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Comparative analysis of manures prepared from vegetable waste for growing Ocimum sanctum Linn

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Abstract
Ocimum sanctum Linn. is an aromatic herb of the plant family Lamiaceae. The plant is commonly cultivated in gardens and traditionally grown in courtyard and temples. Tulsi, the Queen of herbs, is one of the holiest, healing and healthy herbs. The sacred basil, is greatly known for its important role in the traditional Ayurvedic and Unani system of herbal medicines. Like any other plant Tulsi also requires proper nutrients for its growth. In this current experiment, five vegetable waste solutions were used as manures for growing the plants of *Ocimum sanctum* Linn. The morphological changes in the sets were observed and further soil analysis was conducted to find the changes in the contents of the soil nutrients.

Keywords: *Ocimum sanctum* linn., vegetable wastes, soil analysis

Introduction
The plant *Ocimum sanctum* Linn. is distributed throughout the tropical and subtropical regions of Indian subcontinent. The whole plant is rich in phytochemical constituents. The plant is greatly known for its tradtional healing properties. Expectorant, analgesic, anticancer, antidiabetic, antistress, antioxidant, wound healing etc. makes this herb an important part in the lives of the human beings. (N.S. RAINA1). The plant requires 5% water, 45% minerals, 25% air and 5% of organic matter for its proper growth (https://ecotikaindia.online/homemade-fertilizer-for-tulsi/). The supply of organic matter and minerals can be provided using manures and fertilizers. Organic fertilizers are more preferred over the inorganic ones as the former is nature friendly. For the plants that are grown in the houses in soil or plastic pots, homemade manures are good options. The biodegradable wastes can be used in form of manures which can nourish the soil for the plant's growth. In this experiment vegetable wastes has been used for manure preparation and a comparative analysis has been done to evaluate the best suitable manure.

Methodology
Selection of the vegetable wastes-
1. Potato out layer (*Solanum tuberosum* L.)
2. Brinjal (*Solanum melongena* L.)
3. Pea (*Pisum sativum* L.)
4. Cabbage (*Brassica oleracea* L.)
5. Cauliflower (*Brassica oleracea* L.)

Preparation of vegetables waste: The five different vegetable wastes were taken for the manure preparation. The wastes were crushed (each separately) and made into fine pastes. Further, water was added to these pastes and left for overnight soaking. In the morning the mixtures were strained and the solution collected was stored in the bottles. The plants were treated with 10 ml solution each day and after 7 days the data of growth and changes were noted. This data was continuously noted for 5 weeks. In the control set no treatment was given, only watering was done.

Soil Analysis
The soil analysis was performed following the standard protocol of A. McCauley *et al*., 2017 and S. Chaurasia *et al*., 2014.

Soil solution preparation
The treatment process was completed 10 gm soil was collected from each pot. These 10-gm soils were taken in beakers and to this 100 ml of distilled water was added. The beakers were left undisturbed for 24 hrs. After that using Whatman filter paper number 1 the mixture was separated and the collected soil solution were further used for performing soil analysis.

Test for pH
The electrodes were cleaned with distilled water and wiped with fresh tissue papers. After that the electrodes were dipped in the standard buffer solution with pH 7 for calibration. When the displayed reading was available at 7.00 the electrodes were rinsed again with distilled water. Further the electrodes were dipped in the soil solutions one by one and after each reading it was rinsed with distilled water. The pH was noted for each solution in this manner.

Test for chlorinity content
In the conical flask 10 ml soil solution was taken and to it 1ml of Potassium chromate indicator was added. Due to Potassium chromate the soil solution turned yellow in colour. This was titrated with 0.02 N Nitrate solution which at the end point gave pinkish colour. As the colour changed the reading was recorded.
Preparation of Silver nitrate solution- 0.4gm of Silver nitrate powder was dissolved in 100ml of distilled water.
Formula used for Chlorinity test-

$$Cl\text{-}(Mg/l) = (A\text{-}B) \times N \times 35.45 \times 1000/10$$ (N= Gram solute/ amount of solvent x equivalent weight)

Test for alkalinity

10ml soil solution was taken in the conical flask. To it 2-3 drops of Phenolphthalein was added, due to this the solution colour changed into pink. For titration 0.02N sulphuric acid was added in the conical flask and the solution converted into a colourless solution. The used amount of sulphuric acid was noted. Then 2-3 drops of methyl orange indicator were added in the colourless solution and the titration was continued until the yellow colour changed in to orange. Once again, the amount of sulphuric acid was noted.

Preparation 0.02N sulphuric acid- 0.5ml of concentrated sulphuric acid was added to distilled water to make the total volume 500ml.

