BIODEGRADATION OF AGRICULTURAL RESIDUES AND CHICKEN MANURE WITH DIFFERENT ADDITIVES THROUGH IN-VESSEL COMPOSTING PROCESS FOR VALUE-ADDED PRODUCTS

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Abstract - The combination of agricultural residues(red pepper stalks, bean stalks, sea same stalks, etc) and chicken manure were co-composing with sawdust and additives(lime and gypsum) to produce excellent value-added (i.e., compost product). Physical and chemical analysis were used to assess the impact of raw materials with additives on the finished compost's qualities. According to the findings, the additive amendment treatment combination accelerates the biodegradation and mineralization of the treatment mixture, which causes the final product to mature. In the additive amendment treatments, gaseous emissions were minimized, and N was maximized. According to this study, the combination of agricultural residues and chicken manure were co-composing with sawdust, and additives improves the compost's quality.

Keywords - Chicken Manure; Agricultural Residues; Additives; Composting

I. INTRODUCTION

Agricultural activities can generate considerable amounts and variety of organic wastes such as crop refuse, fruit and vegetable refuse, tree trimming waste, animal manure, and poultry manure. Organic waste can be a major threat to the environment, e.g., air pollution, if not managed and treated properly (Sanchez et al., 2022). When landfilled, organic waste undergoes biological degradation process releasing methane gas (CH_4), carbon dioxide (CO_2), hydrogen sulfide (H_2S), nitrous oxide (N_2O), and other gases in small amounts [Andersen et al., 2010; Schirmer et al., 2014]. These gases are major contributors to the global warming and climate change as well [Bogner et al., 2007].

Composting agricultural and other types of organic wastes can be a useful process for recycling nutrients and maintaining organic matter in the soil when the end product of compost is used as a fertilizer or soil conditioner [Ajaweed et al., 2022, Solano et al., 2001; Mohee et at al., 2007; USDA , 2011]. Composting can also reduce carbon to nitrogen (C/N) ratio of the organic waste to levels that are beneficial to the plants [Mohee et at al., 2007; USDA , 2011]. However, the agricultural residues- plant stalks contain more carbon than nitrogen.

On the other hand, numerous billions of chickens are produced each year, which also causes poultry industries to discharge more chicken manure (CM), which, if handled improperly, can pose a hazard to the environment. CM is an organic substance that contains a nutrients necessary for plant development. Normally CM contain more nitrogen. It is preferable to co-compost CM with other organic wastes such as agricultural residues- plant stalks. The principles of co-composting reduce labor and time requirements while also providing financial advantages.

The utilization of chemical and biological additives to mitigate ammonia volatilization and nitrogen loss during the composting process has been extensively studied. These additives have included wood fly ash, lime, phosphor-gypsum, polyethylene glycol, jaggery [Gabhane et al., 2012], zeolite [Nissen, et al., 200], bentonite [Li et al., 2012], superphosphate [Huang et al., 2006], and microbial inoculants [Zhang et al.,2016].

To our understanding, combination of agricultural residues(red pepper stalks, bean stalks, sesame stalks, etc) and chicken manure were co-composing with sawdust and additives(lime and gypsum) has not been studied. Various studies have documented the additives enhanced composting of CM and agricultural residuesalone. The purpose of the current study is to ascertain how adding additivesand sawdustto the co-composting of agricultural residues and CM affects the retention of C and Nin the finished compost as well as to assess the compost's quality.

II. MATERIALS AND METHODS

2.1.Raw materials and experimental design

The study's raw materials were collected from Suwon-Si, South Korea. At a temperature of 20 ±2 °C, the trials were carried out at Kyonggi university, South Korea. T1, T2, T3, T4, and T5 were the study's 5 treatment groups. A eight kg waste mixtures consists of food waste, CM and SD(2:2:1 ratio) used for composting process. Additives (Lime + gypsum, 1:1 ratio)used as 0,1,2,3 and 4%, respectively for T1-T5. A 65% adjustment was made to the initial moisture content. A 8-L in-vessel composter (Fig.1) was used for each treatment, and it was done in triplicate.



