

Original Research Article

Repercussion of controlled decomposition process on carbon dynamics and quality evaluation in chicken manure pellets.

ABSTRACT

Aims: To assessing the benefits of chicken manure pellet as a source of plant nutrients and understand its effect on decomposition under controlled environment by evaluating the dynamics of CO₂.

Place and Duration of Study:Department of Soil Science and Agricultural Chemistry laboratory during June, 2024 to August, 2024.

Methodology:Commercially produced chicken manure pellets were collected from Nanalkaadu, Tuticorin district. Soil samples were collected from the wetland of Agricultural College and Research Institute, Killikulam, Tuticorin. The physical and chemical properties of the collected soil and chicken manure pellets were determined using standard protocols. Incubation study was carried out for 56 days and determined the evaluation of carbon dioxide (CO₂) using alkaline absorption method under anaerobic conditions.

Results:From the observation of incubation study, the dynamics of carbon emission was vacillated and indicates the enhancement of organic matter content by the addition of chicken manure pellet. The analyzed nutrient status revealed that the level of N, P and K was increased by 33 %, 21 % and 27 % over control.

Conclusion:Chicken manure pellet had high nutrient content which is essential for crop growth and development. Chicken manure pellet is able to substitute the inorganic fertilizer as a source of organic amendment supplies major nutrients (N, P and K) to meet the crop needs. Chicken manure pellet involved in enhancing the soil organic carbon. Therefore, future investigation involves the true trial study by adopting and comparing different organic sources of nutrient to structure the better choice for sustainable way of crop cultivation.

Keywords: Chicken manure, Plant nutrients, Carbon emission, Crop growth.

1. INTRODUCTION

A fertilizer plays an important role in crop growth and development by providing plants essential nutrients [1]. Inorganic fertilizer usage has been increased due to its significant role in increasing crop

production. A continuous use of chemical fertilizer leads to soil fertility loss, environmental deterioration including potential risk by creates pollution of air, water and soil [2], [3]. However, synthetic fertilizers are replaced by organic fertilizers helps to create sustainable practices in agricultural production [4]. One of the readily available sources of organic amendment is chicken manure. Chicken manure used as organic fertilizers for increasing soil fertility and helps in higher yields of agricultural crops [5]. Chicken manure able to enhance the soil fertility compared to synthetic fertilizer which includes enhanced soil structure, superior nutrient availability status and increasing soil biotic organisms leads to better crop yields [6], [7]. Application of chicken manure increased available nitrogen and increased Cation exchange capacity significantly [8]. The utilization rate of this manure is forty per cent lesser in agricultural production [9]. Farmers need to understand the nutrient requirements of their crops and adjust the application rates accordingly. [10] (Simonaet *al.*, 2023). Chicken manure had a role on sequestering the soil organic carbon (SOC). The slight changes in soil organic carbon (SOC) had significant effect on global climate change [11]. The main objective of this study is to evaluate the changes in soil nutrient status by the addition of chicken manure pellet and also determine the dynamics of carbon dioxide emission under controlled environment. The awareness among the sustainable agriculture between the farmers is essential for creating healthy lifestyle by reducing the environmental hazards. Therefore, improving the utilization rate of organic material is crucial for the development of sustainable agriculture in future. Upcoming investigation should be focuses on derivation of better practices for nutrient management using organic manure instead of chemical fertilizer to completely attain sustainable way of agriculture.

2. MATERIAL AND METHODS

The sample was collected from a broiler poultry farm collaboration with SKM Chickens established in 2013, the farm encompasses a total of ten acres of cultivable land located in Nanalkaadu, Tuticorin district. Approximately 2,641 chicks per shed were accommodated for growing. Coir pith is a by-product obtained from the husks of coconuts was used as bedding material sourced from the Kanyakumari district. An automated misting system was employed to regulate the humidity levels. To ensure uniform heat distribution, incandescent light bulbs were installed. Separate chambers were designated for feed and water, with an atomized water supply system used for hydration. After a 40-days growing period of the chickens, the bedding material combined with chicken waste was collected. The collected manure was subjected to a drying process to reduce its moisture content. This drying should be achieved through natural sun drying, mechanical drying, or a combination of both methods. For effective palletisation, the target moisture content should be around 15-20%. Subsequent to drying, the manure was pulverized into a finer particulate form using a hammer mill or grinder, which ensures a uniform particle size critical for the pelletizing process. The powdered material was then fed into a pellet mill. In the pellet mill, the material was extruded through a die under higher pressure, forming cylindrical type of pellets. The diameter of the pellets is determined by the size of the die used. The freshly formed pellets were initially hot and soft. They were then subjected to cooling using a pellet cooler, which reduced the temperature of the pellets and protect it from breakage. Additionally, this process of cooling further reduced the moisture content of the pellets. The resultant pellets were then ready to apply in the agricultural field.

Weekly samples were collected from the poultry shed over a period of four weeks. The nutrient content and quality of the collected chicken manure pellet were determined using alkaline permanganate method (Nitrogen), colorimetric method (Phosphorus), flame photometer (Potassium), potentiometric (pH) and conductometric (EC) methods respectively. Incubation study was carried out for 56 days to determine the dynamics of carbon dioxide emission (Figure 1.). The CO₂ evolution was measured using the alkaline absorption method under anaerobic conditions. The experimental setup involved mixing 250 grams of soil sample with 0.5 grams of poultry manure pellets, which was placed in a 500 mL conical flask and maintained under saturated conditions. A 10 mL aliquot of 0.1 N sodium hydroxide (NaOH) solution was introduced into a test tube, which was suspended inside the conical flask using a thread. The conical flask was sealed with non-absorbent cotton and covered with aluminium foil to maintain a controlled environment (for control soil alone taken in conical flask). To measure CO₂, the 0.1 N NaOH solutions was titrated with 1 N hydrochloric acid (HCl) using phenolphthalein as an indicator, until the color changed from pink to colourless.



