RESEARCH ARTICLE
AGROBIOLOGICAL RECORDS
ISSN: 2708-7182 (Print); ISSN: 2708-7190 (Online)
Open Access Journal

CHARACTERISTICS OF COMPOSTING MATERIALS AND BULKING MATERIALS AVAILABLE IN BANGLADESH

Md. Murshed Hasan Mustafa [1,2], Md. Abul Hashem [1], Mahmud Hossain Sumon [3], Md. Sazedul Karim Sarker [4], Md. Abdur Rashid [4] and Md. Mukhlesur Rahman [1]*

[1]Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[2]Rural Development Academy (RDA), Ministry of LGRD and Co-operatives, Gopalganj, Bangladesh
[3]Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[4]Strengthening of Poultry Research and Development Project, Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh

**Corresponding author*: mmrahman.as@bau.edu.bd

ABSTRACT

The quality of compost depends on the characteristics of the composting materials (CM) and bulking materials (BM). The present study was conducted to evaluate the physicochemical properties of composting and bulking materials commonly used in Bangladesh. For this purpose, seven types of CT, such as poultry layer manure (T_1), broiler litter with sawdust (T_2), broiler litter with rice husk (T_3), cattle manure (T_4), goat manure (T_5), horse manure (T_6), and municipal solid wastes (T_7) were investigated. Similarly, the physical and chemical properties of five BM, such as sawdust (T1), rice straw (T2), dry tree leaves (T3), wood shavings (T4), and rice husk (T5), were analyzed in the laboratory. Parameters studied included dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), ash, nitrogen (N), phosphorus (P), potassium (K), and pH. A total of 21 composting material samples and 15 bulking material samples were analyzed using standard methods. The data were analyzed using a Completely Randomized Design (CRD) in SAS. Results showed that T_1, T_2, and T3 of CM contained more N (2.30, 2.21, and 2.04%, respectively) and comparatively less CF (4.98, 6.11, and 9.17%, respectively), with corresponding CN ratios of 19.87, 24.90, and 27.74. In case of BM, very low N was found in T_4, T_1, and T5 (0.08, 0.12, and 0.21%, respectively) and comparatively very high CN ratio (527.50, 434.17, and 199.57%, respectively). It might be stated that the chemical properties of these composting and bulking materials will help in preparing a high-quality compost mix.

Keywords: Composting materials, Bulking materials, Chemical properties, CN ratio.

Article History (ABR-24-256) || Received: 20-Aug-2024 || Revised: 15-Oct-2024 || Accepted: 02-Jan-2025 || Published Online: 09-Mar-2026

1. INTRODUCTION

Composting materials are substances used to prepare compost through the natural decomposition process. These materials include a variety of organic waste items that can break down into nutrient-rich compost, which is then used to improve soil health and fertility. Common composting materials include manure (poultry, cattle, goat, horse, etc.), slaughterhouse waste, kitchen waste, yard waste, fruit waste, municipal solid waste, etc. (Sarker et al., 2009, 2018, 2021; Roy et al., 2013; Rahman et al., 2020a and 2020b; Dhakal et al., 2023; Nazir et al., 2024). Composting materials should ideally be a mix of carbon-rich and nitrogen-rich materials to create balanced compost. Understanding the chemical composition of compost is essential for maximizing its benefits in agriculture, gardening, and landscaping (Lee et al., 2009; Rahman et al., 2024). By assessing and adjusting nutrient composition, pH balance, organic matter contents, and microbial activity, compost can be tailored to meet specific soil and plant needs, promoting sustainable and productive soil management practices (White et al., 2012; Miner et al., 2020). Bangladesh is densely populated with cattle, goats, sheep, buffalo, and poultry, which generate around 156 million tons of cattle manure and 4.5 million tons of poultry manure annually (Modak et al., 2019). Huge amounts of manure are produced daily in Bangladesh, creating an unhygienic and nuisance environment through gaseous emissions (Liu et al., 2011). Moreover, Bangladesh generates approximately 23,000 tons of municipal solid waste (MSW) per day, which translates to about 8.4 million tons annually. This figure has been increasing steadily due to population growth, urbanization, and changes in consumption patterns. The management of MSW remains a significant challenge for Bangladesh, with efforts focused on improving waste collection, recycling, and sustainable

Citation: Mustafa MMH, Hashem MA, Sumon MH, Sarker MSK, Rashid MA and Rahman MM, 2026. Characteristics of composting materials and bulking materials available in Bangladesh. Agrobiological Records 23: 141-148. https://doi.org/10.47278/journal.abr/2026.012

disposal methods to mitigate environmental and health impacts. Compost preparation is one of the main solutions to mitigate environmental pollution and promote resource recovery (Ahsan et al., 2013). It is essential to determine the chemical composition of these composting materials to produce high-quality compost. The chemical composition of these composting materials plays a crucial role in their effectiveness as soil amendments and their impact on plant growth. Composting materials are a rich source of nitrogen (N), phosphorus (P), potassium (K), and other micronutrients that help in plant growth (Sharma et al., 2022; Zhang et al., 2023). The chemical properties of compost indicate the availability and concentration of these nutrients, which directly affects plant growth, soil health, and crop yield (Dharnaik and Patil, 2024; Hirzel et al., 2022).

