Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) compost as an alternative organic fertilizer: A comparative study with conventional organic fertilizers on plant growth and yield of Tomato (*Lycopersicon esculentum*, L)

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Abstract
Water hyacinth compost was evaluated as an alternative organic fertilizer for tomato production. This study investigated the ability of water hyacinth compost (WHC) as an alternative organic fertilizer for tomato (*Lycopersicon esculentum* L.) under field conditions at the University of Science and Technology, Meghalaya, India in Rabi season (2023–24). The treatments were tested in a randomized block design with 6 blocks, namely, cow dung, WHC, cow dung + WHC, vermicompost, vermicompost + WHC and control. Cow dung + WHC gave maximum overall performance in terms of plant height, leaf number, branch number, number of fruit per plant (76.55) and fruit yield per plant (5.97 kg). It also produced the maximum fruit diameter and fruit weight and WHC alone produced the highest relative leaf water content. The same trend was observed for the levels of chlorophyll a and b, which were also highest in the cow dung + WHC treatment. In general, the findings reveal that the use of WHC particularly in association with cow dung can be a beneficial tool to enhance the growth and yield of tomato plant as well as physiological performance. The study indicates that water hyacinth compost is a highly efficient, locally available, eco-friendly organic fertilizer with great potential to sustain tomato production without incurring high costs.

Keywords: Tomato yield, water hyacinth compost, organic fertilizer, sustainable agriculture, *Eichhornia crassipes*.

Introduction

Organic farming is a production system, which avoids or largely excludes the use of synthetic chemical fertilizers. The continued use of organic fertilizers increases soil organic matter, better water infiltration and aeration, higher soil biological activity as the materials decompose in soil and increases yields after the years of application (Baheliya et al., 2024). *Eichhornia crassipes* (Mart.) Solms known as water hyacinth is a free-floating perennial hydrophytes belonging to the family Pontederiaceae. The leaves are broad, thick, glossy, and ovate and float above the water surface. They have long, spongy and bulbous stalks. It is considered as the world's worst aquatic weed (Matebie et al., 2025). Composting water hyacinth (*Eichhornia crassipes*) presents a promising approach for managing the weed and the aquatic environment while increasing agricultural production and soil fertility *Eichornia crassipes* (Mart.) Solms is the plant which can reduce and absorb toxic heavy metals and other pollutants from waste water (Rasool et al., 2023). Water hyacinth can be processed into compost, animal feed and the production of biogas (Belay et al., 2025; Tibebe et al., 2025). Water hyacinth is processed through composting to produce organic material which is softer after decomposition. The composting process itself is a biological process that involves the activity of microorganisms. Continuous use of chemical fertilizers destroy the physical, chemical and biological properties of soil. Because of the repeated use of chemical fertilizers, the soil is lossing its productivity (Hossain et al., 2022). The global environmental pollution can be reduced to a considerable extent by judicious use of chemical fertilizers and the increasing the use of organic fertilizer. Water hyacinth nutrient rich compost have significant benefits to soil health and fertility for sustainable agriculture. Recent research also highlights water hyacinth as a sustainable resource particularly for composting (Canning, 2025; Serafini et al., 2025). This approach transforms a problem into an opportunity for a natural and eco-friendly solution. Proper use of organic fertilizer may reduce the need for chemical fertilizers as well as reduce the cost of production of marginal and small farmers. In India, there is a great possibility of increasing the crop productivity with proper use of organic fertilizers. Water hyacinth compost can be consider as a sustainable organic fertilizer for crop production. For this reason, a comparative study of water hyacinth compost with other organic fertilizers was investigated on the test crop tomato (*Lycopersicon esculentum* .L) in this study.

Result and Discussion

In this experiment different types of organic fertilizer were applied in tomato plant which showed significant effect on plant height at 30 DAT, 45 DAT, and 60 DAT (Figure 1). The highest plant height 70 cm was observed in cow dung and water hyacinth compost (WHC) treated plants (T3) which was at par with vermicompost and WHC (T5) treated plants i e 68.16 cm. The results of chemical properties of water hyacinth compost have been incorporated in the table 1 showing the organic and inorganic contents present in the compost. This increase in plant hieght may be due to getting the macro and micro nutrients from the applied organic fertilizer which increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin content in the plants which ultimately improve the plant height. These findings are similar to the findings of Matebie et al. (2025) and Sun et al. (2023). There was a significant variation among the treatments applied in term of number of leaves per plant at different stages of plant growth (Figure 2). The maximum numbers of leaves were recorded in cow dung combined with WHC (T3) treated plants at 30, 45, and 60 DAT followed by vermicompost combined WHC (T5) treated plants. This may be due to increase in the growth parameters which is attributed by increased meristematical activity of apical tissue, increased in photosynthetic activity and cell division in growth portion of the plant besides, increasing the uptake of nutrients. Similar findings are also reported by Akwukwaegbu et al. (2025).

