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RESEARCH ARTICLE

REPURPOSING MAIZE STRAW AND CHICKEN DUNG INTO MATURE AND NON-PHYTOTOXIC ORGANIC AMENDMENTS

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ABSTRACT

Agricultural residues such as maize straw and chicken dung are produced in substantial quantities in Brunei Darussalam, but remain underutilised due to limited waste management and utilisation strategies. This study evaluated whether composting and co-composting these materials could produce mature and non-phytotoxic organic amendments. Accordingly, three organic amendments were produced from high-carbon and high-nitrogen agricultural wastes: (i) maize straw compost (MS), (ii) maize straw-chicken dung co-compost (MS:CD), and (iii) chicken dung compost (CD). Temperature profiles indicated differing thermal dynamics among the materials. Maize straw compost showed modest thermal activity (28.2 °C to 42.1 °C), MS:CD maintained warm-mesophilic conditions (30.4 °C to 39.0 °C), whereas CD reached a near-thermophilic peak of 50.0 °C. All three organic amendments exhibited near-neutral to slightly alkaline pH (7.19 to 7.87), C/N ratios of 11.6 to 13.9, and organic matter contents between 53.1% and 57.5%. Water-extractable aluminium ions were not detected, and available iron ions content remained low (0.012 cmol kg^{-1} to 0.231 cmol kg^{-1}). Phytotoxicity assessment using a water spinach (*Ipomoea aquatica* F.) germination test showed no inhibitory effects for any of the organic amendments when compared with the soil-only control. Germination indices exceeded 126%, whereas vigour indices of the organic amendments were significantly higher than those observed in the control treatment. Overall, composting and co-composting maize straw and chicken dung produced mature and non-phytotoxic organic amendments, representing a promising pathway for valorising agricultural residues in Brunei Darussalam. However, further soil-based trials are required to confirm their agronomic performance.

KEYWORDS

agricultural waste valorisation, co-composting, composting, organic soil conditioners, phytotoxicity

1. INTRODUCTION

Composting is widely recognised as an environmentally sustainable approach for converting organic wastes into mature organic amendments, besides simultaneously reducing the volume of material destined for disposal (Waqas et al., 2023). In Brunei Darussalam, approximately 1.4 kg of solid waste is generated per capita daily, placing the country among the highest waste producers in ASEAN (Shams et al., 2024). Despite this, only about 2% of the country's waste is composted, and most agricultural residues are not systematically managed (Shams et al., 2024). Farming activities in Brunei Darussalam generate substantial quantities of organic residues, including maize straw and chicken dung. Brunei Darussalam's domestic agricultural production, which includes 577 tonnes of sweet corn, 65,681 tonnes of maize-based livestock feed, and 20.45 million broiler chickens, among others, generates substantial amounts of residual organic materials (Department of Agriculture and Agrifood, 2025). A chicken produces approximately 80 g to 100 g of droppings each day, which amounts to approximately 3% to 4% of its body weight, resulting in approximately 29 kg to 37 kg of dung per chicken annually (Manogaran et al., 2022). In the absence of dedicated agricultural waste management systems, these residues are commonly landfilled or disposed of informally, a practice which leads to odour, flies, ammonia emissions, and greenhouse gas release.

Repurposing these residues through quality composting simultaneously reduces environmental burdens and improves soil health. Composts enhance soil fertility, soil organic matter, crop productivity, and carbon sequestration (Edlinger et al., 2025; Chen et al., 2024). Conventional composting typically uses a single feedstock, whereas co-composting blends materials of contrasting carbon-nitrogen (C/N) ratios to optimise microbial activity and improve compost quality. In this study, carbon-rich, lignocellulosic maize straw was combined with nitrogen-rich chicken dung. Chicken dung alone is often difficult to compost due to rapid ammonification, foul odours, and potential pathogen loads, but co-composting it with structured, high-C/N materials such as maize straw improves aeration, balances the C/N ratio, enhances the thermophilic phase, promotes humification, and reduces gaseous emissions (Bernal et al., 2009; Jiang et al., 2011; Waqas et al., 2018) (Papale et al., 2021; Chen et al., 2024; Li et al., 2023). Regardless of feedstock choice or composting strategy, the suitability of composted materials for agricultural use depends fundamentally on their maturity and biological safety because immature composts may contain phytotoxic substances, including volatile organic acids, ammonia, or excessive soluble salts, which can inhibit seed germination and early plant development (Mahapatra et al., 2022).

