American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-9, Issue-3, pp-334-339
www.ajer.org
Research Paper Open Access

Aerobic Composting of Cow Dung with Rice Straw Biomass

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ABSTRACT: *Aerobic composting was done at a cow farm in An Giang province. There were two treatments. The first treatment was fresh cow dung; the second treatment was cow dung with rice straw. Results showed that composting time of the second treatment was faster than one of first treatment was 10 days. From the first week to the fourth week, temperature of two experiments ranged from 33.2^{0}C to 43^{0}C, increased to peak at the seventh week (49-53^{0}C). Last phase of the experiment, temperature of first treatment was 32^{0}C, temperature of the second treatment was 29^{0}C.In addition, the number of Aspergillus spores in cow dung with straw (2,865 CFU/g) was lower than that in cow dung without straw (3,450 CFU/g). Not detect the worm eggs in both experiments. Concentration of N was relatively low in both piles (0.49-0.58%). However, Kalium and phosphorus in composting with straw was higher than the composting without straw, the ratio of C/N of the first treatment was 16.33 and C/N of the second treatment (with straw) was 18.53. The first stage of experiments, moisture in composting with straw was lower than that in composting without straw. But the end stage of experiments the moisture difference of two experiments were not much.*

KEYWORDS: *Composting, cow manure, cow dung, rice straw, aerobic.*

Date of Submission: 14-03-2020 Date of Acceptance: 31-03-2020

I. INTRODUCTION

In recent years, along with cattle-raising scale, intensive developing rapidly, cattle farm feces is concentrated, the problem of environmental pollution that discharge causes highlights day by day. According to statistics, Vietnam's cowboying number was already more than 5, 654 million head in 2018 [16], every beef cattle daily output fecaluria about 15-25kg daily [4], [13]. The cow's waste amount is up to 142 million tons, and these data are also continuing increase in Vietnam. One dairy cattle farm, with 2,500 cows produces as much waste as a city with around 411,000 people [5]. Due to lack of effective means of cow manure treatment, especially in large scale dairy farms, cow manure packing pollution has been serious concern. In some places, pollution of cow dung is over total amount of industrial pollution and some pollution is up to twice than industrial pollution [5]. Manure management is the big problem in cattle farms. Cattle manure is chronically exposed in air and can produce a large amount of foul gas, wherein contain substantial amounts of ammonia, the poisonous and harmful element such as sulfide, methane, pollutant atmosphere [27]. Additionally, cattle manure is contained substantial amounts of pathogenic microorganism, parasitic ovum and mosquitos and flies can develop, and then cause of disease kind in environment to increase.

