p-ISSN 1410-5659 e-ISSN 2621-5144
Published by:
Unpad Press

Jurnal Ilmu Ternak Universitas Padjadjaran, December 2024, 24(2):220-227
DOI: 10.24198/jit.v24i2.58201
Available online at http://jurnal.unpad.ac.id/jurnalilmuternak

THE DIFFERENT C/N RATIO OF QUAIL FECES AND RICE STRAW MIXTURE AFFECT TEMPERATURE CHANGE, MICROBIAL COUNT, ORGANIC-C CONTENT, AND TOTAL N CONTENT IN EARLY DECOMPOSITION RESULTS

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Abstract

Poultry wastemust be considered in farm enterprise, as it can cause environmental pollution. Quail feces generally has a low carbon-to-nitrogen ratio, necessitating the supplementation of carbon source from rice straw. Rice straw, which contains high fiber content, is often discarded or burned and has not been utilized by farmers, even though it is suitable for processing into solid or liquid organic fertilizer. Because of the substantial changes in temperature and microbial composition that occur during the composting process, initial breakdown is critical. Using native microbes from quail feces, this study aims to analyze the impact of the C/N ratio of a mixture of quail feces and rice straw on temperature changes, total microbial count (bacteria, fungi, and actinomycetes), and the content of organic C and total N during the initial decomposition process. This research employed an experimental method with four treatments of C/N ratio mixtures of quail feces and rice straw: 20, 25, 30, and 35. The observed variables included temperature changes, total microbial count (bacteria, fungi, and actinomycetes), and the content of organic C and total N 14 days of initial decomposition. The best decomposition process was achieved with a C/N ratio of 20, the highest temperature change (thermophilic phase on the second day and a maximum temperature of 65°C), and total counts of bacteria, fungi, and actinomycetes of 9.6 x 10^{11} cfu/mg, 2.7 x 10^{4} cfu/mg, and 5.6 x 10^{6} cfu/mg, respectively. The organic C content was 37.62%, and the total N content was 3.11% (C/N 12.09).

Keywords: C/N ratio; quail feces; rice straw; microbial count

NISBAH C/N CAMPURAN FESES PUYUH DAN JERAMI PADI BERBEDA TERHADAP PERUBAHAN SUHU, JUMLAH MIKROBA, KANDUNGAN C-ORGANIK SERTA N-TOTAL HASIL DEKOMPOSISI AWAL

Abstrak

Limbah peternakan merupakan salah satu faktor yang harus diperhatikan pada usaha peternakan, karena dapat menimbulkan pencemaran lingkungan. Limbah ternak berupa feses puyuh pada umumnya memiliki rasio karbon dan nitrogen yang rendah sehingga diperlukan penambahan jerami padi sebagai sumber karbon. Jerami padi yang mengandung kadar serat yang tinggi lebih banyak dibuang atau dibakar dan belum dimanfaatkan oleh petani, padahal baik untuk digunakan untuk pengolahan pupuk organik padat atau cair (POC). Dekomposisi awal memiliki peran yang sangat penting pada proses pengomposan, karena terjadi perubahan signifikan dalam suhu dan komposisi mikroba. Penelitian ini bertujuan untuk mengetahui pengaruh nisbah C/N campuran feses puyuh dan jerami padi pada proses dekomposisi awal dengan memanfaatkan mikroba indigenous feses puyuh terhadap perubahan suhu, jumlah total mikroba (bakteri, jamur dan aktinomiset) dan kandungan Corganik serta Ntotal. Penelitian ini menggunakan metode ekperimental dengan empat perlakuan nisbah C/N campuran feses puyuh dan jerami padi: 20, 25, 30 dan 35. Peubah yang diamati: perubahan suhu, jumlah total mikroba (bakteri, jamur dan aktinomiset), kandungan Corganik serta Ntotal, yang diamati selama 14 hari hasil proses dekomposisi awal. Hasil penelitian menunjukkan bahwa nisbah C/N 20 menghasilkan proses dekomposisi terbaik, dengan capaian perubahan suhu tertinggi (fase termofilik terjadi pada hari ke-2 dan suhu tertinggi 65°C), total jumlah bakteri, jamur dan aktinomiset adalah 9,6 x 10^{11} cfu/mg, 2,7 x 10^{4} cfu/mg dan 5,6 x 10^{6} cfu/mg serta kandungan Corganik 37,62% dan Ntotal 3,11% (C/N 12,09).