Bulking materials are those substances added to compost piles to improve airflow, moisture retention, and overall structure (Alam et al., 2013; Won et al., 2016; Al-Amin et al., 2020; Rana et al., 2020). Bulking materials create air pockets within the compost pile, allowing oxygen to reach microbial communities responsible for decomposition. Adequate oxygen levels facilitate aerobic decomposition, which is more efficient and produces less odor than anaerobic decomposition. These are also help to regulate moisture levels in the compost pile by absorbing excess moisture and releasing it slowly. This prevents the compost from becoming too wet or waterlogged, which can impede microbial activity and lead to anaerobic conditions (Hossen et al., 2022). Moreover, these materials help to maintain the structural integrity of the compost pile as organic materials decompose and settle. They prevent compaction and ensure that air can circulate throughout the pile, promoting the decomposition and preventing the formation of hardness, anaerobic zones. Common bulking materials available in Bangladesh include sawdust, rice straw, dry tree leaves, wood shavings, rice husk, corn cobs, etc (Alam et al., 2013). Bulking materials are typically added in small amounts relative to the volume of organic waste in the compost pile, often in a ratio of 1 part bulking material to 20 parts organic waste by volume. Adjusting the type and amount of bulking material ensures that compost piles remain well-aerated, sufficiently moist, and conducive to efficient decomposition. There are an estimated 2 million cubic meters of sawdust generated annually. Sawdust emergences as promising resource for many advantages because of cheap, available abundantly and eco-friendly materials (Graves, 2000).

To enhance compost quality, it is crucial to investigate the chemical properties of both composting materials and bulking agents before the composting process begins. Therefore, the primary objective of this experiment was to analyze the chemical properties of various composting materials. These materials included layer manure, broiler manure, cattle manure, goat manure, horse manure, municipal solid waste, sawdust, rice straw, dry tree leaves, wood shavings, and rice husk. The properties examined were pH, dry matter content, total organic carbon, ash content, crude fiber, ether extract, amount of nitrogen, phosphorus, potassium, and the carbon-to-nitrogen (C/N) ratio. These parameters are essential for understanding and optimizing the nutritional content of compost mix, thereby aiming to produce higher quality compost.

2. MATERIALS AND METHODS

2.1. Research Design

Seven CM, such as poultry layer manure, broiler litter with sawdust, broiler litter with rice husk, cattle manure, goat manure, horse manure, and municipal solid wastes, were treated as T1, T2, T3, T4, T5, T6, and T7, respectively. Another five BM, such as sawdust, dry rice straw, dry tree leaves, wood shavings, and rice husk, were treated as T1, T2, T3, T4, and T_5, respectively. The triplicate samples were analyzed in the Animal Science and Soil Science laboratories at Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, from 1st October 2021 to 30th January 2022. All samples were analyzed with three replications, and the data were analyzed using a Completely Randomized Design (CRD) in SAS.

2.2. Parameters Studied

Parameters studied were dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), ash, nitrogen (N), phosphorus (P) and potassium (K) content and pH. The CN ratio was determined by dividing the value of N by the corresponding TOC value. The chemical analysis was done according to the method described by AOAC (2005).

2.3. Statistical Analysis

The data were analyzed using a Completely Randomized Design (CRD) in SAS. Significant mean values were tested using Duncan's Multiple Range Test (DMRT). All results were presented as Mean ± SD.

3. RESULTS AND DISCUSSION

3.1. Physical and Chemical Properties of the Composting Materials

A pictorial view of composting materials available in Bangladesh is given in Fig. 1. The chemical composition of the composting materials is shown in Table 1. A moderate DM% was found among all composting materials, but a slightly higher DM (25.22) was found in T_6 (horse manure). The lowest DM was found in T_1 (18.78) among all

Citation: Mustafa MMH, Hashem MA, Sumon MH, Sarker MSK, Rashid MA and Rahman MM, 2026. Characteristics of composting materials and bulking materials available in Bangladesh. Agrobiological Records 23: 141-148. https://doi.org/10.47278/journal.abr/2026.012

ISSN: 2708-7182 (Print); ISSN: 2708-7190 (Online)
Open Access Journal

treatments. Rana et al. (2020) reported that the initial DM content of cattle manure was 22.15%, increasing to 48.17% after 45 days of composting.

