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RESEARCH ARTICLE

Utilization of urban waste as liquid organic fertilizer for vegetable crops in urban farming system

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Abstract

Converting vegetable, fruit, food, fish offal and slaughterhouse waste that become a problem for the community in the urban areas into useful plant fertilizer is the solution. This study aims to determine (1) the potential of urban organic waste into liquid organic fertilizer and (2) the effectiveness of liquid organic fertilizer (LOF) in increasing the growth and yield of vegetable crops in urban farming systems. The study used Randomized Block Design (RBD) with some treatments P0 (control) and P1 (LOF with 6 types of waste) consisting of P2 (vegetable waste), P3 (fruit waste), P4 (sprouts waste), P5 (food waste), P6 (catfish waste) and P7 (blood waste). The treatment was repeated 3 times for a total of 28 experimental units. The three vegetable plants; eggplant, Bok Choy and mustard, were used in the experiment. The study found that liquid organic fertilizers from vegetables, fruit, sprout, food, fish, blood waste and mixed waste all contain organic matter, varying amounts of nitrogen (N), phosphorus (P), potassium (K), carbon (C), magnesium (Mg), calcium (Ca), copper (Cu), zinc (Zn), iron (Fe) and humic acid. All liquid organic fertilizer treatments increased eggplant and Bok Choy vegetable growth and yield; however, the type of organic waste used as a raw material for LOF did not affect growth but eggplant and Bok Choy yield. LOF from blood waste (P7) and fish waste (P6) has higher measured nutrients and yield from eggplant, Bok Choy and mustard vegetables than other treatments .

Keywords

Liquid organic fertilizer, urban organic waste, urban agriculture, eggplant, bok choy, mustard

Introduction

Urban organic solid waste has the potential to be converted into organic fertilizer to prevent accumulation in landfills and reduce the environmental impact of gas and leachate formation (1). Recycling urban organic waste into organic fertilizer for urban crops proves nutrient circulation for sustainable food production (2). Composting organic waste, rich in essential nutrients for plant growth and health, can produce liquid organic fertilizer (3). Organic waste is no longer a burden but has economic value that can generate additional income for the community (4). Utilizing urban organic waste as a growing medium for vegetables in rooftop farming systems results in a higher yield than farming on land (5). Urban organic waste is processed into biogas fuel, electrical energy, black soldier fly (BSF) larvae and compost, all of which have enormous economic value and must be accounted for when making decisions or formulating urban waste management policies to ensure sustainable urban sanitation and public health (6, 7).

Fertilizers are the best choice in resolving the negative impact of chemical fertilizers (inorganic fertilizers) on plants and soil fertility (8). Organic fertilizers provide macro and micro nutrients and a series of plant growth-stimulating substances (9). The advantages of using organic fertilizers include enhancing soil structure, texture, aeration, water retention and root development at a low cost (10). Using organic waste as plant fertilizer can increase soil fertility, nourish the soil, store water and contain large amounts of organic matter to increase crop yields (11). Compost and liquid organic fertilizer will help maintain soil properties and produce organic food crops without side effects (12).

Liquid organic fertilizer is a solution containing one or more plant nutrients. The advantages of liquid organic fertilizer are that it provides nutrients based on plant needs and can be applied more evenly with concentrations that can be adjusted based on plant needs. (13, 14). The application of liquid organic fertilizer increases macro and micronutrient absorption, influences the carbohydrate content of the leaves, and increases the soil's organic matter content. Liquid organic fertilizer can be used instead of mineral fertilizer on citrus plants with drip irrigation (15). Due to its high nutrient content, liquid organic fertilizer can be used as an additional fertilizer to increase plant growth and health (16). Liquid fertilizer from vegetable food residues can be used as an alternative to synthetic fertilizers to increase crop yields and soil physical properties while lowering the environmental impact of synthetic fertilizers (17). Using liquid organic fertilizer from the weed Alternanthera philoxeroides at concentrations of 10, 15 and 20% can increase maize growth and yield (18).

Urban agriculture can provide fresh food, create jobs, recycle urban waste and support urban resilience to climate change (19). Collaboration between stakeholders along the urban organic waste management chain is essential for developing urban agriculture to create public awareness of the advantages of composting and finding solutions to the problems for producers and users of compost for urban agriculture (11). The city governments need to formulate policies that integrate stakeholders in supporting urban agriculture through training on managing and recycling waste organic matter, the availability of production inputs and water and plant seeds for urban agriculture (20). Recycling waste into organic fertilizer for the development of urban farming will become a green business model and a new opportunity for the people of Surabaya (21). Urban farmers can increase productivity by applying organic fertilizers from urban waste and will ensure the sustainability of urban agriculture (22).

