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Vermicomposting: Analysis of Soil Nutrients Enrichment with Indigenous Species from Jazan Province of Saudi Arabia

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Abstract

The wastes produced in the University campus like shredded paper, used teabags, vegetables, etc. were to be sorted and used for the production of vermicompost. Earth worms used in this study were collected from six locations in and around Jazan. The three major species found in Jazan area were *Lumbricus terrestris, Aporrectodea longa* and *Lumbricus rubellus*. All the sps. belong to the family Lumbricidae and found to be adapted to the environmental conditions of Jizan. They were found to be active in during the vermicomposting experiments. The vermicompost showed increase in its constituents of primary nutrients {Nitrogen (N), Phosphorus (P), and Potassium (K)}, secondary nutrients {Calcium (Ca), Magnesium (Mg)} and micro nutrients {Copper (Cu), Iron (Fe), Manganese (Mn) and Zinc (Zn)} in comparison with the control soil. This study is a precursor to a scientific approach in finding out how more steps need to be taken to utilise the organic waste produced in each province for the production of vremicompost in Jazan.

Keywords: Vermicompost, Soil nutrients, Micronutrients, Macronutrients, Jazan.

Introduction

Vermicomposting is proving to be a highly profitable business recently. Bogdanov (1996) had demonstrated the economic feasibility of vermiculture. The ecological advantages as well as economics of vermicompost were demonstrated from California by Gaddie and Douglas (1975). Studies conducted in Department of Biological and Agricultural Engineering of North Carolina State University by Sherman (2001) on large scale vermicomposting found it to be highly economical and ecofriendly. Earthworm compost was found to have suppressive effect on some root infecting pathogens of cabbage and tomato (Szczech et. al., 1993). Ranganathan and Parthasarathi (2000) recorded enhanced phosphatase activity in earthworm casts in their studies conducted in India.

Getnet and Raja (2013) found that vermicomposting improved the growth and development of Cabbage, *Brassica oleracea Linn* and also prevented sucking pestaphidand. The use of vermicompost seemed to be quite reasonable in agro-management than chemical fertilizers in Ethyopia. Manyuchi and Whingiri (2014) studied the effects of vermicomposting period, substrate quantity, cow dung composition and their interactions on *Eisenia fetida* during vermicomposting. They found that earth worm growth in vermicompost is promoted by increase in these factors.

One research study showed that after only 45 days of applying vermicompost in grape gardens, the availability of minerals such as calcium was comparable to that in plots on which chemical fertilisers were applied. Vermicompost enabled a 2-year-old plant to grow as tall as a 10-year-old plant grown using chemical fertilisers. Moreover, vermicompost reduced the incidence of disease by boosting Calcium and Magnesium levels (Rajendran, 1994). Vermicomposting converted household waste into compost within 30 days, narrowed the C/N ratio and retained more N than traditional methods (Gandhi et. al., 1997). Worms can digest several times their own weight each day, and large quantities of organic waste are passed through an average population of earthworms. The major constraint to vermicomposting is that vermicomposting systems must be maintained at temperatures below 35 degrees Celsius (Edwards, 1995).

The magnitude of the transformation of phosphorus from the organic to inorganic state, and thereby into available forms was found to be considerably higher in the case of earthworm-inoculated organic wastes, showing that vermicomposting may prove to be an efficient technology for providing better P nutrition from different organic wastes (Ghosh et. al., 1999). Alzaydi et al. (2013) studied the demand of compost in the western region of Saudi Arabia. They found that organic waste dominate the total waste (67%) in the region and emphasised the need of improving the quallity of their compost. Vermicomposting is definitely the best ecofriendly alternative for good quality compost production within a shorter period of time.

Arancon and Edwards (2005) made a detailed investigation on the effects of vermicomposts on plants and found that they are not solely attributed to the quality of mineral nutrition provided but also to its other growth regulating components such as plant growth hormones and humic acids. Furthermore, the application of vermicomposts in the field was seen to enhance the quality of soils by increasing microbial activity and microbial biomass which are key components in nutrient recycling, production of plant growth regulators and protecting plants from soil-borne diseases and arthropod pest attacks.