Table 1: Chemical properties of the composting materials available in Bangladesh

Parameters	Treatment							Level of sig
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	
DM (%)	18.78 ± 0.24c	21.83 ± 0.44b	21.72 ± 0.25b	20.76 ± 0.05b	22.27 ± 0.66b	25.22 ± 1.12a	22.24 ± 2.15b	*
TOC (%)	40.69 ± 0.10c	55.04 ± 0.36a	56.58 ± 0.34a	56.50 ± 1.01b	40.53 ± 2.24c	46.36 ± 2.11c	49.70 ± 1.10c	**
Ash (%)	12.27 ± 0.01a	12.23 ± 0.25a	11.14 ± 0.35b	11.50 ± 0.05b	10.45 ± 1.44b	5.25 ± 1.55c	10.36 ± 0.32b	**
EE (%)	1.35 ± 0.55c	1.32 ± 0.01c	1.22 ± 0.02c	1.47 ± 0.56b	1.54 ± 0.12b	1.81 ± 0.04b	3.60 ± 1.10a	*
CF (%)	4.98 ± 0.10c	6.11 ± 0.01c	9.17 ± 0.01c	32.13 ± 1.46a	24.44 ± 1.25b	35.14 ± 2.45a	31.33 ± 0.76a	**
N (%)	2.30 ± 0.29a	2.21 ± 0.12b	2.04 ± 0.02c	1.94 ± 0.02d	1.52 ± 0.04d	1.45 ± 0.02d	1.01 ± 0.04d	*
C/N	17.69 ± 1.4b	24.90 ± 6.62b	27.74 ± 5.55a	29.12 ± 3.42a	26.66 ± 2.14a	31.97 ± 3.18b	49.21 ± 3.24a	**
P (%)	0.33 ± 0.005a	0.20 ± 0.00c	0.18 ± 0.01c	0.24 ± 0.01b	0.21 ± 0.02c	0.25 ± 0.05a	0.31 ± 0.04a	*
K (%)	0.13 ± 0.10a	0.07 ± 0.01b	0.08 ± 0.01b	0.12 ± 0.02a	0.12 ± 0.02a	0.15 ± 0.04a	0.06 ± 0.00b	*
pH	8.11 ± 0.01a	8.10 ± 0.10a	8.01 ± 0.10a	7.60 ± 0.10b	7.510 ± 02b	8.15 ± 0.02a	7.02 ± 0.03c	*

T_1=poultry layer manure, T_2=broiler litter with sawdust, T_3=broiler litter with rice husk, T_4=cattle manure, T_5=goat manure, T_6=horse manure, T_7=municipal solid wastes. Values (Mean ± SD) bearing different alphabets in a row differ significantly at **mean 0.01% and *mean 0.05% level of significance.

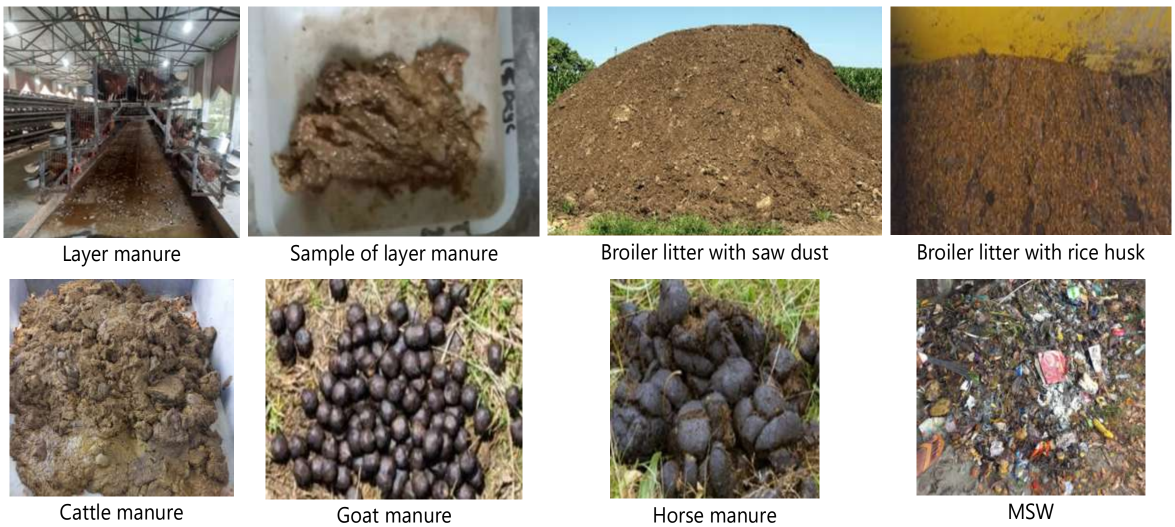

Fig. 1: Pictorial view of available composting materials.

The Total Organic Carbon (TOC) of composting materials ranged between 40.53 to 56.58%. The highest TOC was found in T_3 (56.58%), followed by T2 (55.04%), and the rest of them were moderate. Different composting materials exhibited different TOC content, which was statistically significant (P<0.01). The TOC of composting materials is the key component for compost quality (Sudharsan & Ajay, 2013; Rahman et al., 2013). The TOC represents the amount of carbon bound in organic compounds. High TOC levels indicate a significant presence of organic material, essential for the microbial processes that enhance composting. The TOC also helps to estimate the potential nutrient content in the compost (Kim et al., 2012). Organic carbon is a major component of composting materials, which is vital for soil fertility and plant growth.