Human population is increasing giving rise to intensive farming system and unsuitable cropland management that ultimately results in reduced soil fertility [26], [9]. Extensive use of chemical fertilisers is suggested for replenishment of nutritional deficiencies to increase crop yield. Many disadvantages of widespread use of chemical fertilisers include increase in soil acidity, mineral imbalance and soil degradation [7]. In Vietnam, increasingly high levels of synthetic fertilizer N are applied to croplands. Serious concerns have been raised about the impacts of synthetic fertilizer N production on greenhouse gas emissions [19], [37], [14]. Therefore, seeking supplemental sources of nutrients and reducing synthetic fertilizers consumption, reduce greenhouse gases emission is absolutely necessary. In fact, cow dung itself is a good source of organic fertilizer. Cow dung is high in organic material and rich in nutrients. It contains about 3 percent Nitrogen, 2 percent Phosphorus, and 1 percent Potassium (3-2-1 NPK) [5]. Except for a lot of organic matter, N, P, K and other essential plant nutrients, cow dung contains a variety of enzymes and microorganisms. After making into organic fertilizer, cow dung organic fertilizer can play an irrplaceable role in soil, which helps to improve soil fertility, organic matter, soil physical and chemical property and microbial environment. Nowadays, in Vietnam, there is an increasing research interest in developing the applications of cow dung microorganisms for fertilizers production. It is very effective's alternatives to chemical fertilizers by enhancing productivity in long term with maintaining the soil health and enhances the microbial population [2]. In composting, microorganisms decompose organic substrate aerobically into carbon dioxide, water, minerals and stabilised organic matter [11], [34].Cow dung harbours a diverse group of microorganisms that may be beneficial due to their ability to produce a range of metabolites. Many cow dung microorganisms have shown natural ability to increase soil fertility through phosphate solubilisation [18].Compost is added into the soil to improve nutrients and water-holding capacity [6], [34]. Integration of inorganic, organics and bio-fertilizers can produce 50-92% more yield in Aonla [21]. Cowdung positive response in suppression of mycelial growth of plant pathogenic fungi like *Fusarium solani,F. oxysporum and Sclerotinia sclerotiorum*[8]. Similarly,the research'sMarycowdung extract spray was also reported to be effective for the control of bacterial blight disease of rice and was as effective as penicillin, paushamycin and streptomycin [23]. As research's Pammelcow dung as organic manure increase vigour of plant and reduce the disease incidence of root rots in cotton caused by Phyma-totrichum omnivorum [28]. Similar investigation was done by [1] and reported that organic manure reduce disease incidence caused by a wide range of plant pathogens including bacteria, fungi and nematode species. Research'sMeertenshas reported use of cattle manure in lowland rain-fed rice production with an overall yield improvement; 5 tons/ha increased grain yields by 194 kg/ha over the control treatment [24].Combination of cow dung with NPK (15:15:15) in the concentration of 3 tons/ha and 100 kg/ha, respectively, showed marked increase of 8.9 tons/ha in the yield of potato tuber in comparison to control that yielded only 1.8 tons/ha. The organic carbon of the soil after treatment with this combination NPK (15:15:15) was found to be significantly increased from 1.33 to 3.21%. The combination also improved soil organic matter, phosphate availability, exchangeable ions, effective cation exchange capacity and pH in comparison to untreated soil [26].The same combination has also been reported to increase the yield of maize [7], [9].According to research's Adegunloye, C: N ratio in cowdung manure is an indication that it could be a good source of protein for the microbes which involved in decomposition of organic matter [3]. Manure and urine raise the pH level and accelerate the decomposition of organic matter and termite activity [12]. The major constraint to the use of manure is its limited availability, variable quality due to poor handling, and competing uses on the farm [35]. But, it is with small investment and quick results and the pollution by livestock and breeding is reduced. Animal waste is cheap and easy to be collected, reducing the production cost greatly and provide nutrients for the growth of plant and grow and improve soil. However, very few have reported the quality characteristics of the composts used, that is, the nutrient contents and mineralization rates. Therefore, research on "Composting of cow dung with rice strawbiomass" was done. The aim of this study was to assess the effect of composting process of cow manure and rice straw and to evaluate the quality of composting products. The final compost product can be used directly for agriculture crop.

II. METHODOLOGY

The experiment was conducted in a small farm in An Giang province, from July to the end of September in 2017. In this study, cow manure was used as the main material for composting together with rice straw. Rice straw was cut into 10-15cm size pieces using scissors and was soaked in the water for one day before the composting process. Composting was carried out in a shaded area, the composting process lasted 12 weeks. Compost aeration was ensured by manual flip every week. In this experiment, there were two treatments, was arranged with the mass ratio as follows: (1) 200 kg cow manure without rice straw (2) 200kg cow manure with 400kg rice straw. Because According to research's Du, optimum conditions for cow manure-rice straw composting in terms of CO_2 production were a C/N ratio of 40 and water content of 60% [15]. Moist of raw materials was 80% for cow dung and 50% for rice straw. Therefore, to create a mixture with 60% moisture, cow manure was collected from every morning, a rate of 2 kg rice straw and 1 kg moist cow manure.