The development of urban agriculture (urban farming), which has the potential to provide fresh food for urban residents, must be synchronized with the management of urban organic waste into an integrated programme for developing urban organic agriculture. The research on the application of LOF from urban waste to vegetable crops in urban farming systems aims to (1) provide an alternative method of recycling urban organic waste into organic fertilizer for urban agriculture, (2) determine the potential of each organic waste into LOF, (3) determine the effectiveness of LOF from various types of waste in increasing the growth and yield of vegetable crops in urban farming systems (4) develop a technique for making POC from urban organic waste and (5) develop a technique for mass production of LOF from urban organic waste .

Materials and Methods

The study was conducted in 2021 at the Laboratory of agriculture faculty at Wijaya Kusuma University in Surabaya. The experiment was conducted in 2 stages: making LOF from urban organic waste, and applying them to 2 types of vegetable crops; Bok Choy and eggplant.

Preparing liquid organic fertilizer (LOF)

Organic substrates used in the production of LOF are vegetable waste (limited to Familia Cruciferae), fruit waste (limited to overripe bananas and papayas) and sprout waste (very long sprouts) from market waste, food waste (catering waste) from the wedding ceremony, catfish waste (offal) from the market and cow blood from slaughterhouses. Other materials needed to make LOF include Effective Microorganisms 4 (EM4) liquid as a starter, sugar, bran, coconut water and well water (distilled water).

The stages of making LOF are as follows: (a) Activate the starter by mixing 400 ml of em4 liquid, 400 g of granulated sugar and 4 liters of well water, stirring until the sugar dissolves then put in a small jerry can and incubate for 3-5 days. (b) Make hole with 1 cm diameter in the drum cover (where LOF is made) and attach small hose to remove the fermented air. (c) Cut raw material/ substrate into 3-5 cm pieces as smooth as possible by chopping or blending. (d) Put the refined raw material/substrate of 6 kg into the drum (lof in 30 liters), along with 1500 cc of coconut water, 1 kg of bran, incubated starter solution and 15 liters of well water (distilled water). The mixture of ingredients is stirred until evenly distributed; (e) A white hose is attached to the top of the perforated drum and the other end is placed into a plastic bottle filled with 1.5 liters of water. (f) The drum is tightly closed, the hose on the drum must not reach the mixture of materials, while the other end of the hose on the plastic bottle must be immersed in water (g). For 4 weeks, the drum's cap is opened, the mixtures are stirred as necessary to observe physical condition, color, smell, temperature and ph, then closed. (h) 4 weeks after the cap is opened, the physical condition, color, smell, temperature and pH are observed and the liquid was filtered: first through a coarse filter and second through a cloth filter (fine filter). (i) Finished LOF are byproduct of the filtering process, and stored in large jerry cans that are categorized and labelled based on the raw materials used. (j) A sample of 250 mL is taken to measure the levels of the macronutrients: n, p, k, c-organic as well as the micronutrients: mg, ca, cu, zn, fe, humic acid.

LOF chemical analysis

The nutrient content of 7 LOF formulas was analyzed. The Kjeldahl method was used to analyze the total nitrogen content. The Vandomolybdate method was used to analyze the phosphorus content. While, The AAS (atomic absorption spectrophotometry) method was used to analyze the potassium, calcium, magnesium, iron, zinc, manganese and copper contents (23, 24).

Applying LOF to Vegetables

LOF urban waste was used to fertilize several vegetable crops, including mustard greens, Bok Choy and eggplant. A nonfactorial Randomized Block Design was used to conduct the experiment (RBD). P0 (without LOF), P1 (LOF from a mixture of 6 types of waste), P2 (LOF from vegetable waste), P3 (LOF from fruit waste), P4 (LOF from sprout waste), P5 (LOF from food waste), P6 (LOF from catfish waste) and P7 (given LOF from blood waste) were tested in this experiment. Each treatment was repeated 3 times, for a total of 28 experimental units. Spraying LOF with a concentration of 4% or 40 cc/liter of solution on the plants is done during the day when the plants are not wet, and it is ensured that there is no rain after spraying.