Kata kunci: *Nisbah C/N; feses puyuh; jerami padi; jumlah mikroba*

INTRODUCTION

Quail farming produces feces equivalent to 4.5% of the bird's body weight daily (Suyitno et al., 2012). Quail feces are rich in protein (approximately 21%) and macronutrients such as nitrogen, phosphorus and potassium. However, they also have the potential to pollute the environment because they contain a number of pathogenic microorganisms.

Quail excrement is an unstable organic substance that contains pathogenic and non-pathogenic microorganisms. Therefore, correct management is necessary for composting, which breaks down organic waste into stable nutrients that are safe for the environment.

According to Huri and Syafriadiman (2007), quail feces contain high protein of around 21% and macro nutrients such as nitrogen of 0.061%, P_2O_5 of 0.209%, K_2O of 3.133%. According to Abdel-Rahman et al (2016), the nutrient contents of NPK and S in straw are N (0.5-0.8 %), P (0.070.12 %), K (1.2-1.7 %), and S (0.05-0.10 %).

The C/N ratio is one of the prerequisites for composting. It is the comparison between the carbon (C) and nitrogen (N) contents of organic material. Quail feces have a low C/N ratio so organic materials with a high C/N ratio must be added to reach the right value. One way is to add rice straw, because it has a high C/N ratio of around 41.2% (Sirait, 2019) and helps optimize the C/N ratio.

Carbon and nitrogen are essential for the microbial life processes. High C/N ratio causes decline in the microorganisms' biological activity due to insufficient supply of nitrogen. This leads to stagnant temperature in the compost, longer composting time, and lower-quality compost. On the other hand, if the C/N ratio is too low, extra nitrogen that is not utilized by microbes cannot be taken up by the microbes. This excess nitrogen may volatilize as ammonia or undergo denitrification (Djuarnani et al., 2005).

Rice straw is a by-product of paddy of dried cereal stalks and stems after the grains have been separated. Farmers have not yet optimally processed rice straw waste. Rice straw has a high C/N value due to its low content of cellulose, hemicellulose, lignin, and protein (Sitepu et al., 2017). As a result, rice straw takes longer to decompose (Krisnawan et al., 2018). Because quail feces have a low C/N ratio of 11.72 (Anditya et al., 2015), rice straw, which has a high C/N ratio of 25.51 (Anditya et al., 2015), must be added to the mixture in order to raise the C/N ratio and meet composting criteria. The C/N ratio can be used as an indicator of the fermentation process, namely if the ratio between carbon and nitrogen is still between 20 and 30, this indicates that the fermented fertilizer is ready to be used (Pancapalaga, 2011). To speed up the degradation process, decomposers must be added (Pratama et al., 2022).

The composting/decomposition process transforms complex organic materials into simpler ones and generates high temperatures. The temperature will gradually increase from the mesophilic range, which is <40°C, then rise to the thermophilic range (40-70°C), and then fall back to the mesophilic range. Pathogenic bacteria like Salmonella and Escherichia coli can be killed by the breakdown process due to this temperature increase (Aylara et al., 2020; Hidayati et al., 2021).

A good C/N ratio will affect the Amount, type of microorganism and activity of microorganisms. The activity of bacteria that break down organic materials and reduce the number of pathogenic bacteria occurs at a temperature of 55°C, which is what causes temperature variations in the first decomposition process (Galitskaya et al., 2017). In this study, the number of bacteria, fungi, and actinomycetes in a mixture of quail feces and rice straw is subjected to an initial decomposition process. The aim is to ascertain which C/N ratio results in the highest population of these microorganisms.