Ash contents of the composting materials were ranged between 5.25 to 12.27. The lowest ash content was in T6 (5.25%), and the highest was in T_1 (12.27%) among all treatments. Differences were found in ash content in different composting materials, and these were statistically significant (P<0.01). Higher ash content in layer manure might be due to the addition of Ca supplement and grids in their ration (Quiroga et al., 2010). The EE is the amount of total lipid substance along with free fatty acids. The range of EE was 1.22 to 3.60% among all composting materials available in Bangladesh. The highest EE content was found in T_7 (3.60%) and the lowest EE content was found in T_3 (1.22%). Differences were found in EE content in different composting materials and these were statistically significant (P<0.05). Rahman et al. (2020a) found that the EE content of manure ranged between 2.01 to 2.44%, which is very similar to the present study.

The CF content of composting materials is very important in determining the composting period. The highest CF was found in T_6 (35.14%) and the lowest CF content was found in T_1 (4.98%). Differences were found in CF content in different composting materials and these were statistically significant (P<0.01). The lowest CF in layer manure might be to the nature of layer ration. The CF of the composting materials provides structure and aeration in

ISSN: 2708-7182 (Print); ISSN: 2708-7190 (Online)

Open Access Journal

the compost pile. This helps in maintaining air spaces, which are essential for aerobic decomposition by microorganisms. Bulking materials, like sawdust, straw, wood chips, and tree leaves, help to absorb excess moisture and prevent the compost pile from becoming too wet. This balance prevents anaerobic conditions that can cause odors and slow decomposition in the composting pile. Poultry manure contains less CF compared to ruminant and horse manure, which might be due to their feed characteristics (Ashworth et al., 2020).

Nitrogen content of the composting materials is the key factor of the compost. Table 1 shows the N content of different composting materials available in Bangladesh. Comparatively higher N content was found in T1, T2, and T3 (2.30, 2.21, and 2.04%, respectively), and comparatively lower N was found in T7, T6, and T_5. The differences were statistically significant at 5% level (P<0.05). The N content of the composting materials might be conserved in the compost as NO_3 during the aerobic decomposition process (Rahman et al., 2008; Sharma et al., 2022).

The CN ratio of the composting materials is a value calculated by dividing the TOC by the N content of the sample. The CN ratio of different composting materials ranged between 17.69 to 49.21. The lowest CN ratio was found in T_1 (17.69), and the highest CN ratio was found in T_7 (49.21). A lower CN ratio indicates higher N content in the composting materials, and a higher CN ratio indicates lower N content. The variations in CN ratio were significant at different composting materials (P<0.01). Al-Amin et al. (2020), Rana et al. (2020), Rahman et al. (2020a), and Sarker et al. (2021) conducted several composting investigations and found a very close CN ratio in different composting materials. Ekinci et al. (2021) stated that the initial CN ratios of olive mill pomace, poultry and dairy manure, and straw ranged from 20.03 to 39.99.

Significant differences (P < 0.05) in P content were found among the different composting materials. The highest amount of P was found in T_1 (0.33%), and the lowest amount of P was found in T_3 (0.18%). The highest K content was found in T_6 (0.15%), and the lowest in T7 (0.06%); the differences were significant (P < 0.01) among the composting materials. Khater (2015) found very close P content (0.21%) and K (0.17%) in cattle manure. The pH values of all composting materials were estimated, ranging from 7.02 to 8.15. The values were also significantly different among different composting materials. Kozik et al. (2011) found that the highest value of the pH was 9.0.

3.2. Physical and Chemical Properties of the Bulking Materials

Available bulking materials for composting in Bangladesh are shown in Fig. 2 and the chemical properties of these bulking materials are shown in Table 2. A higher DM% was found in all bulking materials. The highest DM was observed in T_5 (92.13), and the lowest DM was observed in T1 (72.20), and these variations were significant at 1% level (P<0.01). Graves (2000) stated a lower DM content in sawdust (70%) and tree leaves (62%). The TOC value ranged from 41.91 to 52.10% in the available bulking material samples. The TOC values of the bulking materials also showed significant variations among the treatments (P<0.01).

Fig. 2: Pictorial view of available bulking materials.

ISSN: 2708-7182 (Print); ISSN: 2708-7190 (Online)
Open Access Journal

A moderate ash content was found in T_1 to T_4 (3.76 to 8.52%), but a higher ash content was found in T5 (13.87%), and the variations were significant (P<0.01) among different bulking materials. Alam et al. (2013) found 13% ash in sawdust-containing layer litter compost, which is very close to the present study. Comparatively lower EE content was found in all available bulking materials, but differences were significant (P<0.05) among the treatments. Normally, bulking materials consist of plant-based or fibrous parts and contain low fat content. Hossain et al. (2012) stated that sawdust contained 0.6-2.0% fat, which is very close to that of sawdust in this study, but higher than that of rice husk.