Vermicomposting is a widely accepted method of converting organic wastes into highly nutritious organic fertiliser. This method is gaining more acceptance as the modern world has realised the advantages of organic food and the demand for the same is increasing day by day. Thus a lab trial of soil nutrient enrichment with worms was conducted in Jazan, a land famous for its agricultural productivity in Saudi Arabia, especially of fruits and vegetables. This work will definitely help in the advancement of agriculture in the area towards the production of organic fruits and vegetables.

Materials and Methods

In the present study, earth worms were collected from six locations in and around Jazan- namely Baish, Abu-Arish, Al-Ahad, Al-Khuba, Addarb, and from Jazan as native species are best suited for the environment and were identified (Figs. 1&2).

The wastes produced in the campus like shredded paper, used teabags, food waste, vegetables, etc. were sorted and used for the production of vermicompost (Figs. 3 & 4). Vermicomposting was done in the labs for 6 months and the enhancements in the available soil nutrients were analyzed. The sample was dried at room temperature and sieved. Then 1:5 soil suspensions were prepared and the concentration of micronutrients was determined by atomic absorption spectrophotometry (APHA, 1989 and Lindsay and Norvell, 1978).

The primary nutrients are Nitrogen (N), Phosphorus (P), and Potassium (K). The secondary nutrients are Calcium (Ca), Magnesium (Mg) and micro nutrients like Copper (Cu), Iron (Fe), Manganese (Mn) And Zinc (Zn) were estimated.

Figs. 1-4: Preparation of vermicompost in laboratory.

Results and Discussion

Morphological characteristics of local earth worms in Jazan:

The three major species found in Jazan area were *Lumbricus terrestris, Aporrectodea longa and Lumbricus rubellus. L.terrestris* (Fig.5) belong to family Lumbricidae with an average length of 11-20 cm. Body cylindrical in cross section except for broad, flattened posterior. Head end dark brown to reddish brown dorsally, dorsal pigmentation fading towards posterior. *A. longa* (Fig.6) is included in the family Lumbricidae. It is a large species that lives in permanent burrows. They produce piles of worm casts, sometimes more than 5cm high, near their burrows which indicate their high feeding capacity. They are found to grow up to a size of 12 cm. They are long and thin. The upper surface of the body froms the first segment to the saddle. It is entirely dark purple in colour and the rear end of the body is paler. The saddle is usually pale and slightly wider with 4-5 segments. The head is pionted, the tail is rounded and the last segments are distinctly yellow. They are found in soil rich in humus (Fig. 7).

Fig.5 *Lumbricus terrestris*

Fig.6 *Aporrectodea longa*

Fig.7 *Lumbricus rubellus.*

Lumbricus rubellus (Fig.7) also come under family Lumbricidae. It is a slightly larger than *A.longa* and grows up to 13 cm. They are also called red worms due to their redish brown color. The skin is semi-transparent, flexible segmented into circular sections. They are less abundunt in Jazan area in comparison with *A. longa.*

Analysis of nutrients in vermicompost:

There was an increase noticed in P, N and K contents (Table 1) of vermicompost in comparison with the control. The difference between vermicompost and control soil was minimal in P (49.6 / 45 mg/kg), higher in N (113.4/80 mg/kg) and remarkable in K (303.4/43mg/kg). These results generaly agree with previous studies on vermicompost which have reported the nutrient enrichment by vermicomposting. In this respect, Lange (2005) recorded increased levels of Ammonium, Nitrogen, and total Nitrogen as well as in water holding capacity in vermicompost compared to conventional composting.

Table 1: Primary Nutrients {Nitrogen (N), Phosphorus (P), and Potassium (K)}, secondary nutrients {Calcium (Ca), Magnesium (Mg)} and micro nutrients {Copper (Cu), Iron (Fe), Manganese (Mn) and Zinc (Zn)} in different vermicompost samples and control.