MATERIALS AND METHODS

Materials

This research was conducted from August to November 2023 with a duration of 14 days at The KVS Farm Paseh, Bandung Regency. On the 15th day, laboratory analysis was carried out at the Soil Chemistry and Plant Nutrition Laboratory and the 9.7 kg of quail feces, 70.3 kg of rice straw, a oil Biology Laboratory, Faculty of Agriculture, Universitas Padjadjaran.

The materials used in this study included nd 192.8 ml of water. The following materials were used in the analysis: liquid paraffin, NaOH, H_3BO_4, Conway indicator, Se mix, H_2SO_4, and total nitrogen (N-total). NaCl was employed for physiological solutions, and Potato Dextrose Agar (PDA) and Nutrient Agar (NA) growth mediums were utilized to analyze total bacterial, fungal, and actinomycete counts. The equipment utilized included Erlenmeyer flasks, an oven, an autoclave, pipette bulbs, test tube racks, test tubes, cotton, filter paper, a spirit burner, 10 cm petri dishes, label paper, and an incubator.

Figure 1. Rice Straw and Quail Feces

Figure 2. Composting Over 14 Days

Methods

This study employed a descriptive method. The analysis of compost materials included the determination of C-organic content using the Gravimetric method (2016) and ash content, while total nitrogen (N-total) was analyzed using the Kjeldahl method (2005). The compost materials were placed in a compost reactor and treated with activators according to the given treatments. The analysis of C-organic and N-total was conducted on the 15th day.

Isolation of Total Bacteria and Fungi

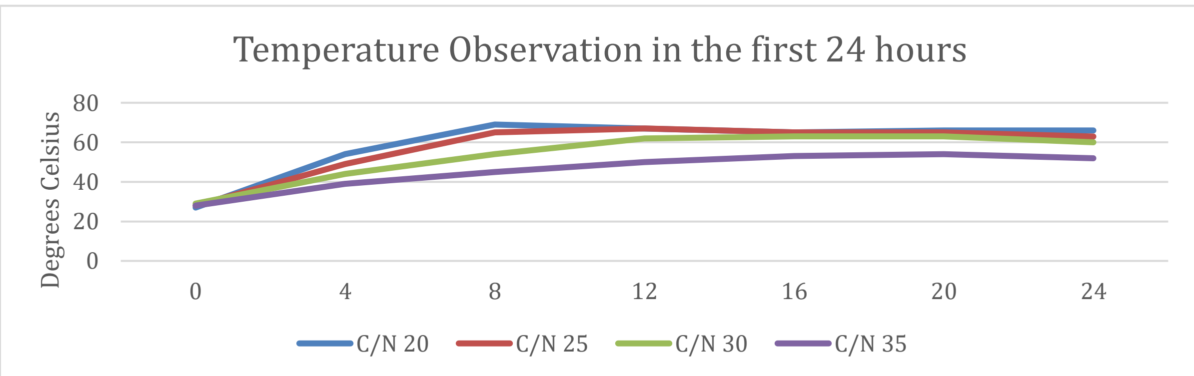
The Total Plate Count (TPC) method was used to determine the total amount of bacteria and fungus. After the composted material had broken down for 14 days, samples were taken to count the amount of bacterial and fungal microorganisms that were present during the decomposition process.