Formula used for alkalinity test:

Calculation for total, phenolphthalein and methyl orange alkalinity are as follows-

Phenolphthalein alkalinity (mg/l as $CaCO_3$) = A x N x 1000/volume of sample

Total alkalinity (mg/l as $CaCO_3$) = B x N x 1000/volume of sample

Methyl orange alkalinity (mg/l as $CaCO_3$) = (B-A) x 1000/volume of sample

Test for organic matter

In the conical flask 10ml solution was taken. To it 0.2ml potassium dichromate solution was added followed by addition of 0.4ml sulphuric acid, 4ml of distilled water, H2SO4, 0.2ml Phosphoric acid, 0.004gm Sodium fluoride, 0.02ml Diphenylamine indicator. This prepared solution was titrated with Ferrous ammonium sulphate solution until the solution changed into green colour.

Preparation of Ferrous ammonium sulphate solution- 1.25ml of concentrated Sulphuric acid was added to 50ml of distilled water and 12.256gm of Ferrous ammonium sulphate was dissolved in this. The final volume was made 62.5ml by adding Distilled water.

Formula used for organic matter test:

OM (mg/l) = 6.791/ W(1-T1/T2) x 10
OM (%) = 6.791/ W(1-T1/T2)
Carbon (%) = 6.791/ W x 1.724(1-T1/T2)

Morphological Results of *Ocimum sanctum* Linn. Plant

The tables 1-6 below represents the morphological observations (Height, Total leaves and New Leaves) for the 5 weeks

Table 1: Plant growth in the control set

About plant growth	Week-1	Week-2	Week-3	Week-4	Week-5	Average
Height(H)	13.5cm	14cm	17.5cm	21cm	25.8cm	18.36
New leaves (NL)	14	24	48	51	94	46.2
Total leaves (TL)	44	63	76	89	114	77.2

Table 2: Plant growth in Potato waste solution

About plant growth	Week-1	Week-2	Week-3	Week-4	Week-5	Average
Height (H)	13cm	22.3cm	26.2cm	35.8cm	41.2 cm	27.7
New leaves (NL)	12	36	46	52	68	42.8
Total leaves (TL)	96	70	140	168	186	132

Table 3: Plant growth in Brinjal waste solutio

About plant growth	Week-1	Week-2	Week-3	Week-4	Week-5	Average
Height (H)	13.1cm	19.2cm	24.3cm	36cm	42.9cm	27.1
New leaves (NL)	8	28	43	50	83	42.4
Total leaves (TL)	42	56	106	148	219	142.2

Table 4: Plant growth in pea waste solution

About plant growth	Week-1	Week-2	Week-3	Week-4	Week-5	Average
Height (H)	14cm	21cm	26.3cm	37.8cm	41.4cm	28.1
New leaves (NL)	14	59	52	42	75	48.4
Total leaves (TL)	49	79	118	179	289	142.8

Table 5: Plant growth in cabbage waste solution

About plant growth	Week-1	Week-2	Week-3	Week-4	Week-5	Average
Height(H)	14.5cm	19.9cm	23.7cm	34.7cm	41.4cm	26.84
New leaves (NL)	15	28	58	67	94	52.4
Total leaves (TL)	48	78	176	213	293	161.6

Table 6: Plant growth in Cauliflower waste solution

About plant growth	Week-1	Week-2	Week-3	Week-4	Week-5	Average
Height (H)	13.5cm	14.8cm	22.5cm	31.3cm	37.8cm	23.98
New leaves (NL)	14	35	56	51	104	52
Total leaves (TL)	44	87	118	230	314	158.6

In comparison to the control set the best height obtained was in the set treated with pea waste solution following the potato > brinjal > cabbage > cauliflower waste solutions. The number of new leaves were highest in the plant treated with the cabbage waste solution following cauliflower > pea > control > potato > brinjal waste solutions. The total number of leaves were found in highest number in the cabbage waste solution following cauliflower > pea > potato > brinjal > control sets.

Results for soil analysis

The tables 7-10 below represents the soil analysis (pH, Chlorinity, Alkalinity and Organic Matter) at the end of the 5th week.

pH test results

Table 7: pH of treated soil solution

S.no.	Sample description	pH
1	Control set	7.02
2	Potato solution	7.03
3	Brinjal solution	7.18
4	Pea solution	7.33
5	Cabbage solution	7.21
6	Cauli flower solution	7.20

The highest pH was observed in plant treated with the pea solution with 7.33 pH and lowest in the control set with 7.03 pH.

Chlorinity test results

Table 8: chlorinity of treated soil solution

S.no	Sample description	Normality of $AgNO_3$	$AgNO_3$ used for sample (ml) A	$AgNO_3$ used for blank (ml) B	Chlorinity (mg/l) (A-B)	Chlorinity content (ppm)
1	Control set	0.02	0.1	0.3	0.2	135.052
2	Potato solution	0.02	0.2	0.3	0.1	354.5
3	Brinjal solution	0.02	0.3	0.3	0.0	0
4	Pea solution	0.02	0.4	0.3	0.1	6.736
5	Cabbage solution	0.02	0.6	0.3	0.3	20.207
6	Cauli flower solution	0.02	0.7	0.3	0.4	26.942

In the chlorinity of the all of five solution, the highest chlorinity content was observed in the potato solution treated plants with 354.5 ppm chloride content and the lowest in the brinjal solution Treated plants with 0 ppm chloride content.