The composting frame size is (200cmx150cmx100cm) contained a base fence constructed from bamboo. The base fence was elevated 30 cm from the ground to facilitate ventilation. This fence open at the top and bottom, was propped up with four bamboo sticks (Fig 1).Three plastic pipes with the composting samples were each put into nylon bags. The piles are half covered by plastic foil to protect from evaporation. Compost samples were taken from each treatment to determine parameters: completely ripe time of materials, temperature (^{o}C), humidity (%), pH, microorganisms, fungal spores, helminth eggs and C/N, N (%), P (%), K (%) in both treatments. The temperature of the central part of the composting pile was monitored per day using thermometer and using a pH meter to measure pH. Total nitrogen, kalium and phosphorouswere determined at the end of the composting process using the TCVN 8557-2010 (2007) and TCVN 8563-2010 (2007) methods accordingly. The characteristics of raw materials used for experiments are shown in Table 1.

Table 1: Characteristics of composting raw materials

Characteristics	Materials		
	Cow Manure	Rice Straw	Mixture
Moiture content (%)	80%	50%	60%
Organic carbon (g·kg^{-1} DW)	378	410	395
Total Nitrogen (g·kg^{-1} DW)	29.3	10.7	17.5
C:N	16.7	41.4	38.6

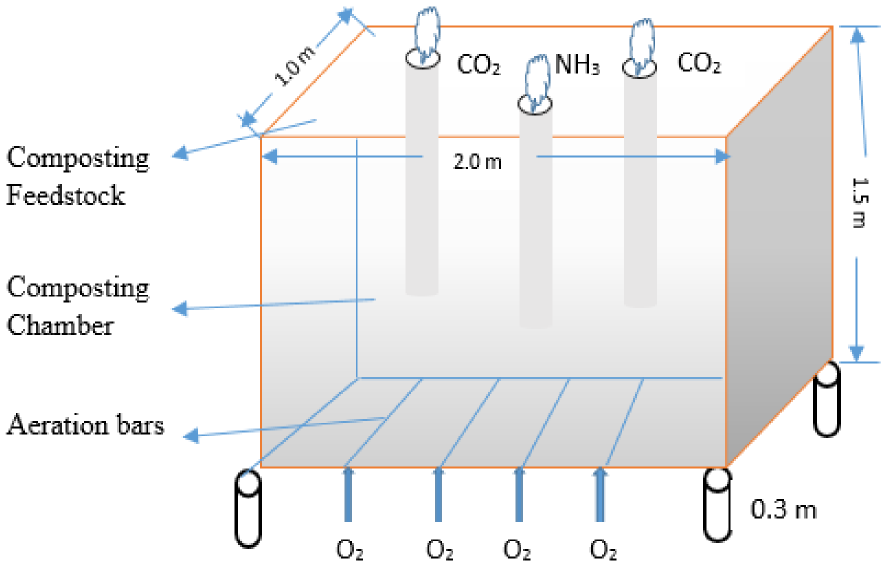

Fig 1. Schematic illustration of composting unit

III. RESULTS AND DISCUSSION

The cow manure rice straw composting process is initiated by the microbiological decomposition of mixed organic materials. The temperature within the composting pile was monitored during the 90 days composting period. This showed that the evolution of the temperature within the composting pile went through three major phases: heating phase, thermophilic phase, and cooling phase. At the beginning of composting, the temperature of two batches continually increased right after composting started. From the first week to the fourth week ranges from 33.2^{0}C to 43^{0}C. The increase in temperature during the composting process was caused by the heat generated from the respiration and decomposition of organic substances by the population of microorganisms [17]. The composting pile achieved maximum thermophilic temperature (53.6°C) at week 7 of the composting cycle for the treatment of cow dung with rice straw and 49^{0}C at week 8 for the treatment of cow dung without straw (Figure 2). This thermophilic phase lasted for approximately 3 weeks, after which the cooling phase started when the temperature gradually decreased for both batches due to the depletion of compostable organic matter.

In treatment 1 including cow dung with rice straw can be completely ripe in the 10th week while treatment 2 (only cow manure) is longer than that one 10 days. Because at that time, the temperature of both treatments was on a par with air temperature at the end of the experiment (29-32^{0}C), this temperature did not fluctuate over a period of 2 weeks and the material mass was falling, fine product, porous manure, uniform color and no odor. This is also a sign that the materials is fully ripe.