RESULTS AND DISCUSSION

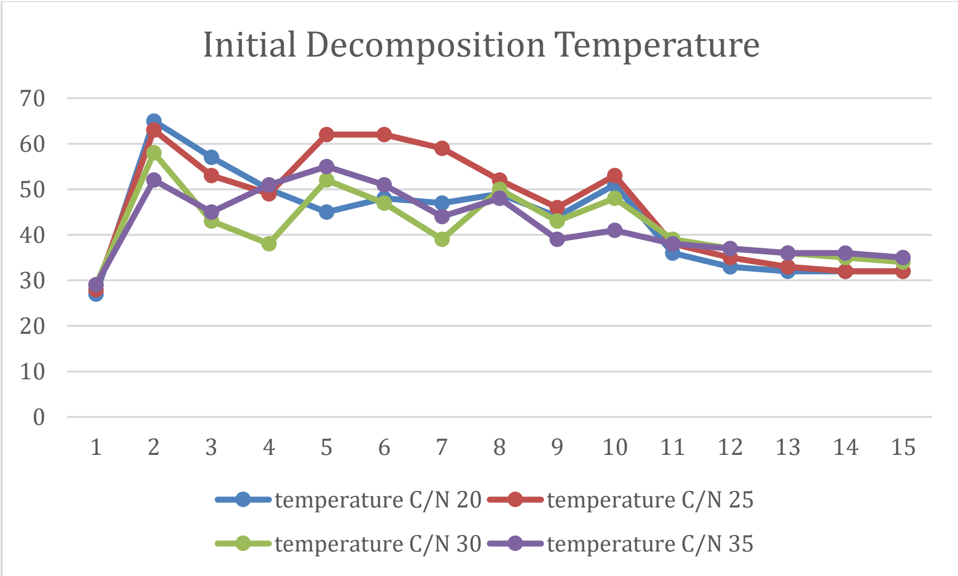
Temperature Change

One important aspect affecting how active bacteria are in breaking down organic matter is temperature. The presence of microbial activity is indicated by temperature changes occurring during the initial decomposition process. Temperature observations based on the C/N ratio in the initial decomposition process were conducted every four hours on the first day. Subsequent temperature observations were carried out once a day for 14 days. The temperature observations on the first day for several C/N ratio treatments can be seen in Graph 1.

Graph 1 shows that, in line with the increase in C/N, the mesophilic temperature in each treatment becomes shorter, because the temperature continues to increase within 24 hours. On day zero, the temperature in each treatment is the same as the room temperature. On day one, each treatment shows a temperature increase ranging from 35°C to 65°C. Within the first eight hours for P1 (C/N 20) and P2 (C/N 25), the first twelve hours for P3 (C/N 30), and the first twenty hours for P4 (C/N 35), the temperature achieves a thermophilic high of 65°C on the first day. This is consistent with the statement by Marlina et al. (2016) that the ideal temperature for composting is the thermophilic temperature, as it is during this temperature that very active decomposition of organic matter occurs. The ideal temperature for thermophilic microbe development is thought to be 65°C. (Robert (2013)



Graph 1. Temperature Patterns During the First 24 Hours of Initial Decomposition



Graph 2. Temperature Changes During the Decomposition Process of Various Treatments

The dynamics of temperature change are evident in Graph 2. On the second and third days, temperatures in all treatments drop but remain above 40°C, except for P3 where the temperature drops to 38°C. Trautmann and Krasny (1997) stated that during the initial stages of composting (up to 40°C), mesophilic bacteria dominate. The growth of mesophilic bacteria stops as the temperature reaches over 40°C, and thermophilic bacteria take over. According to Pratiwi et al. (2013), temperature fluctuations during composting indicate that the roles of mesophilic and thermophilic microorganisms alternate.

On the fourth day, temperatures in all treatments range between 45-62°C, still within the thermophilic stage because the temperature has exceeded 40°C. Temperatures between 30-60°C indicate rapid composting activity (Budianta, 2013). On the fourth, fifth, sixth, seventh, and eighth days, the pile temperature remains in the thermophilic stage, with thermophilic bacteria (heat-resistant bacteria) playing a key role. The temperature and the number of thermophilic bacteria gradually decrease.

On the ninth day, temperatures drop but remain between 41-53°C. From the tenth to the fourteenth day, temperatures continue to decrease, entering the mesophilic stage again as the temperature falls below 40°C, and mesophilic bacteria once again dominate. Thermophilic bacteria no longer develop and decrease due to metabolic by-products that inhibit their growth or the depletion of organic material needed for nutrition. This is consistent with the opinion of Wolna-Maruwka et al. (2009). The dynamics of temperature change occur due to microbial succession in decomposing organic matter into simpler, available forms.