Application of organic fertilizers in different concentration showed significant effect on chlorophyll and carotenoid content in leaf tissues of tomato plant. The highest chlorophyll a contain was obtained from cowdung combined with WHC treatment (1.783 mg/g fresh weight) revealed in Figure 3 which was almost similar with that of vermicompost combined with WHC (1.775 mg/g fresh weight) and chl b, and corotinoid also showed sane trend and recorded 0.5 mg/g fresh weight and 1.36 mg/g fresh weight respectively. An increase in leaf chlorophyll content is due to more rapid exchange of CO_2 into mesophyll cell by virtue of their large surface area (Rehman et al., 2021). Chlorophyll contain are usually increased of N contain (Gezahegn et al., 2024). Tibebe et al. (2025) reported a significant relationship between dry matter and N content. Similar finding were observed by Akwukwaegbu et al. (2025).

Data represented in Figure 4 revealed that the treatments of different organic fertilizers in different combination showed significant effect on the relative leaf water content (RLWC) of leaves. The highest amount of RLWC was found highest 87.22% in the treatment of WHC followed by cowdung combined with WHC treatment. Organic amendments release nutrients gradually, ensuring a continuous supply of essential elements throughout the crop growth period (Belay et al., 2025). This stable nutrient availability facilitates sustained cell expansion and photosynthetic activity, thereby supporting leaf water potential (Rehman et al., 2023).

Data represented in Table. 2 revealed that all the applied treatments increased number of fruits per plant over control. Application of organic fertilizers at different concentration showed significant effect on the number of fruits per plant of tomato plant. The maximum number of fruits per plant of tomato was obtained with T3 (cow dung + WHC) (76.55 nos) followed by vermicompost +WHC (74.50 nos). Treatment of organic manures in different concentration also showed significant effect on fruit diameter and economic yield of tomato. These results collectively suggest that the compost contributes to enhanced fruit nutritional value by improving soil health, facilitating nutrient uptake, and supporting plant metabolic functions (Belay et al., 2025). The maximum diameter of fruits per plant was obtained in T3 (cow dung + WHC) (5.1cm) followed by T2 (WHC). This may be due to increased supply of major plant nutrients. Nitrogen accelerates the development of growth and protein synthesis, thus promoting fruits diameter of tomato (Sun et al., 2023). Baheliya et al. (2024) reported that water hyacinth acts as a natural fertilizer factory, accumulating high levels of macronutrients Nitrogen (N), Phosphorus (P) and Potassium (K). after decomposition and these nutrients become readily available to plants. The highest yields of fruits per plants was recorded from cow dung combined with WHC (5.97kg) followed by vermicompost combined with WHC (74.50 kg). The probable reason for enhanced fruit yield may be due to increased vegetative growth which ultimately leads to more metabolic activities. Application of these manures increase nitrogen levels which enhance carbohydrate metabolism and leaf water content in plants (Dushimeyesu et al., 2024). Gao et al. (2023) and Li et al. (2023) revealed that the application of different level of organic fertilizers, and biofertilizers significantly increased the growth, yield and quality of tomato. The increased number of fruits per plant and the diameter increased the economic yield of the tomato. The data revealed in Table 2 that all the treatment effect shelf life of tomato. The maximum shelf life of fruit was observed with Cow dung combined with WHC (15.50 days) treatment followed by vermincompost combined WHC (13.40 days). This may be due to pericarp thickness. Similar findings are found by Hamad et al. (2022) and Hasan et al. (2020).

Materials and Methods

Materials and tools

Composting of water hyacinth is a natural decomposition process that converts organic materials into nutrient-rich humus. The process transforms huge volumes of plant material into a valuable organic fertilizer. The materials and tools used include 30 days old tomato seedlings, compost of water hyacinth, cow dung, vermicompost, pH meter, conductivity meter 306 (SYSTRONICS), Kjeldahl analyzer, flame photometer, UV-vis spectrophotometer.