Table 2: Chemical properties of the bulking materials available in Bangladesh

Parameter	Treatment					Level of significance
	T_1	T_2	T_3	T_4	T_5	
DM (%)	72.20 ± 1.10c	85.24 ± 2.11b	86.22 ± 1.14b	86.80 ± 0.55b	92.13 ± 1.81a	**
TOC (%)	52.10 ± 0.10a	50.50 ± 0.50a	45.36 ± 0.74b	42.20 ± 0.15c	41.91 ± 0.01c	**
Ash (%)	3.76 ± 0.01d	8.52 ± 0.01b	6.51 ± 0.01c	5.36 ± 0.32c	13.87 ± 0.01a	**
EE (%)	0.81 ± 0.01a	0.91 ± 0.01a	0.96 ± 0.01b	0.25 ± 0.20c	0.23 ± 0.00d	*
CF (%)	45.25 ± 0.01a	32.41 ± 0.97d	34.98 ± 0.36c	34.16 ± 1.04c	36.34 ± 0.01b	**
N (%)	0.12 ± 0.012a	0.35 ± 0.009a	0.62 ± 0.36a	0.08 ± 0.00a	0.21 ± 0.01a	**
C/N	434.17 ± 15.29a	144.2 ± 12.83b	73.1 ± 12.27c	527.50 ± 9.74a	199.57 ± 11.68b	**
P (%)	0.37 ± 0.01a	0.42 ± 0.025a	0.41 ± 0.01a	0.31 ± 0.01b	0.16 ± 0.01c	*
K (%)	0.21 ± 0.01b	0.14 ± 0.02b	0.51 ± 0.01a	0.03 ± 0.00c	0.14 ± 0.05b	*
pH	8.10 ± 0.10b	8.20 ± 0.10b	8.50 ± 0.10a	7.80 ± 0.10c	7.60 ± 0.10c	*

T_1= sawdust, T_2=rice straw, T_3=dry tree leaves, T_4=wood shavings, T_5=rice husk, Values (Mean ± SD) bearing different alphabets in a row differ significantly at **mean 0.01% and *mean 0.05% level of significance.

Higher CF contents were found in all available bulking materials. The highest CF was found in T_1 (45.25%)) and the lowest CF content was found in T_2 (32.41%) and the differences were significant among the bulking materials (P<0.05). Graves (2000) stated that sawdust, wood shavings and dry rice straw were carbonaceous materials and rich in CF. These are characterized by good degradability, provide good structure, good odor absorption, and are available everywhere. These positive characteristics make these materials excellent composting amendments. Comparatively higher N was found in T_3 (0.62%), followed by T_2 (0.35%) and the lowest N was found in T_4 (0.08%). There were significant differences in N content among the bulking materials tested (P<0.01). Graves (2000) stated that rice straw, sawdust, wood shavings and rice husk contained 0.70, 0.24, 0.09 and 0.30%, respectively which is also very close with the present study.

A great variation in the CN ratio was found among the tested bulking materials. The widest CN ratio was found in T_4 (527.50) followed by T_1 (434.17), T_5 (199.57), T_2 (144.29) and the narrowest CN ratio was found in T_3 (73.16). The variations were significant among different bulking materials (P<0.01). For rapid composting, an initial CN ratio between 20:1 to 40:1 is recommended. However, narrow ratio, such as 14:1, are also effective and practical, particularly when composting animal mortalities. Narrow C:N ratios are more effective in composting but necessitate adding substantial amounts of a carbon source, like straw, sawdust, or wood shavings, which decreases the amount of mortalities that can be composted (Graves, 2000). When carbon is overly abundant compared to nitrogen, causing the wider C:N ratio to exceed the ideal range, the composting process decelerates. Here, the availability of nitrogen becomes the limiting factor. With limited nitrogen available, microorganisms take more time to break down the excess carbon. It may take multiple generations of microorganisms to lower the C:N ratio to a more optimal level. Higher P content was found in T_3 (0.42%) compared to others. The values were significantly different at 5% level (P<0.05). The K content in different bulking materials also showed a significant difference, and the highest K was found in T_3 (0.65%). Khater (2015) found very close P content (0.36%) and K (0.42%) in plant residues. The pH value ranged between 7.60 to 8.50 in all bulking materials. The values were also significantly different among different composting materials (P<0.05). The pH values were very similar with the findings of Khater (2015).

According to the Environmental Engineering National Handbook, published by the United States Department of Agriculture and prepared by Graves (2000), several common raw materials were used in composting. These materials include approximately 30 items such as cattle manure, poultry manure, horse manure, swine manure, fish processing wastes, fruit and vegetable wastes, crop residue, finished compost, grass clippings, leaves, limes, livestock manure, newspaper, paper mill sludge, peat moss, sawdust and shavings, bark, cardboard, seaweed and other aquatic plants, seepages and sewer sludge, slaughterhouse and meatpacking waste, spoiled hay and silage, straw, wood ash, and wood chips. Huerta-Pujol et al. (2010) emphasized the importance of identifying and utilizing reliable methods to control the physical and chemical properties of organic wastes during composting. This control is essential for making informed decisions about compost performance directly on site. Quality control measures throughout compost production, as highlighted by Inbar et al. (1993), should ensure appropriate chemical and physical characteristics and achieve a sufficient level of compost maturity, as noted by Benito et al. (2003). The

Citation: Mustafa MMH, Hashem MA, Sumon MH, Sarker MSK, Rashid MA and Rahman MM, 2026. Characteristics of composting materials and bulking materials available in Bangladesh. Agrobiological Records 23: 141-148. https://doi.org/10.47278/journal.abr/2026.012

advantages of compost on crop yield and soil health, as reported in the literature by Hoitink et al. (1997) and Atiyeh et al. (2001), are closely tied to the physico-chemical, and biological characteristics of compost as stated by He et al. (1995).