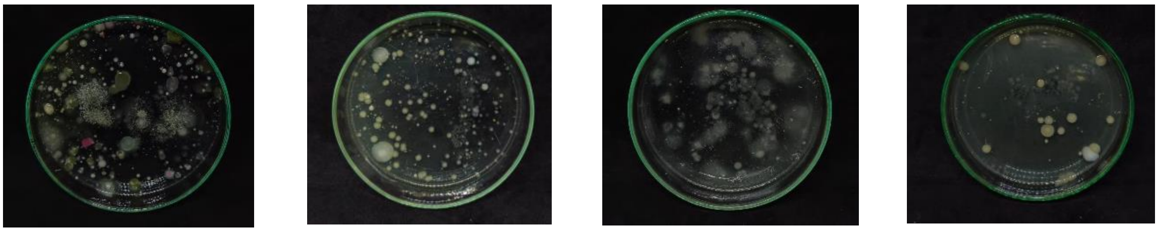
Microbiological Changes

Because the nutrients in organic matter are bonded in a way that plants cannot absorb, soil microbes like bacteria, fungus, and actinomycetes must decompose the material through the mineralization process. On the fifteenth day following the completion of the first 14-day breakdown phase, the microbial population is analyzed. The bacterial population on Nutrient Agar (NA) medium, the fungal population on Potato Dextrose Agar (PDA) medium, and the actinomycete population on Starch Casein Nitrate (SCN) agar medium are counted to measure microbial activity.

On the fifteenth day following the completion of the initial decomposition process, the population of bacteria, fungi, and actinomycetes in the mixture of quail excrement and rice straw were observed. Table 1 displays the findings of the population study of actinomycetes, fungi, and bacteria during the first breakdown of the mixture of rice straw and quail excrement.

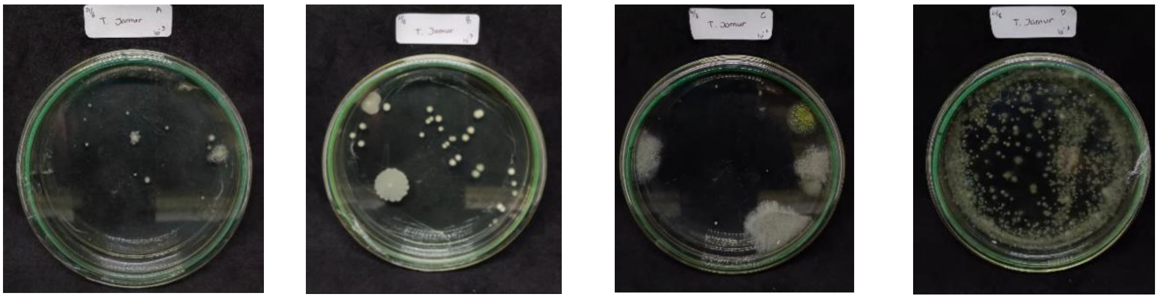
Table 1. Population of Bacteria, Fungi, and Actinomycetes After the Initial Decomposition Process

Treatments	Bacteria (x 10^{11} cfu/ml)	Fungi (x 10^{4} cfu/ml)	Actinomycetes (x 10^{6} cfu/ml)
C/N Ratio 20	9,6	2,7	5,6
C/N Ratio 25	9,1	0,9	4,3
C/N Ratio 30	0,098	1,0	3,5
C/N Ratio 35	0,066	4,6	4,6