Agricultural soils in Brunei Darussalam are strongly acidic, with reported pH values ranging from 3.6 to 4.2 (Zin et al., 2017). In strongly acidic soils, high levels of soluble aluminium (Al) and iron (Fe) ions hinder root growth and nutrient absorption in a wide range of crops by dominating the cation-exchange complex, whereas excessive sulphur (S) compounds can also impair root function (Munyaneza et al., 2024; Jin et al., 2025). Consequently, soil acidity represents a persistent constraint to

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agricultural productivity in the country. Within this context, organic amendments intended for agricultural use must be of sufficient quality to avoid introducing additional chemical constraints, including readily soluble metal forms. Accordingly, such organic amendments must be evaluated not only for selected physicochemical indicators associated with compost maturity, such as compost temperature profile and C/N ratio, but also for the absence of phytotoxic effects. Germination-based bioassays, such as the germination index (GI), are commonly used to assess compost maturity and phytotoxicity because they integrate plant responses to both chemical and biological characteristics of composts (Mahapatra et al., 2022).

In this study, maize straw and chicken dung were composted individually and co-composted to produce organic amendments from locally abundant agricultural residues. It was hypothesised that composting and co-composting maize straw and chicken dung would produce organic amendments that are mature and non-phytotoxic. To this end, the objective of this study was to produce organic amendments derived from maize straw and chicken dung through composting and co-composting and to characterise their maturity and phytotoxicity using selected physicochemical indicators and a biological germination assessment. By focusing on compost maturity and biological safety, this work provides a foundational assessment of compost and co-compost quality needed for the responsible reuse of maize straw and chicken dung in subsequent soil-based and agronomic applications.

2. MATERIALS AND METHODS

2.1 Feedstocks and production of organic amendments

Three organic amendments were produced using maize straw and chicken dung as the primary feedstocks: (i) maize straw-based compost (MS), (ii) maize straw-chicken dung co-compost (MS:CD), and (iii) chicken dung-based compost (CD). Composting in this study refers to the use of a single feedstock (MS and CD), whereas co-composting denotes the combined use of maize straw and chicken dung (MS:CD). The initial pH and EC of the raw maize straw and chicken dung are presented in Table 1.

Table 1: pH and electrical conductivity of the maize straw and chicken dung feedstocks

Property	Maize Straw	Chicken Dung
pH-H_2O	6.79 ± 0.04	7.78 ± 0.03
Electrical conductivity ($dS\ m^{-1}$)	1.13±0.02	6.13± 0.04

Polystyrene containers (55 cm × 42 cm × 32 cm) were filled with feedstocks to within 1 cm of the rim. The mass required to fill this volume was recorded and used as the baseline for determining feedstock quantities in each treatment. For MS, 3.5 kg of dried and ground maize straw was used. For CD, 25.6 kg of dried and ground chicken dung was applied. In the co-composted treatment (MS:CD), maize straw and chicken dung were combined at a 1:1 (w/w) ratio, with 1.75 kg of each feedstock. All treatments were supplemented with additives in proportion to support microbial activity during composting and co-composting. These included raw chicken dung (10% w/w of the main feedstock), chicken feed (5% w/w), molasses (0.5% v/w), and effective microorganism (EM) solution (0.5% v/w). The additives were incorporated uniformly into each treatment before composting and co-composting. Moisture content was adjusted using tap water to achieve suitable conditions, with approximately 11 L of water added per treatment, accounting for water contributed during successive mixing steps. All composting and co-composting processes were carried out in aerated polystyrene containers, each with five holes punctured on the sides and lid to facilitate airflow, under ambient environmental conditions. The processes were maintained for approximately 12 weeks. Turning was carried out manually to maintain aeration and ensure uniform decomposition: every three days during the active phase, every six days during stabilisation, and every nine days during maturation. Pile temperatures were monitored throughout using a digital probe thermometer to indicate microbial activity and decomposition progress. After the composting and co-composting period, the organic amendments were air-dried for two weeks to remove residual moisture and halt biological activity, marking the completion of the organic amendment production.