Yang (2000) highlighted ideal conditions for successful composting, emphasizing the selection of compostable materials, composting processes, changes in properties during composting, and the production of versatile bio-fertilizers. A range of materials, from high-fertilizer-value animal wastes to low-fertilizer-content straw and husks, are utilized in composting, often in combinations where components may be processed separately at times. The substrate's optimal conditions include a CN ratio of 30–40, pH levels between 6 and 8, and a moisture content of 60–65%. These optimum conditions for composting would be maintained through the suitable combination of composting materials and bulking materials.

4. CONCLUSION

The physico-chemical properties of composting and bulking materials, such as moisture content, pH, temperature, carbon-to-nitrogen ratio, and particle size, are crucial for the efficiency and effectiveness of the composting process. These properties influence microbial activity, decomposition rates, and the quality of the final compost. Correct information about these properties helps to identify the amounts of composting materials and bulking materials for standardizing the moisture and CN ratio of compost mix. Optimum moisture and CN ratio of compost mix ensures optimal conditions for the breakdown of organic matter, leading to the production of nutrient-rich compost that can enhance soil quality.

Declarations

Funding: This research work was funded by a national research organization named “Krishi Gobeshona Foundation (KGF)” (Project Code: TF 82- L/20).

Acknowledgement: We would like to express our appreciation to Krishi Gobeshona Foundation (KGF) for funding this research work (Project Code: TF 82- L/20). The authors acknowledged Bangladesh Agricultural University Research System (BAURES) for monitoring the research.

Conflicts of Interest: The authors declare no competing interests exist.

Data Availability: All primary data supporting the findings of this study are included within the article.

Ethics Statement: In this study, we didn’t use any live animals; therefore, no ethical statement is required.

Author’s Contributions: This work was carried out in collaboration among all the authors. Md. Murshed Hasan Mustafa, Md Mukhlesur Rahman, and Md Abul Hashem have designed the study and drafted the experimental protocol. Md. Murshed Hasan Mustafa and Md Abul Hashem conducted the experiment as well as analyzed the data and coordination. Author Mahmud Hossain Sumon performed the statistical layout, treatments and interpreted the study results. Md. Mukhlesur Rahman was monitoring and aiding to final manuscript writing. All authors read and approved the final manuscript.

Generative AI Statements: The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

Publisher’s Note: All claims stated in this article are exclusively those of the authors and do not necessarily represent those of their affiliated organizations or those of the publisher, the editors, and the reviewers. Any product that may be evaluated/assessed in this article or claimed by its manufacturer is not guaranteed or endorsed by the publisher/editors.

REFERENCES

Ahsan, A., Ismail, N., Rahman, M.M., Imteaz, M., Rahman, A., Mohammad, N., & Salleh, M.A.M. (2013). Municipal solid waste recycling in Malaysia: present scenario and future prospects. Fresenius Environment Bulletin, 22, 3654-3664. http://hdl.handle.net/1959.7/uws:19629

Al-Amin, M., Rahman, M.M., Islam, S.M.A., Dhakal, H., Khan, M.R.I., Amin, M.R., & Kabir, A.K.M.A. (2020). Effect of bulking materials over the composting of bio-slurry. Bangladesh Journal of Animal Science, 49(2), 142-150. https://doi.org/10.3329/bjas.v49i2.53224

Alam, F., Hashem, M.A., Rahman, M.M., Rahman, S.M.E., Hossain, M.M., & Rahman, Z. (2013). Effect of bulking materials on composting of layer litter. Journal of Environmental Science and Natural Resources, 6, 141-144. DOI: https://doi.org/10.3329/jesnr.v6i1.22054

AOAC, (2005). Methods of the Association of Official Analytical Chemists. Arlington Virginia USA AOAC p. 780. Method No. 920.85. Vol. II:15th Ed.

Ashworth, A.J., Chastain, J.P., & Moore, P.A. (2020). Nutrient characteristics of poultry manure and litter. A book of Animal Manure, American Society of Agronomy (ASA), USA. 67: 63-67.

Atiyeh, R.M., Edwards, C.A., Subler, S., & Metzger, J.D. (2001). Pig manure vermicomposting as component of a horticultural bedding plant medium: effects on physicochemical properties and plant growth. Bioresource Technology, 78, 11–20. https://doi.org/10.1016/S0960-8524(00)00172-3

Benito, M., Masaguer, A., Moliner, A., & Antonio, D.R. (2005). Use of pruning waste compost as a component in soilless growing media. Bioresource Technology, 97, 2071–2076. https://doi.org/10.1016/j.biortech.2004.06. 006

Dhakal, H.R., Kabir, A.K.M.A., Gulshan, Z., Amin, M.R., Rahman, M.M., & Khan, M.R.I. (2023). Effect of deep bedded pack system in manure management for reducing heat stress of cattle in Bangladesh. Asian Journal of Dairy and Food Research, 42(2), 174-178. https://doi.org/10.18805/ajdfr.DRF-289