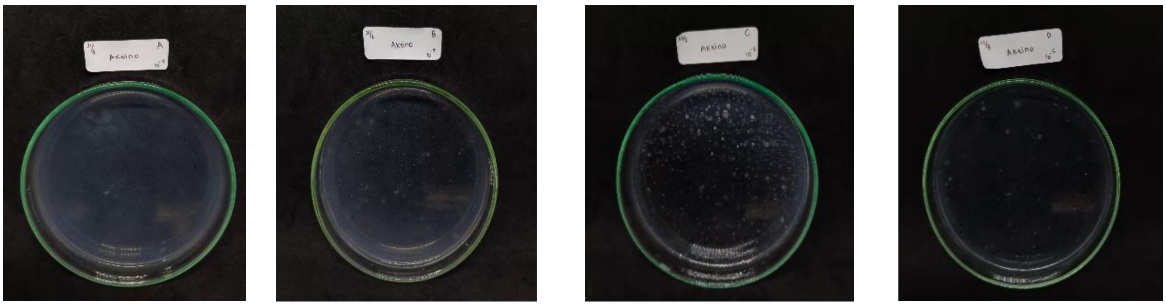
A. B. C. D.

Figure 3. Total bacteria testing results (A. C/N 20, B. C/N 25, C. C/N 30, D. C/N 35)



A. B. C. D.

Figure 4. Total Fungal Colony Testing Results (A. C/N 20, B. C/N 25, C. C/N 30, D. C/N 35)



A. B. C. D.

Figure 5. Total Actinomycete testing results (A. C/N 20, B. C/N 25, C. C/N 30, D. C/N 35)

The population of actinomycetes, fungi, and bacteria that resulted from the first breakdown process under different C/N ratio treatments of 20, 25, 30, and 35 is displayed in Table 1. In terms of C/N ratios, the highest bacterial count was found in ratio 20 (9.6 x 10^{11} CFU/ml), followed by ratio 25 (9.1 x 10^{11} CFU/ml), ratio 30 (9.8 x 10^{9} CFU/ml), and ratio 35 (6.6 x 10^{9} CFU/ml). Figure 3 presents the total bacterial count results in a clearer manner.

These results indicate that the treatments with 20 and 25 C/N ratios have a high nitrogen content derived from quail feces, resulting in greater bacterial growth compared to the other treatments. This is consistent with Marlina (2009) claim that a high C/N ratio above 30 is unable to supply enough nitrogen for ideal microbial growth, preventing temperature fluctuations in the compost brought on by microbial activity. As fungi break down more organic material when the C/N ratio is >20, there are more bacteria overall than in other treatments. This is in line with research by Djuarnani et al. (2005), which showed that bacteria work to quickly accelerate the composting process by consuming proteins and carbohydrates from materials that have already been broken down by fungi.

Through metabolic activities, bacteria convert complex organic substances like proteins and carbohydrates into simpler ones in order to gain energy. Moreover, carbon (C) is activated during metabolism and used by bacteria for development, whereas nitrogen (N) is utilized for the construction of bacterial cells (Ismayana et al., 2012). With a C/N ratio of 35 and 4.6 x 10^4 CFU/ml, treatment C/N 35 had the highest fungal count. By contrast, the fungal count for treatment C/N ratio: 20 was 2.7 x 10^4 CFU/ml, for treatment C/N ratio: 25, it was 0.9 x 10^4 CFU/ml, and for treatment C/N ratio: 30, it was 1.0 x 10^4 CFU/ml. Figure 4 presents the overall fungal colony count results in a clearer manner.

The study's findings show that there is a larger organic matter content and a higher fungal count at a C/N ratio of 35, where the composition contains more rice straw. Because fungi may employ specialized enzymes to break down complex organic molecules, they are able to breakdown organic matter with a higher C/N ratio, which accounts for the large number of fungi with a C/N ratio of 35. Fungi can handle more complex carbon sources, they dominate the breakdown process at a C/N ratio of 35. This is due to the fact that fungi feed on simple carbon substrates (Marlina, 2009).