The experimental procedure is conducted as follows:

a) planting media using top soil from Mojosari, Mojokerto Regency

b) The loosened soil media is placed in polybags to fill up to 2/3 of the volume of the polybags. The eggplant polybag size is 50 x 50 cm, while the mustard greens and Bok Choy polybag size is 40 x 40 cm.

c) The media-filled polybags are then arranged in lanes as many as experimental repetitions and rows as many as experimental treatments. For eggplant, the distance between polybags is 100 cm between lanes and 50 cm between rows, while for mustard and Bok choy plants is 75 cm between lanes and 40 cm between rows.

d) Polybags are used to grow eggplant, mustard greens and Bok choy as well as to protect them from rain and direct sunlight.

e) When the seeds are 2 weeks old, they are moved to place that that get direct sunlight.

f) After 3 weeks or when the seedlings have three leaves, they are moved to experimental polybags. The selected seeds must be good, fresh, upright and free from pests and diseases

g) Treatment includes clearing weeds in polybags or on the land around the polybags, irrigation based on plant needs, weeding and pest and disease control.

h) LOF is applied by evenly spraying it on the plant leaves during the day when the leaves are not wet and predicted that it will not rain a few hours.

i) The 40 days old Mustard and bok choy plants are harvested by cutting off the plant parts above the ground, then weighing them to get data on the residual weight, then taking the edible parts and weighing them to get data on consumption weight

j) Eggplants are harvested by picking edible fruit based on consumption criteria in twice a week for 7 weeks (14 harvests). Then, the data is gathered based on the weight and number of fruits from 14 harvests. The longest fruit from each harvest is measured and averaged over 14 harvests.

k) The number of leaves and plant height are growth variables, while harvest weight, consumption weight and other plant-specific parameters are yield variables.

Statistical analysis

Data on eggplant and Bok choy vegetable growth and production are statistically analyzed using analysis of variance (ANOVA). If the F test results show a significant treatment variance, the multiple comparison test is conducted using the Least Significant Difference (LSD) Test of 5% to find the average value of the significantly different treatments. Microsoft Excel 2010 is used to calculate the analysis of variance and (LSD) Test .

Results

Chemical analysis showed that organic matter (OM), nitrogen (N), phosphorus (P), potassium (K), organic carbon (C), magnesium (Mg), calcium (Ca), copper (Cu), zinc (Zn), iron (Fe) and humic acid were found in the eleven tested materials (although at different levels). The Kjeldahl method of total-N analysis showed that the lowest score of LOF of fruit waste was 0.03%, while the highest score LOF of sprout waste and catering waste was 0.08%. The Spectronic method on P2O5 content showed that LOF of blood waste had the lowest score of 0.04% and LOF of fruit waste and sprout waste had the highest score of 0.09%. The AAS method showed that the lowest score (0.31%) in fruit waste and the highest score (0.82%) in sprout waste for K2O. Humic acid levels in the mixed waste LOF ranged from 3.82 ppm to 7.32 ppm in

Table 1. Data on plant nutrient content in LOF with various types of organic wastes as raw materials

No	Variables/ ingredients in LOF	Raw materials for LOF						
		Mixed waste P1	Vegetable waste P2	Fruit waste P3	Sprout waste P4	Food waste (catering) P5	Fish waste P6	Slaughter house Waste P7
1	BO (%)	20.34	20.81	21.05	17.98	22.15	21.10	19.88
2	N (%)	0.06	0.04	0.03	0.08	0.08	0.05	0.07
3	P(%)	0.06	0.08	0.09	0.09	0.06	0.08	0.04
4	K (%)	0.51	0.80	0.31	0.82	0.50	0.63	0.70
5	C organic (%)	0.85	0.98	1.22	0.79	1.08	0.81	0.98
6	Mg (ppm)	4.01	2.86	3.02	3.08	2.26	4.12	3.88
7	Ca (ppm)	6.11	2.52	3.02	3.18	2.26	10.41	11.80
8	Cu (ppm)	0.86	0.69	0.65	0.52	0.56	0.78	0.82
9	Zn (ppm)	2.90	3.81	3.14	2.83	2.93	3.16	3.11
10	Fe (ppm)	0.15	0.12	0.11	0.05	0.08	0.07	0.13
11	Humic acid (ppm)	3.85	5.22	6.05	4.12	4.95	7.32	6.50

Note: The numerical value in a column followed by the same letter is not significantly different based on the 5% LSD test. NS= not significant.