Place and time

The experiment was conducted at the Department of Botany, University of science and technology, Meghalaya, India (26.1021ºN 91.8466ºE), during the period of October to February 2023 and 2024. The general climate of the area is wet and humid, experiences hot summer and moderately cold winters, interspersed with rainy months.

Experimental design
The experiment comprised of six treatments viz. T1: Cow dung, T2: Water hyacinth compost (WHC), T3: Cow dung combined with water hyacinth compost (WHC), T4: Vermicompost T5: Vermicompost combined with water hyacinth compost (WHC), T6 Control and laid out in randomized block design with six replications.

Conduction of the study
The water hyacinth weeds are collected and the compost were prepared (Figure 5). Tomato seedlings (cv. emerald) of 30 days old were transplanted. The recommended package of practices was followed for the cultivation of the crop. Application of organic fertilizer treatment was carried out, first at 15 Days after Transplanting (DAT) and second at 15 days after the first treatment. For compost analysis the samples were taken and air-dried, ground, and sieving with 2 mm sieve. The pH and EC were measured from the extraction of a 1:10 w/v ratio of compost to distilled water (Singh et al., 2012). Organic C (OC) was determined by the wet digestion method (Walldey and Black, 1934). Total N (TN) was determined in the Kjeldhal digestion method (Bremner and Mulvaney, 1982). Available P (Pav) was analyzed by employing the Bray II method (Bray and Kurtz, 1945). A flame photometer was used to examine the exchangeable K (Ex. K) after it was extracted using 1 mol l-1 NH_4OAc (pH 7).

Observed variables
Observations on vegetative growth, physiological and yield parameters of the experimental plants were recorded. The chlorophyll content in leaf was recorded by following the method of Arnon (1949). The Relative leaf Water Content (RLWC) was calculated followingthe formula of Barrs and Weatherley (1962).

Statistical analysis
Data recorded were analyzed statistically as suggested by Gomez and Gomez (1984). The experiments were conducted in triplicates and the result represents the mean± standard variation. One-way analysis of variance with the least significant difference (LSD) was performed to determine the significant differences.

Conclusions
This study demonstrates that water hyacinth compost is an effective and sustainable alternative to conventional organic fertilizers for tomato cultivation. Comparative evaluation revealed that the application of Water Hyacinth compost significantly improved plant growth and yield parameters,. Beyond tackling water hyacinth menace, composting unlocks its hidden potential for managing environmental waste. It is an approach for resolving diverse challenges by recycling of waste for environmental benefits ensuring food security. Local participation in the composting will bring additional income to the people.Water hyacinth composting can act as a nature-based solution to safeguard our water resources and restore soil health by managing the invasive aquatic weed into a valuable agricultural input. Overall, the findings confirm that water hyacinth compost can be recommended as a cost-effective, eco-friendly, and locally available organic fertilizer for crop production. Its adoption can reduce dependence on costly chemical fertilizers and traditional organic fertilizers, enhance sustainable crop production, and contribute to both improved soil health and effective weed management , particularly for resource-limited smallholder farmers in India.

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Conflict of interest: The authors declare that they have no conflict of interest.

Authors Contribution:
Milu Rani Das: research concept, research design, methodology, data collection, writing original draft; Nilam Sarma: Proofreading, revision of original draft, Data validation; Kaustuvmani Patowary: Writing, concept development, overall supervision

References
1. Akwukwaegbu RN, Stanley HO, Abu GO, Vincent-Akpu IF (2025) Comparative study on physicochemical composition of Eichhornia crassipes compost and bacterial isolates from forest soils as biofertilizing potentials in the Niger Delta, Nigeria. International Journal of Research Publication and Reviews 6(2):1537–1541.
2. Arnon DI (1949) Copper enzymes in isolated chloroplasts. Polyphenoloxidase in *Beta vulgaris*. Plant Physiol 24:1–15. http://dx.doi.org/10.1104/pp.24.1.1