Sample	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
	mg / kg			mg / kg					
1	110.0	41.0	350.0	1780.0	312.0	14.0	8.8	1.10	0.62
2	118.0	81.0	255.0	1710.0	285.0	15.0	8.9	1.00	0.62
3	95.0	16.0	301.0	1815.0	325.0	15.0	10.0	1.00	0.86
4	100.0	12.0	455.0	1908.0	365.0	8.5	5.2	0.76	0.70
5	120.0	50.0	375.0	1860.0	385.0	22.0	11.3	3.50	1.00
6	125.0	58.0	330.0	1786.0	380.0	10.0	7.6	1.00	0.62
7	132.0	117.0	215.0	1868.0	250.0	18.0	11.5	0.72	0.50
8	125.0	47.0	235.0	1710.0	250.0	17.0	10.4	1.30	1.00
9	96.0	24.0	215.0	1690.0	310.0	16.0	9.6	0.65	0.72
Average	**113.4**	**49.60**	**303.40**	**1791.90**	**318.00**	**15.10**	**9.30**	**1.20**	**0.70**
Control	**80.0**	**45.00**	**43.00**	**705.00**	**62.00**	**6.60**	**3.20**	**0.22**	**0.18**

Calcium enrichment was also found to be significant (1791.9 mg/kg over 705 mg/kg in the control). In case of Manganese, vermicompost contained 9.3 mg/kg in comparison to 3.2 mg /kg in control. Magnesium, Iron, Zinc and Copper recorded 318 mg/kg over 62 mg/kg, 15.1 mg/kg over 6.6 mg/kg, 1.2 mg/kg over 0.22 mg/kg and 0.7 mg/kg over 0.18 mg/kg, respectively in vermicompost in comparison to control soil. Previous studies clarified that vermicomposting is found to promote the growth of plants as well as increase the resistence to pest infestation. Comparatively longer duration of vermicomposting by using *Lumbricus rubellus* enhanced the quality of vermicompost by the increase of the macronutrient elements while reducing the heavy metal concentration and C/N ratio (Jamaludin and Mahmood, 2010). Getnet and Raja (2013) substanciated that vermicompost has significant impact on cabbage growth promotion and reduces the aphid infestation. The last authors also added that healthy organic soil conditions can produce healthier plants resistant to diseases and also vermicompost is found to have suppressive effect on some root infecting pathogens. Therefore wormicomposting can reduce the use of chemical pesticides and also harmful pesticides used in agriculture.

Vermicomposting process, once developed can be spread to areas like agricultural farms, food industries producing large quantities of organic wastes, Urban solid waste management projects, etc. with enormous benefits in terms of environmental restoration. Lange (2005) found that vermicomposting can reduce the time span for compost production to almost half in comparison to conventional composting. According to Norman and Clive (2005), the effects of vermicompost on plants are not solely attributed to the quality of mineral nutrition provided but also to its other growth regulating components such as plant growth hormones and humic acids. Furthermore, the application of vermicompost in the field enhances the quality of soils by increasing microbial activity and microbial biomass which are key components in nutrient cycling, production of plant growth regulators and protecting plants soil-borne disease and arthropod pest attacks.

There is a gap between production and import of compost in the Kingdom of Saudi Arabia (Alzaydi et. al., 2013)."The Fruit Basket of Saudi Arabia" which is the attribute given to Jazan definitely needs to do more towards this direction in pioneering and furthering agricultural output. Therefore this study is a precursor to a scientific approach in finding out how more steps need to be taken to utilise the organic waste produced in each province for the production of compost in Jazan.