Figure 1. Incubation of treated and non-treated samples in replicates

3. RESULTS AND DISCUSSION

3.1 INITIAL CHARACTERISTICS OF EXPERIMENTAL SOIL

The soil used in this experiment was sourced from the fields at Tamil Nadu Agricultural College and Research Institute, Killikulam, Tuticorin district. The soil texture was identified as sandy clay loam with the composition of clay (28%), silt (15%), sand (25%), and fine sand (31%). The physical and chemical properties of the soil were determined, Bulk density 1.22 mg m^{-3} , Water holding capacity (WHC) 55%, pH 7.65, Electrical conductivity (EC) 0.17 ds m^{-1} , Soil organic carbon (SOC) 0.51%, Available nitrogen (N) $210.29 \text{ kg ha}^{-1}$, Available phosphorus (P) $182.42 \text{ kg ha}^{-1}$ and Available potassium (K) 196 kg ha^{-1} .

3.2 CHARACTERISTICS OF CHICKEN MANURE PELLETT

Chicken manure pellet was collected on weekly basis from June, 2024 to July, 2024 to analyze the effect of duration on improvement in the nutrient status of the pellet. The nutrient contents of the chicken manure pellets were presented in the Table 1. From the results it was observed that the nutrient content of the pellet was significantly increased over time. These variations were attributed due to the fluctuations in the nutrient composition of the feed and the period of bedding collections for pelleting. Nutrient assessment of chicken manure pellet showed that the pellets had been rich in essential nutrients [12] such as nitrogen (N), phosphorus (P), and potassium (K), which is crucial for plant growth and development [13]. The nutrient composition may vary but generally provides a balanced fertilizer for crops [14]. Pellets are denser than raw manure, which makes them easier for handling, transportation, and storage.

Table 1. physic chemical properties and nutrient stauts of weekly collected sample

Sample collection	Nitrogen (%)	Phosphorus (%)	Potassium (%)	pH	Ec (dsm ⁻¹)
1 st week	42.56	23.40	17.78	5.25	0.11
2 nd week	42.28	24.45	31.00	7.30	0.18
3 rd week	41.80	24.92	31.36	8.10	0.40
4 th week	41.30	28.21	32.68	8.70	0.58

3.3 ANALYSIS OF CO₂ DYNAMICS

Incubation experiment was carried out for 56 days from June, 2024 to Aug, 2024. The samples were collected and analyzed periodically. From the result (Figure 2.), it was found that the rate of emission was slightly raised during the first week of incubation and started to declined afterwards. The rate of emission of CO₂ has been reached its peak during the period of 21st to the 42nd day. Then the emission was declined after its peak evolution. On comparing the non-treated (T1) and treated (T2) sample, it is observed that T2 (soil + chicken manure pellets) has greater CO₂ evolution than T1 (control) from the 3rd day onwards. An increase in CO₂ evolution indicates an enhancement in the organic matter content within the soil [15]. Due to their compact nature, chicken manure pellets decompose more slowly compared to raw chicken manure and other organic amendments [16]. This slow release provides a steady supply of nutrients to plants over time[17]. The pellet form helps in minimizing nutrient leaching and runoff into water bodies compared to other form of manures, contributing to better environmental management [18].

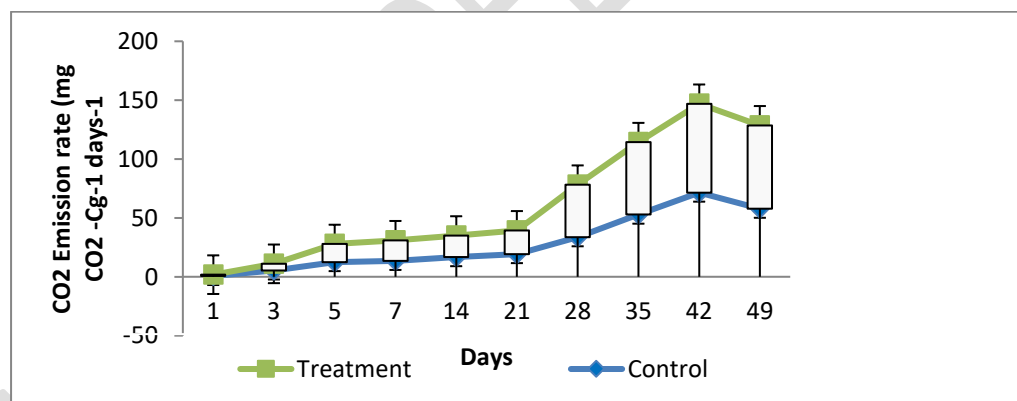


Figure 2. CO₂ evolution of treated and non-treated soil under controlled condition.

4. CONCLUSION

Chicken manure pelletsexhibited a significant increase in nutrient content over time, indicating their effectiveness as a nutrient-rich fertilizer. These pellets characterized by their higher density and ease of handling relative to raw manure, deliver a consistent and balanced supply of essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K). Their reduced decomposition rate compared to raw manure ensures a prolonged release of nutrients, which enhances soil organic matter and helps, mitigates the carbon dioxide emission. Consequently, chicken manure pellets represent a robust and environmentally sustainable option for crop fertilization. Future research could focus on optimizing pellet formulation and application methods to further improve nutrient use efficiency and environmental impact.

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