3. Baheliya AK, Patel KK, Yadav V, Kumar D (2024) Harnessing the power of nature: composting water hyacinth as a solution to water pollution. Harit Dhara 7(1):20–23.
4. Barrs HD, Weatherley PE (1962) A re-examination of the relative turgidity techniques for estimating water deficits in leaves. Aust J Biol Sci 15:413–428. http://dx.doi.org/10.1071/BI9620413
5. Belay T, Tassie N, Tilahun G, Ejigu D, Girmay S, Seid A, Assefa WW, Wondie A, Kassa Y, Fetene B, Mengistu D (2025) Effect of water hyacinth (*Pontederia crassipes*) vermicompost on tomato (*Solanum lycopersicum* L.) growth and yield in the vicinity of Lake Tana, Northwest Ethiopia. Discover Food 5:362. https://doi.org/10.1007/s44187-025-00675-1
6. Bremner JM, Mulvaney CS (1982) Nitrogen-total. In: Page AL, Miller RH, Keeney DR (eds) Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. American Society of Agronomy, Soil Science Society of America, Madison, Wisconsin, pp 595–624.
7. Bray RH, Kurtz LT (1945) Determination of total organic and available forms of phosphorus in soils. Soil Science 59:39–45. http://dx.doi.org/10.1097/00010694-194501000-00006
8. Canning A (2025) A review on harnessing the invasive water hyacinth (*Eichhornia crassipes*) for use as an agricultural soil amendment. Land 14(5):1116.
9. Dushimeyesu E, Habimana S, Munyandamutsa F, Rugwiro P, Mubashankwaya I, Nyiransabimana D (2024) The effect of water hyacinth (*Eichhornia crassipes*) organic fertilizer on the vegetative growth of carrot (*Daucus carota*), Royal Chantenay variety. Turk J Agric - Food Sci Technol 12(2):268–273.
10. Gao F, Li H, Mu X, Gao H, Zhang Y, Li R, Cao K, Ye L (2023) Effects of organic fertilizer application on tomato yield and quality: A meta-analysis. Appl Sci. 13(4):2184.
11. Gezahegn A, Selassie YG, Agegnehu G, Addisu S, Mihretie FA, Kohira Y, Lewoyehu M, Sato S (2024) Sustainable weed management and soil enrichment with water hyacinth composting and mineral fertilizer integration. Environ Chall 16:101007.
12. Gomez KA, Gomez AA (1984) Statistical Procedures for Agricultural Research. 2nd edn. John Wiley and Sons, New York, 680 p.
13. Hamad SA, Shaman SA, Mohammed AA, Asmawi AEA (2022) Effects of organic and inorganic fertilizers on growth and yield of tomato (*Solanum lycopersicum* L). Al-Azhar J Agric Res 47(1):191–205.
14. Hasan S, Uddin MN, Karim R (2020) Assessment of heavy metal contamination in water and aquatic plants of the Buriganga River, Bangladesh. Environ Sci Pollut Res 27(11):12345–12355. https://doi.org/10.1007/s11356-020-12345-6
15. Hossain ME, Shahrukh S, Hossain SA (2022) Chemical fertilizers and pesticides: impacts on soil degradation, groundwater, and human health in Bangladesh. In: Singh VP, Yadav S, Yadav KK, Yadava RN (ed) Environmental degradation: challenges and strategies for mitigation, Water Science and Technology Library, vol 104. Springer, Cham.
16. Li F, Yuan Y, Shimizu N, Magaña J, Gong P, Na R (2023) Impact of organic fertilization by the digestate from by-product on growth, yield and fruit quality of tomato (*Solanum lycopersicon*) and soil properties under greenhouse and field conditions. Chem Biol Technol Agric 10(1):70.
17. Matebie M, Yayeh B, Yihenew G. Selassie, Ashenafei G, Solomon A, Shinjiro S (2025) Synergistic effects of water hyacinth compost and blended mineral fertilizers on key soil properties and bread wheat yield. J Sustain Agric Environ 4:e70054. https://doi.org/10.1002/sae2.70054
18. Rasool S, Ahmad I, Jamal A, Saeed MF., Zakir A, Abbas G, Seleiman MF, Caballero-Calvo, A (2023) Evaluation of phytoremediation potential of an aquatic macrophyte (*Eichhornia crassipes*) in wastewater treatment. Sustainability 15(15):11533.
19. Rehman M, Jyoti SY, Pradhan AK, Regon P, Tanti B (2021) Characterization of boro rice (Oryza sativa L.) varieties of Assam (India) based on their morphological traits. Int J Bot Stud 6(5):1051–1062.
20. Rehman M, Kundu B, Regon P, Tanti B (2023) Biochemical and molecular properties of boro rice (*Oryza sativa* L.) cultivars under abiotic stresses. 3 Biotech 13(12):422.
21. Serafini LF, Arrobas M, Rodrigues MÂ, Feliciano M, Miguens F, Oliveira V, Santos D, Tuesta JL, Gonçalves A (2025) The composting of water hyacinth: A life cycle assessment perspective. Waste Biomass Valor 16(1):507-23.
22. Singh WR, Das A, Kalamdhad A (2012) Composting of water hyacinth using a pilot scale rotary drum composter. Environ Eng Res 17(2):69–75. https://doi.org/10.4491/eer.2012.17.2.069
23. Sun J, Jin L, Li R, Meng X, Jin N, Wang S, Xu Z, Liu Z, Lyu J, Yu J (2023) Effects of different forms and proportions of nitrogen on the growth, photosynthetic characteristics, and carbon and nitrogen metabolism in tomato. Plants 12(24):4175.
24. Tibebe D, Kehali J, Kassa Y, Fentie T, Biru B, Hailu Sheferaw A, Assefa F, Aregahagne S, Moges Z, Ayele S (2025) Evaluating the nutrient content and heavy metal safety of water hyacinth-based compost: a sustainable solution for chemical fertilizer reduction and nutrient recycling in agriculture. Sci Afr 30:e02985. https://doi.org/10.1016/j.sciaf.2025.e02985
25. Walldey AJ, Black IA (1934) Estimation of soil organic carbon by the chromic acid titration method. Soil Sci. 37, 29-38.