LOF of fish waste. Table 1 shows data on 11 components in 7 different types of LOFs.

Mustard Plant Growth and Production

Plant length measurements used plant length indicators and number of leaves on plants aged 35 days from planting. Table 2 shows data on plant length and the number of mustard leaves. The application of LOF from urban organic waste significantly increased the length of the mustard plant. Plant length in the control treatment (19.93 cm) was significantly different from plant length in the LOF treatments of fish waste (26.17 cm), mixed waste (25.36 cm) and sprout waste (24.94 cm). Applying s LOF urban waste had no effect on the number of leaves of mustard plants aged 35 days, but the lowest score was in the control (7.67), while the highest score was in the application of LOF from fish waste (9.89) and the administration of LOF waste sprouts (9.33) and blood waste (9.11). Table 1 shows the growth of mustard plants in all liquid organic fertilizer. treatments based on variable plant length and number of leaves.

Table 2. Data on the length and number of leaves of mustard in 35 days with liquid organic fertilizer from various types of urban organic waste.

Treatment	Plant length	Number of leaves
Control	19.93±4.11 cd	7.67±3.22
P_1 (LOF from mixed waste)	25.36±6.77 ab	9.00±2.56
P_2 (LOF from vegetable waste)	19.80±5.11 cd	8.89±2.89
P_3 (LOF from fruit waste)	21.21±4.21 bcd	8.22±1.98
P_4 (LOF from sprout waste)	24.94±3.89 ab	9.33±2.67
P_5 (LOF from catering waste)	19.24±4.33 d	9.22±2.87
P_6 (LOF from fish waste)	26.17±3.23 a	9.89±3.65
P_7 (LOF from blood waste)	23.86±2.35 abc	9.11±2.78
LSD 5 %	4,26	TN

Note: The numerical value in a column followed by the same letter is not significantly different based on the 5% LSD test. NS= not significant.

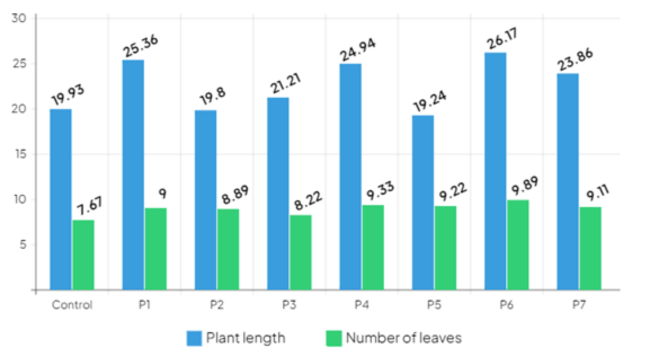

Fig. 1. The growth of mustard in 35 days with the application of liquid organic fertilizer from various types of urban organic waste.

Plant length, number of leaves, residual weight and consumption weight were used to measure mustard production. Mustard plants were harvested 40 days after they were planted. Table 3 shows the complete data on the variable production of mustard greens. The number of leaves and length of the mustard plant were not affected by LOF application, but had a significant effect on residual weight and consumption weight variables. The residual weight was found to be lowest in the control treatment (41.00 g) and highest in the LOF treatment of blood waste (109.67 g). The control treatment had the lowest con-

Table 3. Data of mustard plants Production fed liquid organic fertilizer from various types of urban organic waste .

Treatment	Plant length (cm)	Number of leaves	Residual weight (gr)	Consumption weight (gr)
Control	8.53±6.98	9.33±3.76	41.00±5.12 b	32.33±4.03 b
P_1 (LOF from mixed waste)	0.33±6.07	10.78±2.87	74.67±9.34 ab	57.33±7.23 ab
P_2 (LOF from vegetable waste)	6.74±5.89	9.67±3.03	62.33±7.88 b	46.33±5.86 b
P_3 (LOF from fruit waste)	6.52±5.64	10.00±2.11	55.67±6.54 b	47.67±5.66 b
P_4 (LOF from sprout waste)	2.60±7.11	10.22±3.88	74.33±9.36 ab	61.33±6.53 ab
P_5 (LOF from catering waste)	3.96±5.99	10.00±4.02	40.33±5.64 b	32.67±2.67 b
P_6 (LOF from fish waste)	2.49±7.33	10.89±4.65	74.67±8.22 ab	60.33±5.12 ab
P_7 (LOF from blood waste)	9.44±7.39	10.78±3.98	109.67±10.76 a	85.33±9.55 a
LSD 5 %	TN	TN	40,99	30,24