Dharnaik, A., & Patil, S. (2024). In-vessel aerobic composting of organic waste using synthetic and natural bulking agents. Compost Science & Utilization. https://doi.org/10.1080/1065657X.2024.2414983

Ekinci, K., Tosun, İ., Şevik, F., Bıtrak, N.B., Sülük, K., & Kumbul, B.S. (2021). Effects of initial c/n ratio on maturity and stability of compost produced from two-phase olive mill pomace, poultry and dairy manure and straw. Compost Science & Utilization, 29(3–4), 95–106. https://doi.org/10.1080/1065657X.2023.2270972

Graves, R.E. (2000). Common Raw Materials for Farm Composting. Environmental Engineering National Engineering Handbook, United States Department of Agriculture (USDA), Part 637, Chapter: 2A (1-5).

He, X., Logan, T.J., & Traina, S.J. (1995). Physical and chemical characteristics of selected US Municipal solid waste composts. Journal of Environmental Quality, 24, 543-552. https://doi.org/10.2134/jeq1995. 00472425002400030022x

Hirzel, J., Sánchez, C., Roa, R., & Tramón, S. (2022). Nitrogen, phosphorus, and potassium availability in three compost derivatives from the wine industry and two fertilizers. Compost Science & Utilization, 30(1–4), 29–43. https://doi.org/10.1080/1065657X.2023.2283515

Hoitink, H.A., Stone, A.G., & Han, D.Y. (1997). Suppression of plant diseases by composts. Horticulture Science, 32, 184-187.

Hossain, M.E., Rahman, M.J., & Islam, K.M.F. (2012). Nutritive value of sawdust. Online Journal of Animal Feed Research, 2(3), 288-291.

Hossen, M.S., Khan, M.R.I., Azad, M.A.K., Hashem, M.A., Bhuiyan, M.K.J., & Rahman, M.M. (2022). Effects of moisture content on the quality of vermicompost produced from cattle manure. Bangladesh Journal of Animal Science, 51(2), 40-46. https://doi.org/10.3329/bjas.v51i2.60493

Huerta-Pujol, O., Soliva, M., Martinez-Farre, F.X., Valero, J., & Lopez, M. (2010). Bulk density determination as a simple and complementary too in composting process control. Bioresource Technology, 101, 995-1001. https://doi.org/10.1016/j.biortech.2009.08.096

Inbar, Y., Chen, Y., & Hoitink, H.A. (1993). Properties for establishing standards for utilization of composts in container media. In: Hoitink, H.A.J., Keener, H.M. (Eds.), Science and Engineering of Composting: Design, Environmental. Microbiological and Utilization Aspects. Ohio State University, USA, pp: 668-690.

Kim, M.J., Lee, J.S., Kumar, S., Rahman, M.M., Shin, J.S., & Ra, C.S. (2012). Indirect Estimation of CH4 from Livestock Feeds through TOCs Evaluation. Asian-Australasian Journal of Animal Sciences, 25, 496-501. http://dx.doi.org/10.5713/ajas.2011.11352

Khater, E.S.G. (2015). Some Physical and Chemical Properties of Compost. International Journal of Waste Resources. 5(1), 1-5. https://doi.org/10.4172/2252-5211.1000172

Kozik, A., Hutnik, N., Matynia, A., Gluzinska, J., & Piotrowski, K. (2011). Recovery of phosphate (V) ions from liquid waste solutions containing organic impurities. Chemik, 65, 675–686.

Lee, J.E., Rahman, M.M., & Ra, C.S. (2009). Dose effects of Mg and PO4 sources on the composting of swine manure. Journal of Hazardous Materials, 169, 801-807. https://doi.org/10.1016/j.jhazmat.2009.04.026

Liu, Y.H., Rahman, M.M, Kwag, J.H., Kim, J.H., & Ra, C.S. (2011). Eco-friendly production of maize using struvite recovered from swine wastewater as a sustainable fertilizer source. Asian-Australasian Journal of Animal Sciences 24(12), 1699-1705. http://dx.doi.org/10.5713/ajas.2011.11107

Miner, G.L., Delgado, J.A., Ippolito, J.A., & Stewart, C.E. (2020). Soil health management practices and crop productivity. Agricultural and Environmental Letters, 5(1), e20023. https://doi.org/10.1002/ael2. 20023

Modak, M., Chowdhury, E.H., Rahman, M.S., & Sattar, M.N. (2019). Waste management practices and profitability analysis of poultry farming in Mymensingh district: A socioeconomic study. Journal of Bangladesh Agricultural University, 17(1), 50–57. https://doi.org/10.3329/jbau. v17i1.40663

Nazir, R., Ajmal, S., Fatima, S., Junaid, M., Wahab, M., & Arif, A. (2024). Strategies for the integrated management of tomato wilt. Agrobiological Records, 17, 91-99. https://doi.org/10.47278/journal.abr/2024.027