Tables

Table1. Chemical properties of water hyacinth compost

Compost parameters	**Values**
pH	7.1
EC (dS m-1)	2.45
OC(%)	8.02
TN(%)	0.96
Pav (mg kg-1	256.5
Ex. K (cmol(+) kg-1)	9.85

* Values are means of triplicate samples (n =3); OC: organic carbon; TN: total nitrogen; Pav: available phosphorus; Ex. K: exchangeable potassium.

Table 2: Effect of different organic fertilizer on fruits diameter, weight, fruits per plant, yields per plants and shelf life.

Treatments	**Fruit Diameter (Cm)**	**Fruit Weight (G)**	**Fruit Number Per Plants (Nos)**	**Yield Per Plant (Kg)**	**Shelf Life (Days)**
Cow dung	4.46± 0.258	68.25±1.494	70.16±1.747	4.78±0.269	12.66±0.835
Water hyacinth	4.76±0.296	72.33±1.154	72.66±2.37	5.25±0.07	12.75±0.598
Cow dung + water hyacinth	5.06±0.357	75.75±1.467	76.55±1.167	5.97±0.190	15.50±0.502
Vermico mpost	4.56±0.358	71.50±1.667	71.83±1.445	5.13±0.13	11.25±0.509
Vermico mpost + water hyacinth	4.93±0.342	73.33±1.434	74.50±1.679	5.46±0.06	13.40±0.556
Control	4.16±0.304	64.66±1.785	65.33±1.220578	4.22±0.297	8.33±0.606

Values are expressed as mean ±SD (n= 3)