Note: The numerical value in a column followed by the same letter is not significantly different based on the 5% LSD test. NS= not significant.

sumption weight (32.33 g), which was significantly different from the LOF treatment from blood waste (85.33

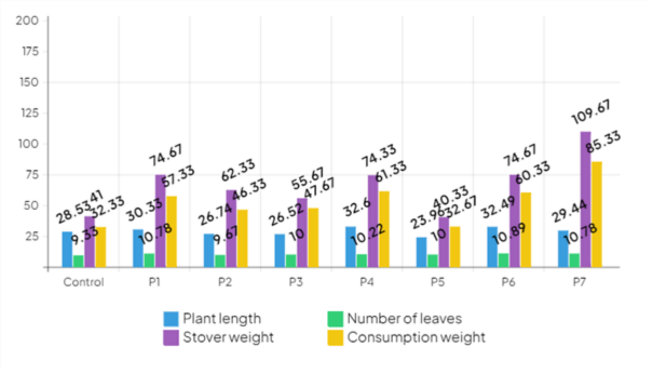

Fig. 2. Yield of mustard fed with liquid organic fertilizer from various types of urban organic waste.

g). Fig. 2 shows an overview of mustard crop yields based on variable plant length, number of leaves, residual weight and consumption weight in all liquid organic fertilizer treatments.

Bok Choy growth and yield

Plant length and number of leaves were used as indicators of Bok choy plant growth 35 days after planting. Length and number of Bok choy leaves are shown in Table 4. Plant length was significantly affected by the use of LOF from urban organic waste, with the control treatment having the lowest value (19.67 cm) compared to the LOF treatment from the waste mixture (23.39 cm) and vegetable waste treatment (40.67 cm) (22.33 cm). The number of leaves on 35-day-old Bok choy plants was not significantly affected by LOF in urban waste, but it was highest in the LOF treatment made from mixture of waste (19.44), fruit waste (19.33) and blood waste (19.33). (19.33). (19, 22). Fig. 3 shows an overview of Bok

Table 4. Data on plant length and number of leaves of bok choy plants

Treatment	Plant length (cm)	Number of leaves
Control	19.67±2.33 c	17.33±6.88
P_1 (LOF from mixed waste)	23.39±3.54 a	19.44±8.64
P_2 (LOF from vegetable waste)	22.33±3.56 ab	17.89±6.82
P_3 (LOF from fruit waste)	20.06±2.34 c	19.33±8.45
P_4 (LOF from sprout waste)	20.50±3.86 b	16.89±7.61
P_5 (LOF from catering waste)	20.00±3.65 c	15.78±6.39
P_6 (LOF from fish waste)	21.67±1.23 abc	17.89±5.44
P_7 (LOF from blood waste)	21.39±2.17 abc	19.22±6.98
LSD 5 %	2,22	NS

Note: The numerical value in a column followed by the same letter is not significantly different based on the 5% LSD test. NS= not significant.

choy plant growth based on variable plant length and number of leaves of liquid organic fertilizer.

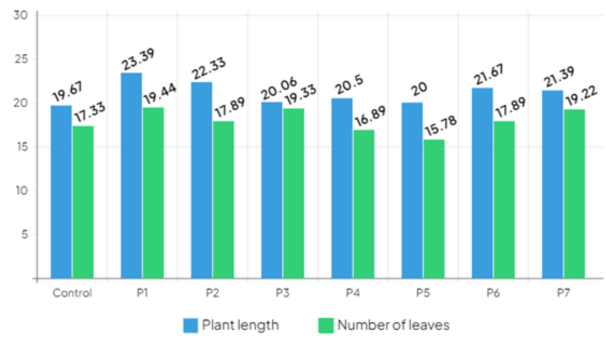

Fig. 3. The growth of Bok choy in 35 days with the application of liquid organic fertilizer from various types of urban organic waste.