2.2 Physicochemical analyses of the organic amendments produced

The Munsell colour of each organic amendment was determined using the Munsell chart to provide a qualitative indication of humification and maturity. All subsequent analyses were conducted on air-dried samples and performed in triplicate. pH and electrical conductivity (EC) were measured in a 1:10 (w/v) distilled water suspension (FAO, 2021; Singh et al., 2012) prepared by mixing 10 g of organic amendment with 100 mL of distilled water using an OHAUS AquaSearcher benchtop meter. Water-extractable Al^{3+} was determined using the back-titration method described by Tan (2005). A 10 g sample was shaken with distilled water, filtered, diluted, and titrated using a 1 M sodium fluoride-assisted back-titration to quantify readily soluble Al^{3+}. Available Fe^{2+} in the organic amendments was quantified by extracting the samples with 1 M ammonium acetate (pH 7.00) following Tan (2005), after which available Fe^{2+} concentrations were measured with a Shimadzu AA-7000 atomic absorption spectrophotometer. Total organic carbon (TOC) was determined using the Walkley-Black wet oxidation method (FAO, 2019), and organic matter content was estimated by multiplying the TOC with the van Bemmelen factor (1.724). Total nitrogen (TN) was analysed using the Kjeldahl digestion, distillation, and titration procedure (Bremner, 1965). Subsequently, the C/N ratios of the organic amendments were calculated as the ratio of TOC to TN.

2.3 Biological test

A phytotoxicity test was conducted to determine whether the organic amendments inhibited early seedling development. The germination-based test was performed by directly seeding certified water spinach seeds into soil and organic amendment mixtures. Paddy soil collected at a depth of 20 cm from a paddy field in Batong, Brunei Darussalam, using an auger, was chosen and used as the growth medium to represent highly acidic soil with high levels of Al and Fe, which pose significant agronomic challenges. The soil's water holding capacity (WHC) was first determined using the percolation method, after which 60% WHC was used as the optimum moisture level Muratore (2025). For each experimental unit, 300 g of air-dried, ground, and sieved soil (< 2 mm) was placed into a polypropylene container (Base area = 150 cm^2) and adjusted to 60% WHC before seed sowing. The soils were mixed with the organic amendments produced at the recommended field rate of 5 t ha^{-1}, scaled proportionally to 8 g per 300 g soil for the germination experiment (Department of Agriculture and Agrifood, 2023). Four treatments (T1, T2, T3, and T4) were evaluated in a Completely Randomised Design. The details of the treatments are provided as follows:

- T1 (Control): 300 g soil only
- T2: 300 g soil + 8 g MS organic amendment
- T3: 300 g soil + 8 g MS:CD organic amendment
- T4: 300 g soil + CD organic amendment

Each treatment consisted of three replicates, with ten water spinach seeds sown per replicate. Containers were maintained indoors under uniform natural light, and moisture was replenished to maintain 60% WHC throughout the 16-day germination experiment. At harvest, the number of germinated seeds, root length, and shoot length were recorded. Seed Germination Percentage (Equation 1), Relative Seed Germination (Equation 2), Relative Root Growth (Equation 3), Germination Index (Equation 4), and Vigour Index (Equation 5) were calculated following (Ch'ng et al., 2013):

- Seed Germination Percentage (G, %)

$$G\ (\%) = \frac{N_g}{N_t} \times 100 \tag{1}$$

where N_g is the number of seeds germinated within a replication, and N_t is the total number of seeds sown within the replication.

- Relative Seed Germination (RSG, %)

$$RSG\ (\%) = \frac{G_t}{G_c} \times 100 \tag{2}$$

where G_t is the number of germinated seeds within the treatment (T2, T3, and T4), and G_c is the number of germinated seeds in the control (T1).