Treatment C/N 20 had the largest concentration of actinomycetes, 5.6 x 10^6 CFU/ml, with a C/N ratio of 20. Treatment C/N 35, which had a C/N ratio of 35 and 4.6 x 10^6 CFU/ml, was followed by treatment C/N 25, which had a C/N ratio of 25 and 4.3 x 10^6 CFU/ml, and treatment C/N 30, which had a C/N ratio of 30 and 3.5 x 10^6 CFU/ml. Figure 5 provides a clearer illustration of the complete actinomycete count data.

Actinomycetes become more prevalent with a C/N ratio of 20 because of their capacity to break down organic matter that contains complex carbon compounds with a lower C/N ratio. When decaying organic matter is present, the quantity of actinomycetes rises. According to Mutmainnah (2013), these organisms are frequently found in sediments and compost. Actinomycetes grow best in temperatures between 28 and 37°C, however some can still grow to considerable quantities in temperatures between 55 and 65°C (Mutmainnah, 2013).

Changes in C/N ratio

The compost material's C/N ratio study up until the fourteenth day revealed a drop to about 12.09 to 32.04. This is consistent with BSN (2004), which says that a compost's optimal C/N ratio should be between 10 and 20. A C/N ratio of 25 is thought to be ideal for the first stages of decomposition, enabling bacteria to reach their ideal state for producing single-cell protein and sustaining their population In the meantime, the decomposition process will slow down if the C/N ratio is too high (>30), as the bacteria that are breaking down the organic material won't have enough nitrogen to synthesis protein (Yoga et al., 2016)

The quality and maturity of compost materials can be determined by looking at the C/N ratio. Nitrogen (N) is needed for protein synthesis, which is the building block of metabolic cells, and organic carbon (C) is needed for energy fulfillment and growth during the first breakdown phase. Microorganisms use nitrogen for the production of proteins and break down carbon molecules for energy. Microbes will lack N for protein synthesis if the C/N ratio is too high, which will cause delayed breakdown (Isroi, 2008).

Microorganisms break down organic matter into simpler components like carbon dioxide, water, and other nutrients like nitrogen during the decomposition process. However, there is a possibility that nitrogen will become immobilized in the soil. This is due to microorganisms requiring nitrogen for their growth and metabolism. These microorganisms will take nitrogen from the decomposed organic matter and convert it into more complex organic compounds. These organic compounds will then become immobilized in the soil and unavailable to plants (Sinsabaugh et al., 2008).

Microbial reproduction will be aided by the inclusion of organic material with a high C/N value since microorganisms require carbon as an energy source. The mechanism by which organic matter breaks down will immobilize nitrogen in the soil, lowering plant availability. After the C/N value decreases, some microbes die and release nutrients back into the soil (Sinsabaugh et al., 2008).

Table 2. Result of initial decomposition C/N ratio analysis

Treatments	C-organic	N-total	C/N
C/N 20	37.62	3.11	12.09
C/N 25	36.97	2.69	13.74
C/N 30	36.57	1.92	19.04
C/N 35	39.42	1.23	32.04

The weight and volume of organic waste drastically decrease during composting as a result of changes in the C/N ratio because more soluble nitrogen compounds (ammonia) are present and most carbon compounds are lost to the atmosphere. Almost all treatments had a lower carbon content as of day 14 according to observations (Table 2). Compared to other treatments, the C/N ratio was lower in the C/N 30 therapy, it probably has more decomposer bacteria because of this.

Almost all treatments showed an increase in nitrogen, except for P4 (C/N 35), where the total N value was almost the same as before decomposition. This aligns with temperature observations, which indicated that microbes were less active in the initial decomposition stage in P4 because the straw was not readily available to microbes. As a result, the degraded material's C/N ratio shrinks and becomes more stable, eventually resembling the soil's ratio.

CONCLUSIONS

The best decomposed material with the largest microbial count and total N content (final C/N ratio 20) was formed during the decomposition process of the mixture of rice straw and quail feces with a C/N ratio of 20. A C/N ratio of 20 can be obtained by mixing rice straw with quail excrement to provide a raw material for liquid organic fertilizer.

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