Figures

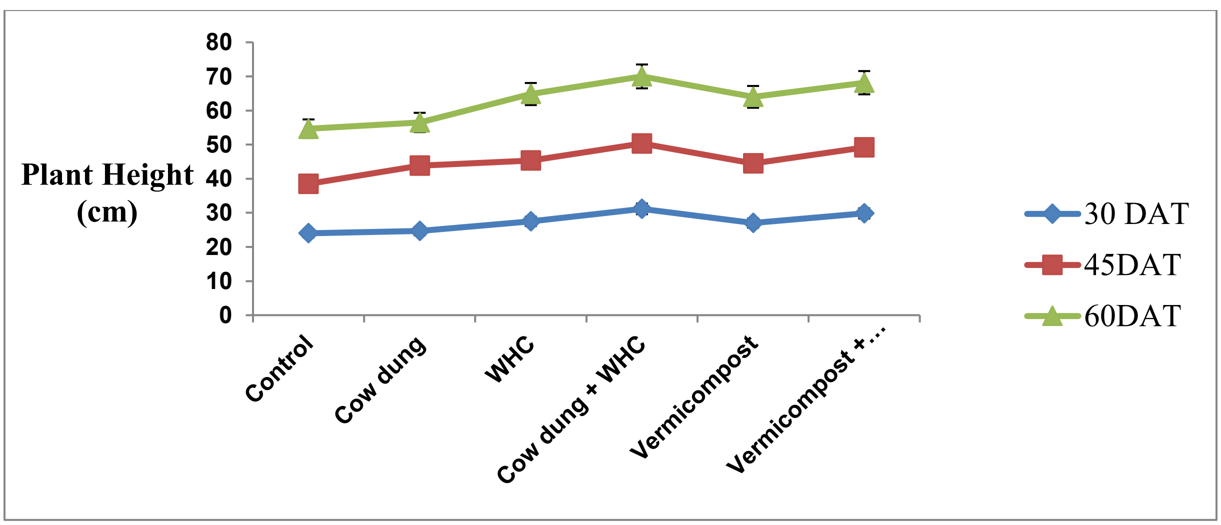

Figure 1. Effect of different organic fertilizer on the plant height of tomato at different days after transplantation. Values represent mean ± standard deviation (n = 3).

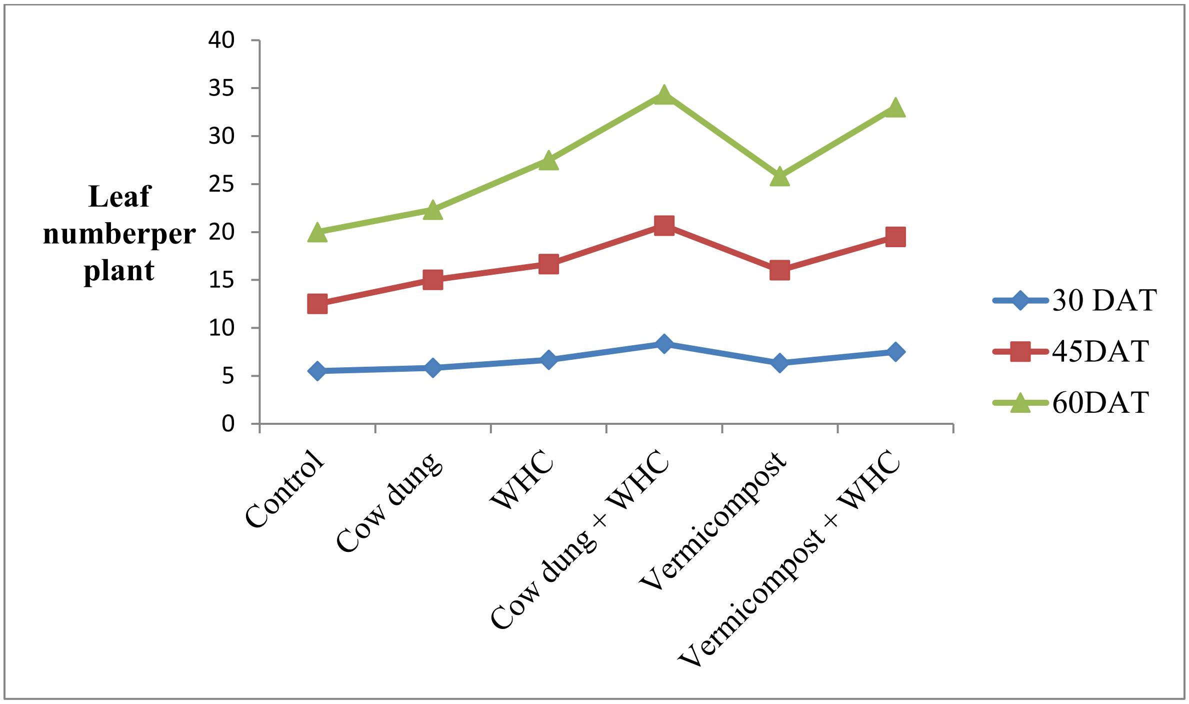

Figure 2. Effect of different organic fertilizer on leaf number per plantg of tomato at different days after transplantation. Values represent mean ± standard deviation (n = 3).