Bok choy plants are harvested 40 days after planting. The yield of bok choy plants is measured using plant length variables, number of leaves, residual weight and consumption weight. The use of LOF had a significant effect on the number of leaves, residual weight and consumption weight at harvest. The control treatment had the fewest leaves (15.00), compared to the other treatments that had more than 20 leaves. The control treatment produced the least amount of residue (112.33 g), while the LOF treatment produced the most (231.67 g), followed by fish waste (244.33 g), blood waste (236.00 g) and vegetable waste (236.00 g) (188 g). The control treatment had the lowest consumption weight (99.67 g), which was significantly lower than the LOF treatment from a waste mixture (210.56 g), fish waste (223.89 g) and blood waste (223.89 g) (198.00 g). Table 5 provides all of the data on the variable yield of bok choy. Fig. 4 shows bok choy plant yields for all liquid organic fertilizer treatments based on variable plant length, number of leaves, residual weight and consumption weight.

Eggplant growth and yield

The growth of eggplant plants is unaffected by LOF treatment of various types of urban organic waste. Table 6 shows data on the plant height and number of leaves of eggplant plants 35 days after planting. Quantitative data on plant height show that the control treatment has the lowest value (45.33 cm), while the LOF treatment from mixed waste (50.28 cm) and vegetable waste (50.61 cm) has the highest value when compared to other treatments. Quantitative data on the number of leaves shows that the control treatment (21.67) has the lowest value, and the LOF treatment of the waste mixture (28.89) has the highest value compared to the other treatments. Fig. 5 shows an overview of eggplant plant growth in all liquid organic fertilizer treatments based on variable plant height and number of leaves.

Table 5. Data on the yield of bok choy plants fed with liquid organic fertilizer from various types of urban organic waste.

Treatment	Plant length (cm)	Number of leaves	Residual weight (gr)	Consumption weight (gr)
Control	19.83±3.76	15.00±1.72b	112.33± 6.86 c	99.67± 9.66 c
P_1 (LOF from mixed waste)	24.78±4.23	22.67±3.11 a	231.67±11.87 a	210.56±14.33 a
P_2 (LOF from vegetable waste)	22.44±3.98	23.67±2.76 a	188.56± 6.96 a	168.89± 9.11 ab
P_3 (LOF from fruit waste)	21.39±2.78	23.33±2.47 a	150.67± 5.82 bc	135.33± 8.53 bc
P_4 (LOF from sprout waste)	21.89±4.04	16.33±1.98b	194.33± 7.56 ab	174.67± 7.66 ab
P_5 (LOF from catering waste)	21.50±3.77	24.33±3.22 a	132.11± 6.41 bc	118.78± 5.97 bc
P_6 (LOF from fish waste)	23.44±2.87	23.33±2.74 a	244.33±12.45 a	223.89±12.86 a
P_7 (LOF from blood waste)	24.44±4.12	25.00±3.02 a	236.00±10.88 a	198.00±12.77 a
LSD 5 %	TN	4.50	63.03	60.90

Note: The numerical value in a column followed by the same letter is not significantly different based on the 5% LSD test. NS= not significant.

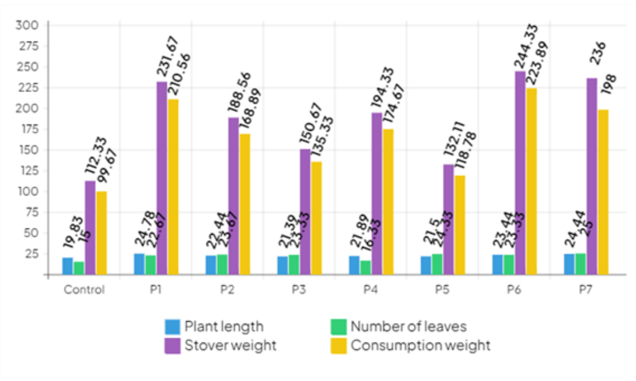

Fig. 4. Yield of bok choy fed with liquid organic fertilizer from various types of urban organic waste.

Using LOF of urban organic waste could increase the yield of bok choy. Research (19) concluded that giving LOF from cow urine 3 times a week could significantly increase the number of leaves, chlorophyll content and harvest weight of bok choy plants.

Table 6. Data on growth of eggplant fed with liquid organic fertilizer from various types of urban organic waste.