- Relative Root Growth (RRG, %)

$$RRG\ (\%) = \frac{L_t}{L_c} \times 100 \tag{3}$$

where L_t is the mean root length of the treatment (T2, T3, and T4) and L_c is the mean root length of the control (T1).

- Germination Index (GI, %)

$$GI\ (\%) = \frac{RSG\ (\%) \times RRG\ (\%)}{100} \tag{4}$$

- Vigour Index (VI)

$$VI = G\%_t \times (L_r + L_s) \tag{5}$$

where $G\%_t$ is the germination percentage of the treatment, whereas Lr and Ls are the mean root and shoot lengths (cm) of the treatment, respectively.

2.4 Data analysis

Data were analysed using the Statistical Analysis System (SAS) version 9.4 (SAS Institute Inc., 2025). Analysis of variance (ANOVA) was conducted to determine treatment effects, and Tukey's test ($p < 0.05$) was applied to compare the treatment means.

3. RESULTS AND DISCUSSION

3.1 Temperature dynamics during composting and co-composting

The organic amendments exhibited distinct temperature patterns throughout the production process. In MS, temperature increased from 30.0 °C to a peak of 42.1 °C by Day 4, followed by a gradual decline and a secondary rise to 38.8 °C on Day 37.

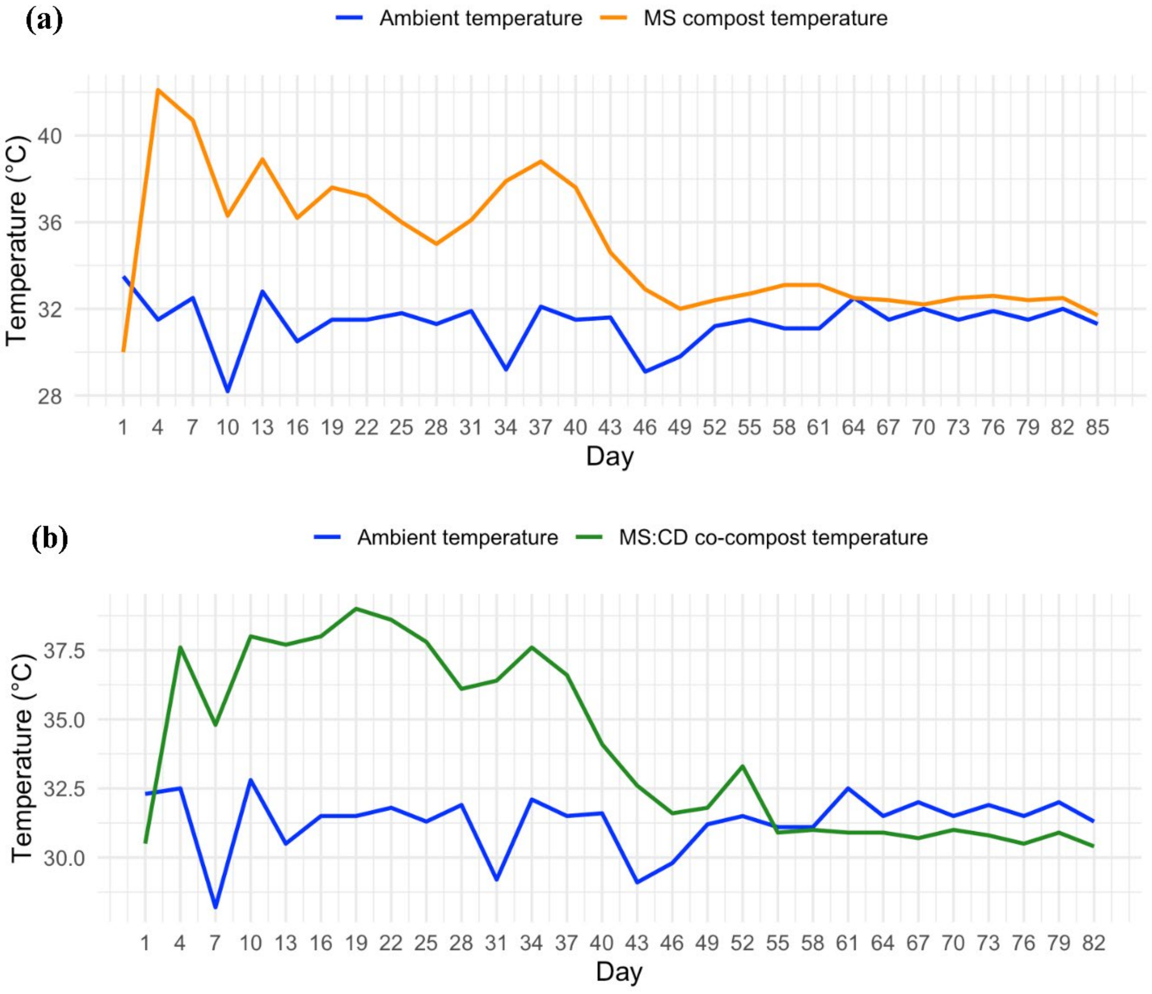
Thereafter, temperatures progressively decreased and stabilised close to ambient conditions, reaching parity with ambient temperature (32.5 °C) by Day 64. This trend suggests that microbial activity had subsided and the material was transitioning toward maturity. The MS:CD treatment displayed the lowest overall temperature magnitude among the treatments but maintained a relatively extended warm-mesophilic phase.