Alkalinity test results

Table 9: Alkalinity of treated soil solution

S.no	Sample description	H_2SO_4 used with phenolphthalein indicator (ml) A	H_2SO_4 used with methyl orange indicator (ml) B (A+B)	Phenolphthalein alkalinity (mg/l as $CaCO_3$)	Methyl orange alkalinity (mg/l as $CaCO_3$)	Total alkalinity (mg/l as $CaCO_3$)
1	Control set	0.2	0.7	0.4	50	1.4
2	Potato solution	0.1	0.7	0.2	40	1.0
3	Brinjal solution	0.8	13.0	1.6	50	26
4	Pea solution	0.3	0.6	0.6	30	1.2
5	Cabbage solution	0.3	0.6	0.6	30	1.2
6	Cauli flower solution	0.1	0.5	0.2	40	1.0

In the alkalinity test the highest alkalinity content was found in the brinjal solution treated plants i.e., 26 mg/l and the lowest was noted in two solution treated plants namely potato and cauli flower with the same alkalinity content of 1.0mg/l.

Organic matter content test results

Table 10: Organic matter of treated soil solution

S.no	SAMPLE	OM (mg/l)	OM (%)	Carbon (%)
1	Control set	67.91	0.68%	67.91%
2	Potato	27.16	2.68%	3.15%
3	Brinjal	16.98	1.7%	1.94%
4	Pea	16.98	1.7%	1.94%
5	Cabbage	16.98	1.7%	1.94%
6	Cauli flower	22.64	2.26%	2.62%

In the organic matter content, the highest content was of the potato solution treated plants with 2.68% organic matter and the lowest organic content was in the brinjal, pea, cabbage solution treated plants with organic matter content of 1.7%.

Discussion

Diksha Dinkar Ausekar 2016, treated *Ocimum sanctum* plants for 10 weeks with organic and inorganic fertilizers and observed the plant height, weight and leaf area. The result derived was best in the plants that had been treated with the organic fertilizers. Total organic matter and micronutrients were found to be present in good amount in the soil that was treated with the organic matter. In the present study 4 vegetable waste solutions i.e., potato, brinjal, pea, cabbage and cauli flower were used as manures and the plants of *Ocimum sanctum* were treated accordingly. In one set no treatment was given and this was considered as the controlled set. In the present study the height acquired by the plants, number of new leaves and total number of leaves were recorded for 5 weeks. According to Diksha Dinkar Ausekar 2016, the best result was found in the organically treated plants while in our study in terms of height the best result was obtained in the pea waste solution. In terms of new leaves and total number of leaves the best result was obtained in the plant set treated with cabbage waste solution. The results suggest that the green wastes of pea and cabbage were rich in phytonutrients that helped in growth of the plants. The alkalinity content of the soil is provided by their pH. The standard pH of soil for growing *Ocimum sanctum* Linn. is in between 6-7.5 (http://ecocrop.fao.org/ecocrop/srv/en/home). In the current study the pH of all the taken samples illustrates the pH range from 7-7.33 which supports the suitable and standard range. The chlorinity range below 70 ppm is considered generally safe for all plants. Sensitive plants are injured in the range of 70-140 ppm. Moderately tolerant plants are having injuries in the range of 141-350 ppm which can cause several problems to the plants challenging their survival (A. McCauley *et al.*, 2017). In the current study the chlorinity content of the soil in the brinjal, pea, cabbage and cauliflower waste solution treated sets was below 70 ppm, therefore considered safe for the plants. The control set showed 135.052ppm chlorinity content which can cause injuries and stress to the plants. The chlorinity content of the soil treated with the potato waste solution was 354.052ppm which was much more than the plant can tolerate. According to the Kandasamy Selvam *et al.*,2013 *Ocimum sanctum* is one of the sensitive plants that gets easily affected due to salinity stress. Therefore, the control set and the set treated with the potato solution had high risk of getting injured due to the high salinity content of the soil. As stated by national medicinal plants for the growth of *Ocimum sanctum* the range of organic matter should be in between 2.4-3 % (https://www.nmpb.nic.in/sites/default/files/ publications/ Information_about_Organic_Cultivation_of_Tulsi_and_Brahmi.pdf). In the current study the range of organic matter content of the control set and the other treated sets were below the given

range. This shows that organic matter content in all the sets were low, which could further affect the growth of the plants.

Conclusion

In the current research it has been observed that the waste solutions prepared from the pea and cabbage provided the suitable conditions and nutrients for the growth of the *Ocimum sanctum* Linn. plants. This also supports that homemade organic manure are suitable for growing plants by providing nutrients. These are equally useful to the plants as market manures and fertilizers. This study has been evaluated in terms of morphological features and soil analysis. Further researches like phytochemical analysis, macro and micro nutrient analysis are required to evaluate the particular reasons of growth in these plants.

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