Quiroga, G.C., Astrillón, L., Fernández-Nava, Y., & Maranón, E. (2010). Physico-chemical analysis and calorific values of poultry manure. Waste Management, 30, 880–884. https://doi.org/10.1016/j.wasman. 2009.12.016

Rahman, S.M.E., Islam, M.A., Rahman, M.M., & Oh, D.H. (2008). Effect of cattle slurry on growth, biomass yield and chemical composition of maize fodder. Asian Australasian Journal of Animal Sciences, 21, 1592-1598. https://doi.org/10.5713/ajas.2008.80190

Rahman, M.M., Salleh, M.A.M., Sultana, N., Kim, M.J., & Ra, C.S. (2013). Estimation of total volatile fatty acid (VFA) from total organic carbons (TOCs) assessment through in vitro fermentation of livestock feeds. African Journal of Microbiology Research, 7(15), 1378-1384. https://doi.org/10.5897/AJMR12.1694

Rahman, A., Hashem, M.A., Kabir, A.K.M.A., Bhuiyan, M.K.J., & Rahman, M.M. (2020a). Influence of amount of red worm (Eisenia foetida) on the organic matter degradation during vermicomposting of cattle manure. Bangladesh Journal of Animal Science, 49, 45-54. https://doi.org/10.3329/bjas.v49i1.49377

Rahman, M.Z., Kabir, A.K.M.A., Hashem, M.A., Islam, M.A., Haque, M.R., & Rahman, M.M. (2020b). A comparative study of assessing organic matter decomposition between composting and vermicomposting process. Asian Journal of Medical and Biological Research, 6(4), 768-776. https://doi.org/10.3329/ajmbr.v6i4.51245

Rahman, M., Mustafa, M.M.H., Islam, Y., Hashem, M.A., Sumon, M.H., & Rahman, M.M. (2025). Investigating the Characteristics of Pakchong Fodder Using Struvite Containing Compost Comparing with Chemical Fertilizer. International Journal of Agriculture and Biosciences, 14(2), 232-237. https://doi.org/10.47278/journal.ijab/2024.216

Rana, M.S., Hashem, M.A., Murshed, H.M., Bhuiyan, M.K.J., & Rahman, M.M. (2020). Influence of bulking materials on the organic matter degradation during composting of cattle manure. Journal of Agriculture, Food and Environment, 1, 33-38. https://doi.org/10.47440/ JAFE.2020.1305

Roy, B.C., Khan, M.R.I., Rahman, M.M., Salleh, M.A.M., Ahsan, A., & Amin, M.R. (2013). Development of a convenient method of rumen content composting. Journal of Animal and Veterinary Advances, 12, 1439-1444.

Sarker, M.A., Hashem, M.A., Murshed, H.M., Kamal, M.T., Haque, M.R., & Rahman, M.M. (2021). Production and evaluation of vermicompost from different types of livestock manures. Journal of Agriculture, Food and Environment, 2(2), 62-67. http://doi.org/10.47440/JAFE.2021.2211

Sarker, L.R., Khan, M.R.I., & Rahman, M.M. (2018). Ensiling of wet rice straw using biogas slurry and molasses in monsoon of Bangladesh. Journal of Animal Science and Livestock Production, 2(1:2). DOI: 10.21767/2577-0594.100012

Sarker, B.C., Alam, M.A., Rahman, M.M., Islam, A.F.M.T., & Choudhury, M.G.F. (2009). Waste management of commercial poultry farms in Bangladesh. Journal of Innovation and Development Strategy, 3, 34-37.

Sharma, R., Kandel, S., Khadka, S., & Chaudhary, S. (2022). Nutrient content in different sources of organic manures of different farms in Bhaktapur district of Nepal. Journal of Agriculture and Natural Resources, 5 (1), 150-156. https://doi.org/10.3126/janr.v5i1.50705

Sudharsan, V.V., & Ajay, S.K. (2013). Composting of Municipal Solid Waste (MSW) mixed with cattle manure. International Journal of Environmental Sciences, 3(2), 2068-2079. https://doi.org/10.6088/ijes. 2013030600025

White, P.J., Crawford, J.W., Alvarez, M.C.D., & Moreno, R.G. (2012). Soil Management for Sustainable Agriculture. Applied and Environmental Soil Science, 2012, 850739. https://doi.org/10.1155/2012/850739

Won, S.G., Park, J.Y., Rahman, M.M., & Ra, C.S. (2016). Co-composting of swine mortalities with swine manure and sawdust. Compost Science and Utilization, 24(1), 42-53. https://doi.org/10.1080/1065657X.2015. 1055008

Yang, S. (2000). Recent advances in composting issues in the management of agricultural resources: Proceedings of a seminar in commemoration of Fifths 30th anniversary, National Taiwan University, Taipei, Taiwan ROC, 6-8 September, 2000: 195-216.

Zhang, Z., Yang, H., Wang, B., Chen, C., Zou, X., Cheng, T., & Li, J. (2023). Aerobic co-composting of mature compost with cattle manure: Organic matter conversion and microbial community characterization. Bioresource Technology, 382, 129187. https://doi.org/10.1016/j.biortech .2023.129187