Temperatures remained between 34.8 °C and 39.0 °C for approximately one month before gradually approaching ambient levels. Following this phase, pile temperatures consistently tracked ambient conditions, indicating progression into the maturation stage. In contrast, CD exhibited the greatest thermal activity, with temperatures ranging from 38.3 °C to 50.0 °C from the initial peak on Day 4 through Day 82. Unlike MS and MS:CD, CD did not demonstrate a sustained decline toward ambient temperature within the monitoring period. This persistence of elevated temperatures suggests continued microbial activity and implies that thermal stabilisation associated with compost maturity had not yet been fully achieved by the end of the monitoring period.

These differences in thermal behaviour may reflect variation in feedstock composition and structural characteristics, which influence microbial dynamics and heat production during decomposition (Awasthi et al., 2015). The relatively high and sustained temperatures observed in CD are consistent with the high N content and readily degradable substrates in chicken dung, which support rapid microbial growth and ongoing metabolic activity (Bernal et al., 2009). At the same time, temperature fluctuations between 38.5 °C and 50.0 °C may indicate periodic oxygen limitation associated with the dense, moisture-retentive nature of chicken dung, potentially leading to the formation of anaerobic microsites (Awasthi et al., 2015; Rynk et al., 2022).

By comparison, MS, which is composed mainly of lignocellulosic maize straw, exhibited a more moderate thermal response. The lower peak temperatures and earlier stabilisation are consistent with the high C/N ratio and structural complexity of maize straw, both of which can constrain nitrogen availability for microbial growth and limit metabolic heat generation (Papale et al., 2021; Rynk et al., 2022). The MS:CD co-compost showed a comparatively lower peak temperature but sustained a longer warm-mesophilic phase. This pattern suggests that combining maize straw with chicken dung moderated nitrogen availability and improved aeration, resulting in a more regulated decomposition process. According to Rynk et al. (2022), blending carbon-rich and nitrogen-rich feedstocks can enhance metabolic efficiency besides maintaining more stable thermal conditions during composting.

Overall, the treatments followed distinct thermal pathways: CD reached near-thermophilic conditions and remained thermally active, whereas MS and MS:CD moved towards stabilisation near ambient temperatures by the end of the monitoring period.