Treatment	**Plant height (cm) in 35 days**	**Number of leaves in 35 days**
Control	45.33± 9.86	21.67±6.11
P_1 (LOF from mixed waste)	50.28± 8.33	28.89±5.34
P_2 (LOF from vegetable waste)	50.61±11.67	26.67±5.57
P_3 (LOF from fruit waste)	47.78±12.76	23.67±8.33
P_4 (LOF from sprout waste)	50.00± 9.71	25.22±7.32
P_5 (LOF from catering waste)	48.39± 8.67	22.44±5.34
P_6 (LOF from fish waste)	48.50± 9.65	26.11±4.94
P_7 (LOF from blood waste)	44.33± 7.43	24.22±5.95
LSD 5 %	TN	TN

Note: The numerical value in a column followed by the same letter is not significantly different based on the 5% LSD test. NS= not significant.

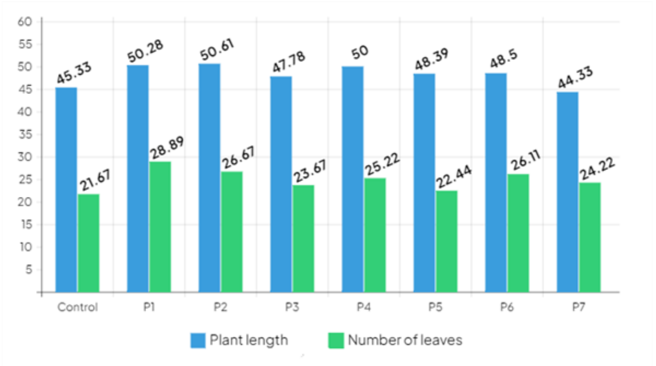

Fig. 5. The growth of eggplants in 35 days after using liquid organic fertilizer from various types of urban organic waste.

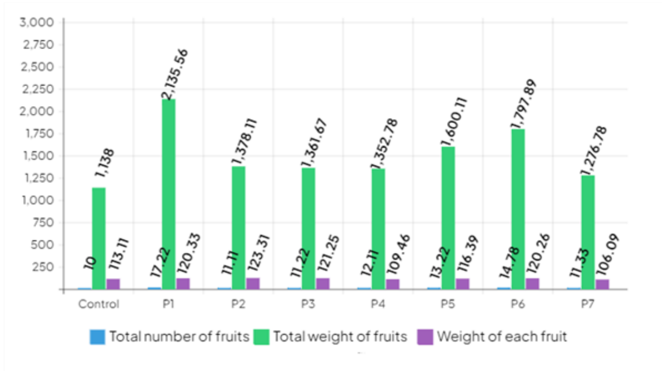

Fig. 6. Yield of eggplant fed with liquid organic fertilizer from various types of urban organic waste.

Eggplant is harvested 70 days after planting and continues twice a week until the plants are 120 days old. The treatment of various types of urban organic waste with LOF significantly effected eggplant crop yields. Table 7 shows data for 14 harvests on the number of fruits, fruit weight, and weight per eggplant. The use of LOF from urban organic waste increase eggplant yields significantly. When compared to the control treatment, plants given LOF from a mixture of waste (17.22 pieces) and fish waste (14.78 pieces) significantly produce more fruits (10.00 pieces). The group applied the LOF from a mixture of waste (2,135.56 g) and fish waste has the highest value in the fruit weight parameter (1,797.89 g). The weight parameter per fruit is not significantly different between treatments, meaning that the fruit size is nearly identical. Fig. 6 shows an overview of eggplant crop yields based on the number of fruits, total weight of fruits and weight per fruit in all liquid organic fertilizer treatments.

Table 7. Data on eggplant yields fed with liquid organic fertilizer from various types of urban organic waste

Treatment	Total number of fruits	Total weight of fruits (g)	Weight of each fruit (g)
Control	10.00±0.98 c	1,138.00±55.33 c	113.11±6.66
P_1 (LOF from mixed waste)	17.22±2.33 a	2,135.56±34.33 a	120.33±7.43
P_2 (LOF from vegetable waste)	11.11±1.87 bc	1,378.11±25.37 bc	123.31±9.43
P_3 (LOF from fruit waste)	11.22±0.86 bc	1,361.67±41.79 bc	121.25±6.98
P_4 (LOF from sprout waste)	12.11±1.87 bc	1,352.78±39.88 bc	109.46±11.83
P_5 (LOF from catering waste)	13.22±2.03 abc	1,600.11±51.88 abc	116.39±12.45
P_6 (LOF from fish waste)	14.78±1.43 ab	1,797.89±32.78 ab	120.26±8.32
P_7 (LOF from blood waste)	11.33 ±0.89 bc	1,276.78±36.23 bc	106.69±11.34
LSD 5 %	4.16	575.90	NS

Note: The numerical value in a column followed by the same letter is not significantly different based on the 5% LSD test. NS= not significant.