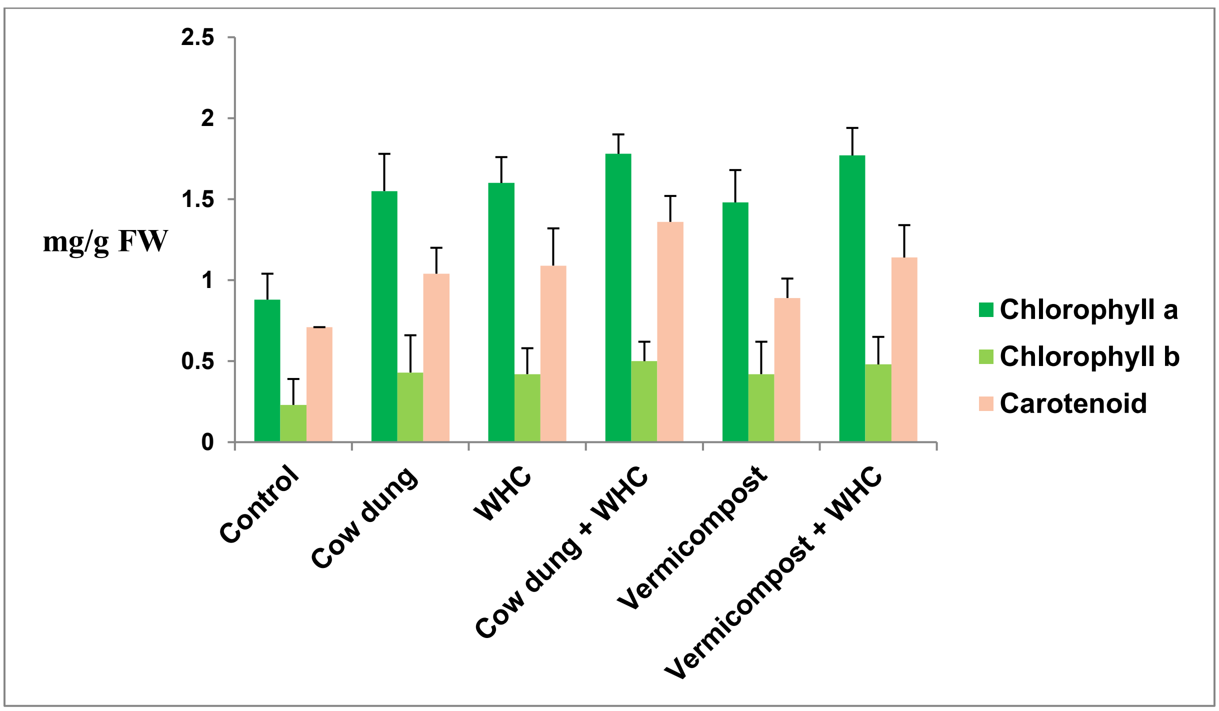

Figure 3. Effect of different organic fertilizer on chlorophyll a, Chlorophyll b and carotinoid content of leaves of tomato at vegetative stage. Values represent mean ± standard deviation (n = 3).