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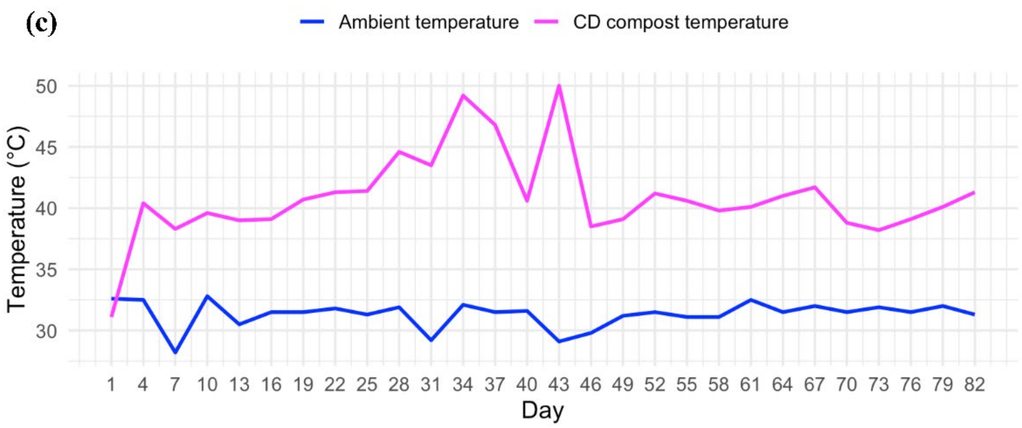

Figure 1: Composting and co-composting temperature profiles of the organic amendments: (a) maize straw compost (MS), (b) maize straw and chicken dung co-compost (MS:CD), and (c) chicken dung compost (CD).

3.2 Selected physicochemical properties of the organic amendments produced

The selected physicochemical properties of the organic amendments are presented in Table 2. Compared with the raw feedstocks, the composts and co-compost exhibited darker colours (Figure 2), reflecting progressive humification and the formation of more stable organic fractions (Bernal et al., 2009). Among the produced amendments, CD recorded the highest pH (7.87), which aligns with the alkaline characteristics of poultry manure. During composting, ammonification and mineralisation processes can generate hydroxyl ions, contributing to an increase in pH (Jiang et al., 2011; Waqas et al., 2018; Bernal et al., 2009). The MS:CD co-compost displayed an intermediate pH of 7.35, suggesting that the inclusion of maize straw moderated the alkalinity associated with chicken dung. Co-composting buffers manure alkalinity, as carbonaceous residues mitigate the increase in pH driven by ammonification (Papale et al., 2021; Chen et al., 2024). The final pH range (7.19 to 7.87) falls within values typically reported for mature composts (7.0 to 8.5) and may be advantageous for application to the strongly acidic soils commonly found in Brunei Darussalam (Lalremruati and Devi, 2023).

Electrical conductivity of the organic amendments increased in the order of MS (5.29 dS m^{-1}) < MS:CD (8.30 dS m^{-1}) < CD (8.46 dS m^{-1}), reflecting the soluble salt content of the feedstocks. Raw maize straw exhibited a comparatively low EC (1.13 dS m^{-1}), consistent with maize residues that generally contain limited soluble ions (Rizzo et al., 2013). In contrast, raw chicken dung had a higher EC (6.13 dS m^{-1}), attributable to its enrichment in ammonium, phosphate, and potassium salts (Waqas et al., 2018; Ch'ng et al., 2013). The increase in EC of the organic amendments results from the mineralisation of organic matter and the release of soluble inorganic ions during microbial decomposition. This process involves breaking down complex organic compounds into simpler forms, thereby releasing soluble inorganic ions into the compost matrix that increase the solution's ionic strength (Bernal et al., 2009). The contribution of chicken dung to the organic amendment mixtures appears to have been a key factor influencing EC values.

Water-extractable Al^{3+} was not detected in any of the mature organic amendments, indicating that composting and co-composting reduced soluble Al forms to levels unlikely to induce phytotoxicity upon application. Available Fe remained detectable, with concentrations of 0.012 cmol kg^{-1} in MS, 0.052 cmol kg^{-1} in MS:CD, and 0.231 cmol kg^{-1} in CD. The comparatively higher Fe ions content in CD reflects the natural abundance of Fe in poultry manure, which originates from Fe present in poultry feed ingredients (Bolan et al., 2010). However, available Fe^{2+} concentrations in MS and MS:CD were substantially lower than those measured in the soil used in this study (8.07± 0.02 cmol kg^{-1} of exchangeable Al^{3+} and 1.13 ± 0.05 cmol kg^{-1} of exchangeable Fe^{2+}).