Discussion

LOF derived from urban organic waste contained organic matter, nitrogen, phosphorus, potassium, carbon, magnesium, calcium, copper, zinc and iron. Variable amounts of Zn, Mn, Fe and Cu may be directly attributable to microorganism-metal interactions that affect solubility (25). Food waste fertilizers have 1.5 times more phosphorus, the same amount of nitrogen and 1.5 times less potassium than goat manure (26). Liquid fertilizer made from vegetable food waste contains 0.83 % nitrogen, 16.5 mg/kg phosphorus and 20.62 cmol/kg potassium (17). Gunapaselam fish waste LOF contained micronutrients, macronutrients and essential amino acids, which could stimulate plant growth (27). Fish offal extract provides adequate plant macronutrients, including 2.11 % nitrogen, as amount of 0.22.

LOF from urban organic waste can increase mustard, Bok Choy and eggplant plant growth and yield. LOF from urban organic waste contain organic matter, nitrogen, phosphorus, potassium, carbon, magnesium, calcium, copper, zinc, iron and humic acids, required by plants. The increased pH of LOF (5.52), which converted non-volatile ammonium ions into volatile ammonia, might alter the balance between ammonium ions (NH4+) and ammonia (NH3) (1). LOF can increase soil's total available nitrogen, NO3-N, K exchanged and pH (28). Plants given LOF showed an increase in nitrogen-fixing bacteria, phosphate solubilizing bacteria and potassium (29). The result of the study showed that the LOF of fish waste had the nitrogen, phosphorous, potassium and microelements required by plant growth and soil fertility and utilized extensively in the agricultural sector (30). The application LOF from fish waste could increase plant length, number of leaves, chlorophyll content, stomata conductance and dissolved material content in leaves, number of flowers, number of fruits and cucumber fruit weight (31). LOF from vegetable waste had a substantial impact on strawberry plant height, leaf area and fresh weight (24). Plant growth was directly affected by the availability of absorbable nutrients, while LOF of vegetable waste played a role in providing these nutrients. The growth, quantity and quality of vegetables harvests could all be improved by using LOF extracted from water hyacinth at a 10% concentration (32).

LOF from animal waste (fish waste and cow blood) has greater impact effect on plant growth and yield than LOF from vegetal waste (vegetable waste, fruit, sprouts and catering waste). Chemical analysis data shows that LOF from fish waste and blood waste contained more organic matter, nitrogen, phosphorus, potassium, carbon, magnesium, calcium, copper, zinc, iron and humic acid than LOF from other materials. Humic acid can increase garlic grow and yield (33). This study has found that plants given LOF animal waste has greater amount of biomass, increased nutrient absorption and development of new organs (leaves and fibrous roots) (15). The nitrogen content of LOF from fish waste added with papaya leaves (containing papain enzyme) was higher (0.49%) than that of the control treatment (only from fish waste), which contained only 0.30 % nitrogen (34). The biogas slurry C/N ratio produced from the rumen content of cows reached 12.17 after 4 weeks, indicating that the fertilizer was ready to be used on plants (35).

Conclusion

Liquid organic fertilizers from vegetables, fruit, sprout, food, fish, blood waste and mixed waste contain organic matter, varying amounts of nitrogen (N), phosphorus (P), potassium (K), carbon (C), magnesium (Mg), calcium (Ca), copper (Cu), zinc (Zn), iron (Fe), and humic acid. LOF from blood waste and fish waste contains eleven substances which are relatively higher than others. The results of the application test on plants showed that LOF from urban organic waste increased the growth and yield of eggplant, bok choy and mustard. The type of organic waste had no effect on growth but affected the production of eggplant and bok choy. Plants given LOF from fish waste and blood waste produced higher yields than those given LOF from other materials.

The type of organic waste has no effect on growth but does affect the production of vegetable crops. Plants that were applied with LOF from fish waste and blood waste produced higher yields than those given LOF from other materials.

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Authors contributions

DH: planning all research materials, analyzing data and writing manuscripts, TTS: preparing experimental designs, assisting in data analysis and discussion, MT: conducting experiments and collecting research data.

Compliance with ethical standards

Conflict of interest : Authors declare that they don't have any conflict of interest.

Ethical issues : None.

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