At the beginning of the composting process, the value of pH was 6.5. In the first stage, the microorganisms break down the organic matter into fatty acid forms. Therefore, pH was low. And then these fatty acids were converted into NH_4 and CO_2. During the composting process, the microbial activities resulted in production of NH_3 that increased the pH rapidly to a maximum value of 7.48 (cow dung with rice straw) and 7.1 (only cow dung) on week 10. After that, due to the volatilization or microbial assimilation of ammonical nitrogen, the pH gradually declined and reached a value of 7.0 at the end of composting (Fig 3). The release of CO_2 might also be responsible for a decrease in the pH value [29].

The moisture in two piles was very high, fluctuating around 69.2% -77.83% in the first week to the third week. After that, undergo many times flipped materials, the moisture of composting decreased rapidly, until the 4th week onwards the humidity dropped and we adjusted the humidity appropriately between 54% and 60% by squeezing the material by hand, if there was water flowing out, it would be sufficient moisture. At the end of the experiment, the moisture of the treatment of cow manure was 60.3% and 58.6% for the treatment of cow manure with rice straw. The difference in moisture in the two traetments was not large. Generally, the the moisture content decreased over process time in both compost piles, but decreased greater in the pile of cow dung with rice straw. The decrease of the moisture content during composting course was in agreement with comparable data from other authors [22], [32]. Flipping operations which were performed along the process should tend to decrease moisture contents. In addition, the increase of temperature in the compost pile also increased water evaporation.

In the treatment of cow manure, a count of 3,450 *Aspergillus*spores (cfu/g), while the treatment of cow manure with rice straw was 2,865 (cfu/g). Results showed that both treatments had a very high number of fungal spores. However, helminth eggs were not found in both piles. And C/N ratio in the pile of cow manure was 16.33 and in the pile of cow manure with rice straw was 18.53. Because the C/N ratio in both piles is less than 20:1, therefore nitrogen was lost due to conversion to NH_3. Three of the parameters often used to assess the quality of compost are Nitrogen (N) and Phosphorous (P), Kalium (%) contents. N content in the compost pile with rice straw addition was lower than that in the pile without rice straw addition. The total N value was 0.49% for the treatment with rice straw and 0.58% for the treatment without rice straw. However, it was observed that the P, K content in compost with rice straw addition was higher than compost without rice straw. The total P, K value was 1.04%; 0.57% respectively for treatment with rice straw and 0.46% P; 0.33% K for treatment without rice straw. The results were higher than that from other authors who found P content in the cow dung compost of 0.42% [25]and ranged from 0.15 to 0.22% ofresearch's Jusoh [17]. During the composting process, the organic carbon content decreased from 395 to 274g/kg, due to microbiological decomposition of organic matter and conversion of C to CO_2.