Total organic carbon ranged from 30.8% to 33.4%, corresponding to organic matter contents of 53.1% to 57.5%. These values fall within the typical range reported for mature composts. According to Sullivan et al. (2018), organic matter contents between approximately 25% and 65% are generally characteristic of well-prepared composts, whereas values exceeding 65% may indicate incomplete decomposition. The organic matter contents observed in this study, therefore, suggest that the amendments were sufficiently stabilised. During compost maturation, microbial decomposition progressively mineralises labile carbon fractions whilst retaining more stable organic carbon forms, resulting in stabilised compost materials enriched with humified organic matter (Waqas et al., 2023).

Total nitrogen ranged from 2.29% in MS to 2.78% in CD, with MS:CD containing 2.66%. Nitrogen levels exceeding 2% of dry weight have been reported to partially substitute conventional nitrogen fertilisers in crop production (Sullivan et al., 2018). The resulting C/N ratios (11.6 to 13.9) fell within the commonly accepted range for mature compost (10 to 20), suggesting that the organic amendments were stabilised and unlikely to induce nitrogen immobilisation following soil application (Jiang et al., 2011). The relatively lower C/N ratio observed in MS:CD may reflect the balanced integration of carbon-rich maize straw and nitrogen-rich chicken dung. An optimal C/N ratio provides sufficient carbon as an energy source whilst supplying adequate nitrogen for microbial biomass synthesis, thereby supporting efficient microbial metabolism during composting (Awasthi et al., 2015). This balance promotes microbial immobilisation of nitrogen within the compost matrix and reduces nitrogen losses through volatilisation, ultimately contributing to nutrient stabilisation and the production of mature compost (Awasthi et al., 2015). Overall, the evaluated physicochemical indicators suggest that the produced organic amendments exhibited characteristics consistent with compost maturity under the conditions of this study.

Table 2: Selected physicochemical properties of the organic amendments produced from maize straw and chicken dung

Property	MS	MS:CD	CD
Munsell Colour	(7.5YR 2.5/1, Black)	(10R 2.5/2, Very dusky red)	(10R 2.5/1, Reddish black)
pH-H_2O	7.19 ± 0.003	7.35 ± 0.01	7.87 ± 0.01
EC (dS m^{-1})	5.29 ± 0.03	8.30 ± 0.27	8.46 ± 0.46
Water-extractable Al^{3+}	n.d.	n.d.	n.d.
Available Fe^{2+} (cmol kg^{-1})	0.012 ± 0.001	0.052 ± 0.004	0.231 ± 0.004
Total Organic C (%)	31.7 ± 0.28	30.8 ± 0.43	33.4 ± 0.30
Organic Matter (%)	54.7 ± 0.49	53.1 ± 0.75	57.5 ± 0.52

Table 2 (cont): Selected physicochemical properties of the organic amendments produced from maize straw and chicken dung

Total N (%)	2.29 ± 0.01	2.66 ± 0.08	2.78 ± 0.04
C/N Ratio	13.86 ± 0.10	11.62 ± 0.32	12.01 ± 0.14

Note: n.d. = Not detectable. MS = Maize straw-based amendment. MS:CD = Co-composted maize straw and chicken dung amendment. CD = Chicken dung amendment.

Figure 2: Colour transformation of the organic amendments before (Left) and after (Right) composting and co-composting for (a) maize straw amendment, (b) maize straw and chicken dung amendment, and (c) chicken dung amendment.

