reducing environmental pollution and creating good products for cultivation, limiting the use of chemical fertilizers, and minimizing the problem of soil environmental degradation.

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