Fig.1. In-Vessel composter

2.3. Physicochemical and gaseous emission analysis

On each composting day, the variables including temperature, C:N ratio, CO_2, NH_3, pH, NH_4^+-N, and NO_3-N were measured. The data is shown as mean standard deviation and all trials were performed in triplicate.

III. RESULTS AND DISCUSSION

3.1. Effect of additive amendment on temperature, pH, C:N ratio

During the composting process, the thermophilic stage did not extend in the control (T1), but it happened in the treatments with the increases the % ofadditives in treatment mixtures.

The pH values for treatments T1 through T5 at the end of the composting process were, respectively, 8.01 0.16, 8.30 0.25, 8.29 0.33, 8.47 0.42, and 8.73 0.17, reaching a standard value.

Each treatment of the initial C/N ratios were in the optimal range: 25.3 0.76, 25.3 1.01, 26 1.30, 26.17 0.79, and 29.26 1.17 (T1-T5). In all of the treatments, the C/N ratio decreased significantly, with the final values of all treatments (T1- T5). In particular, the T5 treatment C:N ratio shown maturity and it witnessed a value less than20.

3.2. Changes in gaseous emission

All of the treatments had a similar CO_2 emission profile, with higher emissions at the beginning of the process that peaked, then lower emissions as the composting process progressed. On the fifth composting day, all treatments reached their peak emission.The emission rates fell following the thermophilic phase, which suggests a reduction in microbial activity, and the trends were stable with the temperature changes of this study. According to Fig. 2, T5 had the highest CO2 emission, which was followed by other treatments. The CO_2 emission significantly increased in the biochar adjusted treatments (T5>T4>T3) in comparison to control T1 and the combination with salts alone added mixture T2.

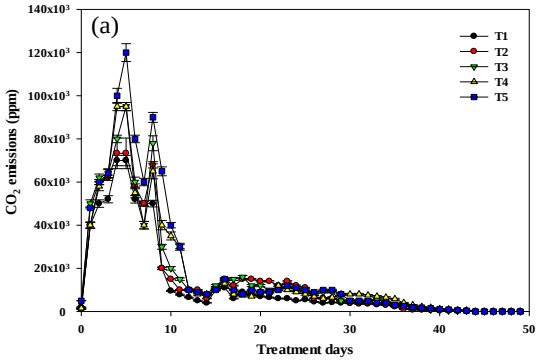


Fig.2. CO_2 emission profile

3.3. Nitrogen conservation

The order of the NH_3 emission was seen to be T5,T4, T3, T2 and T1 (Fig. 3). In the initial phases of composting, all the treatments had an increase in emission, which was followed by decreases and saturation in the final stages. The addition of additives to the CM and agricultural residues co-composting reduced nitrogen loss by up to 45%. In the current investigation, T5 showed the smallest reduction in nitrogen loss, whereas the mixed salts and biochar treatments showed the greatest reduction.

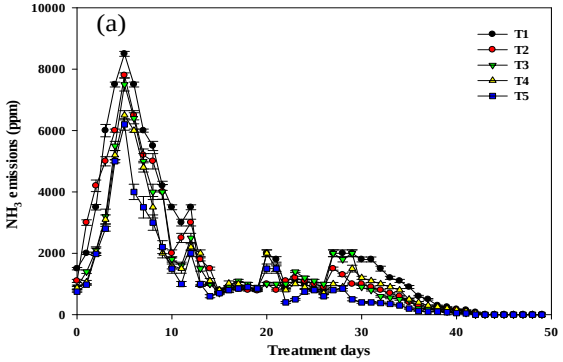


Fig.2. NH_3 emission profile

IV. CONCLUSIONS

In this study, the co-additives(Lime + gypsum) could help in combination of CM and agricultural residuesthrough co-composting process as well as to enhance the soil attributes to which the compost is added.

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