3.3 Phytotoxicity assessment

Water spinach seed germination remained high across all treatments, ranging from 83.33% to 96.67%, with no significant differences detected among them (p > 0.05) (Table 3). Germination index values above 60% to 80% are commonly interpreted as indicative of mature, non-phytotoxic compost (Mahapatra et al., 2022; Zucconi et al., 1981, as cited in Ch'ng et al., 2013). In the present study, all treatments with the organic amendments produced GI values above 100%, suggesting that phytotoxic effects were absent under the experimental conditions. The highest GI was observed in T2 (139.88%), followed by T3 (137.01%) and T4 (126.57%), with all organically amended treatments differing significantly from the unamended control (T1) (p < 0.05). Root length also varied among treatments, with T3 producing the longest mean root length (3.22 cm). Root elongation is regarded as a sensitive indicator of phytotoxicity because roots are directly exposed to soluble constituents in the growth medium (Wang et al., 2001). The absence of root growth inhibition in T2, T3, and T4 further supports the non-phytotoxic nature of the organic amendments produced. Shoot length followed a similar trend to root length. Shoot growth exhibited a comparable pattern. The tallest shoots were recorded in T2 (13.63 cm), significantly exceeding those of the control (6.85 cm) (p < 0.05), whereas intermediate responses were observed in T3 and T4.

Although the magnitude of shoot growth differed among amended treatments, no evidence of suppressed development was observed, indicating that early seedling growth remained unaffected by amendment incorporation. Vigour index values followed a similar trend, with the highest value recorded in T2 (1620.3), followed by T3 and T4, and the lowest value observed in the control (806.0). As VI integrates both germination percentage and seedling growth, the consistently higher values observed in organically amended treatments further suggest that the organic amendments supported normal early seedling development rather than imposing phytotoxic constraints. Within the scope of this biological assessment, the germination index bioassay indicates that composting and co-composting maize straw and chicken dung produced organic amendments that did not exhibit phytotoxic effects.

Table 3: Germination indices of water spinach seedlings (*Ipomoea aquatica* F.) under different treatments after 16 days

Treatment	Mean Root Length (cm)	Mean Shoot Length (cm)	Mean Seed Germination (%)	Relative Seed Germination (%)	Relative Root Growth (%)	Germination Index (%)	Vigour Index
T1 (Control)	2.48^{b} ± 0.22	6.85^{b} ± 0.64	86.67^{a} ± 3.33	100.00^{a} ± 0.00	100.00^{a} ± 0.00	100.00^{b} ± 0.00	806.0^{b} ± 56.32
T2	3.07^{ab} ± 0.12	13.63^{a} ± 1.64	96.67^{a} ± 3.33	112.04^{a} ± 7.23	124.83^{a} ± 8.70	139.88^{a} ± 12.87	1620.3^{a} ± 191.53
T3	3.22^{a} ± 0.10	13.36^{ab} ± 1.67	83.33^{a} ± 3.33	96.76^{a} ± 7.87	131.00^{a} ± 7.96	137.01^{ab} ± 7.25	1376.0^{ab} ± 123.79
T4	2.89^{ab} ± 0.12	11.38^{ab}± 1.58	93.33^{a} ± 3.33	107.87^{a} ± 3.96	117.87^{a} ± 7.55	126.57^{ab} ± 3.67	1343.0^{ab} ± 209.83

Note: T1 (Control) = 300 g paddy soil only; T2 = 300 g paddy soil + 8 g 100% maize straw-based organic amendment; T3 = 300 g paddy soil + 8 g 1:1 (w/w) mixture of maize straw and chicken dung organic amendment; and T4 = 300 g paddy soil + 8 g 100% chicken dung-based organic amendment. Distinct letters within columns indicate significant differences in means among the treatments, as determined by Tukey's HSD test at $p < 0.05$ (For example, a > b > c).

4. CONCLUSION

This study provides new evidence that maize straw and chicken dung can be successfully transformed into mature and non-phytotoxic organic amendments through composting and co-composting. Practically, these findings demonstrated the feasibility of repurposing maize straw and chicken dung into high-quality organic amendments, providing a practical pathway to reduce organic waste sent to landfills, mitigate environmental impacts from unmanaged manure, and promote circular-resource use within the agricultural sector. Further research on soil incubation and field conditions is recommended to validate the agronomic benefits of the maize straw and chicken dung amendments in improving acid soil and crop productivity.

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