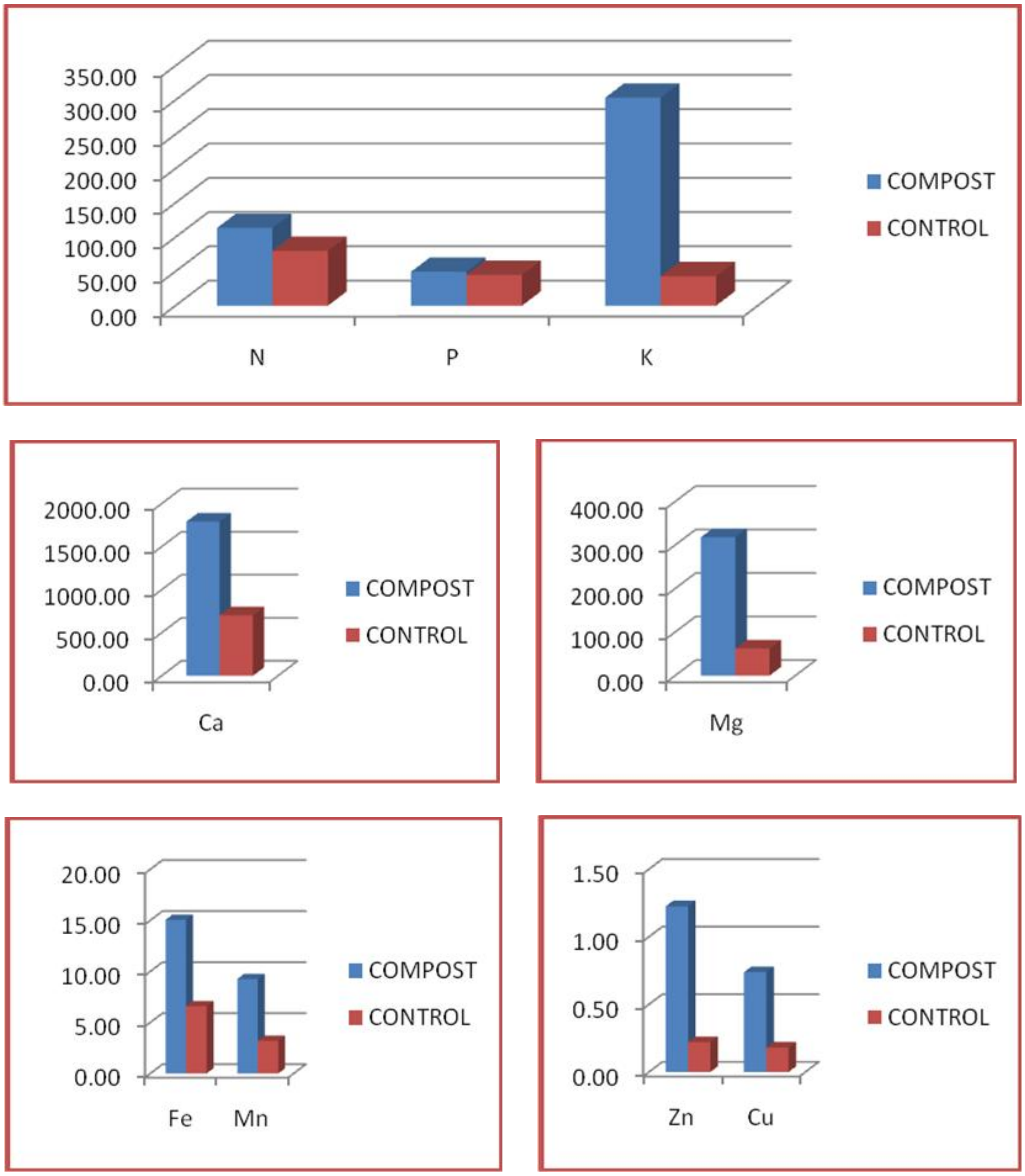

Fig. 8: Histograms showing analysis of nutrients in vermicompost. There was an increase noticed in P, N and K contents of vermicompost in comparison with the control. The difference in the measured nutrients between vermicompost and control soil was minimal in P, high in N and remerkable in K. Calcium enrichment was also found to be significant. Manganese, Magnesium, Iron, Zinc and Copper also recorded variably higher values in vermicompost in comparison to control.

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