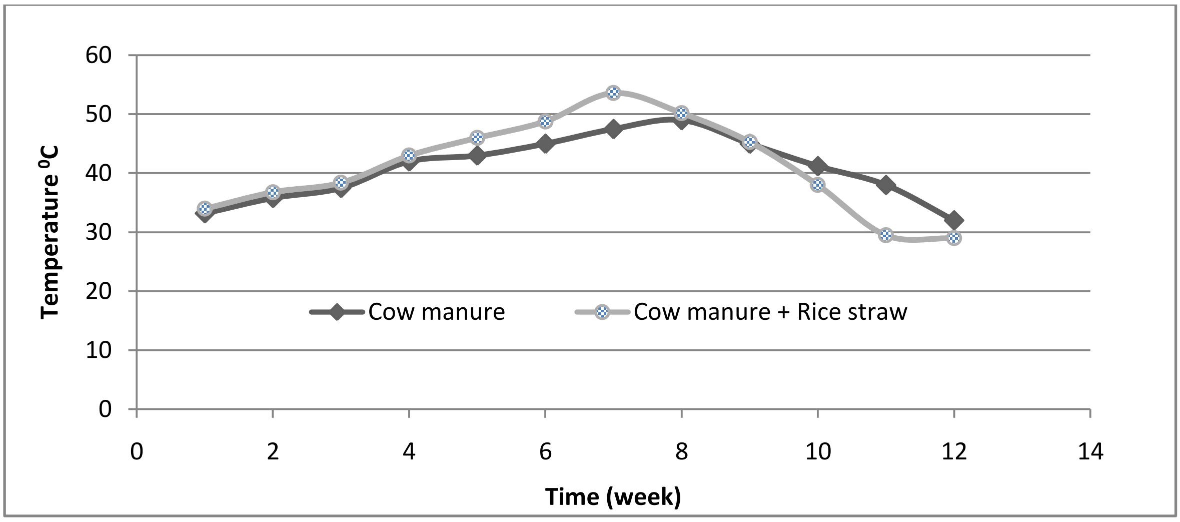

Fig 2. Evolution of Temperature

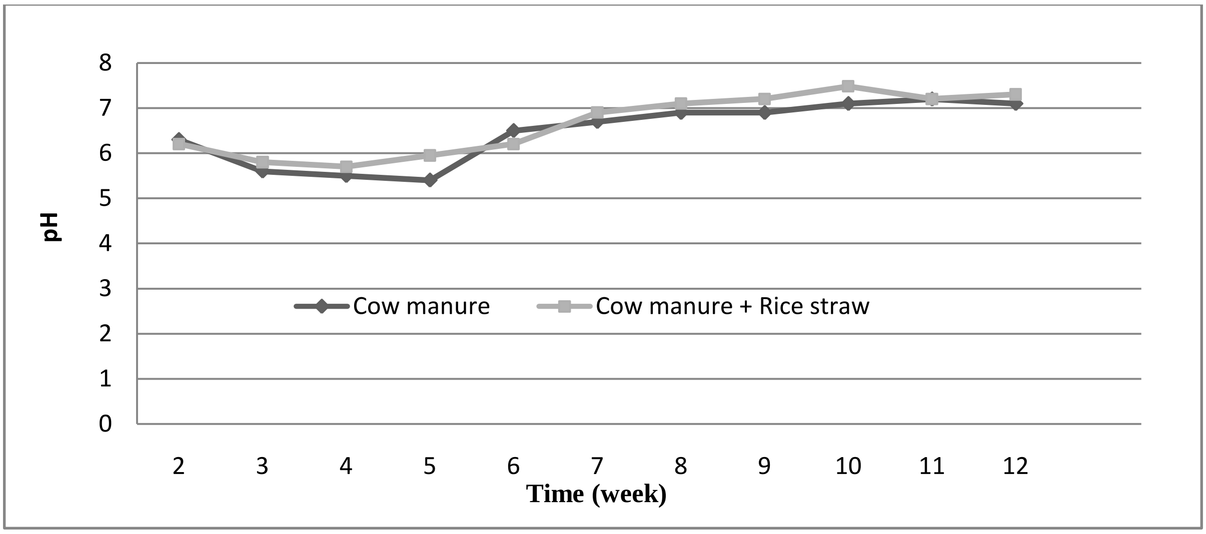

Fig 3. pH value

IV. CONCLUSION

Generally, based on the obtained results, it is possible to conclude that rice straw should be collected and added into the composting process of cow manure. Because our results showed that there was an increase in nutrient content in the compost product . However, in this study, it took too long (12 weeks) to have the final product. Therefore, we need to add bio-enzymes to speed up the composting process.Cow dung host a wide variety of microorganisms varying in individual properties. Exploitation of cow dung microflora can contribute significantly in sustainable agriculture and energy requirements. It is one of the bioresources of this world which is available on large scale and still not fully utilised. The understanding of the mechanisms enabling cow dung microbes to degrade hydrocarbons can promote bioremediation of environmental pollutants.

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Phan Truong Khanh. T,etal." Aerobic Composting of Cow Dung with Rice Straw Biomass." *American Journal of Engineering Research (AJER)*, vol. 9(03), 2020, pp. 334-339.