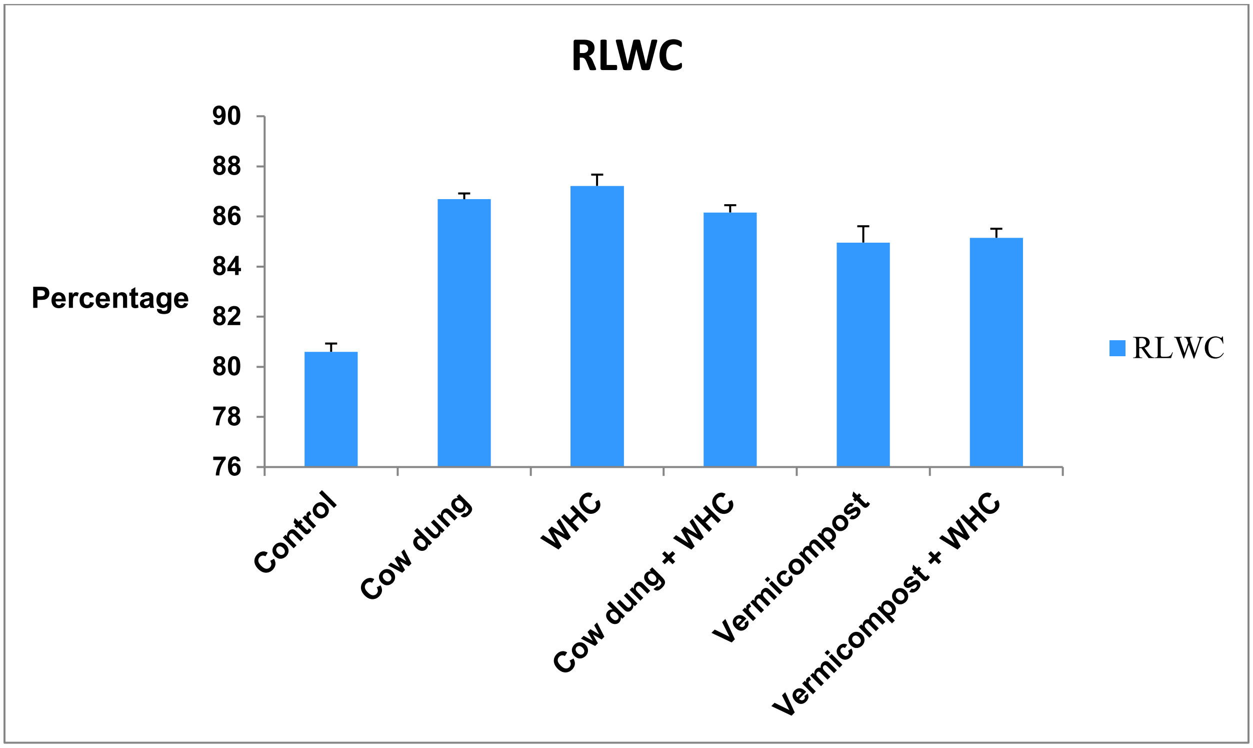

Figure 4. Effect of different organic fertilizer on Relative leaf water content (RLWC) of leaves of tomato at vegetative stage. Values represent mean ± standard deviation (n = 3).

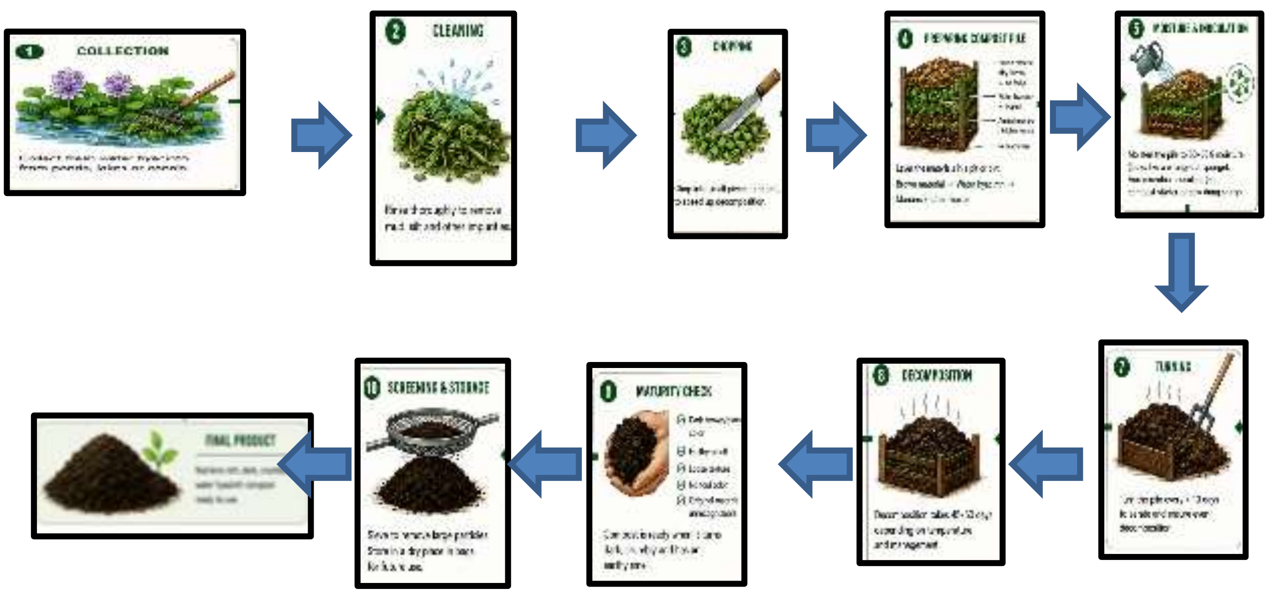

Figure 5. The process of making water hyacinth compost