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Evaluation of a New Composting Method towards Speedy Biodegradation of Water Hyacinth for Effective Bio-Resource Utilization in Farmer's Level

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ABSTRACT

Water hyacinth is a major threat for water bodies and at the same time it could be a excellent for organic soil resources if suitable composting technique can be adopted. Novcom composting method was tried out for effective biodegradation of water hyacinth in Krishi Vigyan Kendra, Howrah, West Bengal during January to February, 2014 and the results showed a good quality mature compost can be obtained within 21 days. The analytical results showed qualitative aspects of Novcom compost in terms of total NPK content (4.18 %), total microbial count (in the order of 10^{14} to 10^{16} c.f.u.) and germination index (> 1.0 which it confirmed that the compost enhanced rather than impaired germination and radical growth) as also substantiated by the high compost quality index. Absence of any infrastructural requirement for composting, speedy biodegradation period (21 days), high end product quality indicated the potential of Novcom Composting Method towards large scale adoption among farmer's level

Key words: Composting Method, Compost Quality.

INTRODUCTION

The water hyacinth has caused major problems, e.g., reduction of fish due to its rapid growth and the robustness of its seeds. It forms dense mats that avert river traffic, block irrigation canals, and destroy rice fields (Gupta et al., 2007). As water hyacinth decays, there is a sharp increase in nutrient levels in water body, which ultimately creates the problem of eutrophication in aquatic system. On the other hand the water hyacinth would have a great potential if seen as raw material for agricultural usage (Gunnarsson and Petersen, 2007). Much work has been carried out in different parts of the world to develop environmentally sound and appropriate methods for the management and control of this weed. Different researchers studied the utilization of water hyacinth as animal feed, feed for solid-phase fermentation, raw material for making pulp, paper and paper board and the vermicomposting of water hyacinth (Gupta et al., 2007). However, a novel technology with ecological sound and economically viable is urgently required to solve the problem of aquatic weed disposal and management (Dhal et al 2012).

In this context, *Novcom* composting method emerged as a viable option as found from FAO funded project report (Bera et al, 2013). In this process compost is produced within 21 days and no specific infrastructure is required which may prove helpful for large scale adoption within common farmer's class. Hence the present study was taken to evaluate the *Novcom* composting process for effective biodegradation of water hyacinth.

MATERIALS AND METHODS

The study was done at Krishi Vigyan Kendra (KVK), Jagatballavpur, Howrah as a part of a M.Sc. Project work in 2014. Analytical work was done partly in the Dept. of Agricultural Chemistry and Soil Science (Calcutta University) and at Inhana Biosciences laboratory, Kolkata. Composting was done through *Novcom* composting method (Seal *et al*, 2012) utilizing water hyacinth and cowdung (80 : 20 ratio) as raw material.

Analysis of compost samples:
10 representing samples from compost heaps were collected and analyzed for different quality parameters following the methodology described in Seal *et al.* (2012). Compost Quality Index was calculated as per the methodology of Bera *et al.* (2013).

$$\text{Compost Quality Index (CQI)} : \quad \frac{NV_{NPK} \times MP \times GI}{C/N \text{ ratio}}$$

Where
NV_{NPK} = Total nutrient value in terms of total ($N+P_20_5+K_20$) percent.
MP = $\log_{10}$ value of total microbial population in terms of total bacteria, total fungi and total actinomycetes.
GI = Germination Index.

Classification of compost as per CQI

Compost Quality Index (CQI)		Compost Quality Classification
> 2.00	:	Poor
2.00 – 4.00	:	Moderate
4.00 – 6.00	:	Good
6.00 – 8.00	:	Very Good
8.00 – 10.00	:	Extremely Good

RESULTS AND DISCUSSION

Table 1: Quality parameters of *Novcom* compost prepared at KVK, Howrah

Sl. No	Parameter	Range Value	Mean value	(±) S.E.
Physical Parameters				
1.	Moisture percent (%)	57.88 – 67.1	63.52	1.13
2.	Bulk density (g/cc)	0.38 – 0.46	0.41	0.02
3.	Porosity (%)	60.16 – 64.3	62.78	1.14
4.	Water holding capacity (%)	184 – 232	214	4.21
Physicochemical Parameters				
5.	pH_{water} (1 : 5)	7.09 – 7.69	7.23	0.21
6.	EC (1 :5) dSm^{-1}	2.25 – 2.90	2.61	0.32
7.	Total Ass Content (%)	43.62 – 49.58	46.24	2.13
8.	Total Volatile Solids (%)	50.42– 56.38	53.76	2.37
9.	Organic Carbon (%)	28.01 – 31.32	29.87	1.22
10.	CEC (cmol(p+)kg^{-1})	178 - 237	212	11.23
11.	Compost Mineralization Index	1.39 – 1.77	1.55	0.18
Fertility Parameters				
12.	Total Nitrogen (%)	1.79 – 2.28	2.08	0.04
13.	Total P_2O_5 (%)	0.86 – 1.10	0.94	0.05
14.	Total K_2O (%)	1.02 – 1.37	1.16	0.08
15.	C/N ratio	13:1 – 15:1	14:1	0.46
Stability Parameters				
16.	CO_2 Evaluation Rate ($mgCO_2$–C/g OM/day	1.89 – 3.23	2.16	0.14
Microbial Parameters (total count)				
17.	Bacteria	(12–53) $x10^{16}$	39 $x10^{16}$	5.3$x10^{16}$
19.	Fungi	(19 – 45) $x10^{14}$	31 $x10^{14}$	3.0 $x10^{14}$
20.	Actinomycetes	(15–32) $x10^{14}$	27 $x10^{14}$	1.9 $x10^{14}$
Maturity & Phytotoxicity Parameters				
21.	Seedling Emergence (% of control)	92 – 123	112	2.80
22.	Root Elongation (% of control)	89 – 114	97	2.25
23.	Germination Index (phytotoxicity bioassay)	0.82 - 1.40	1.09	0.06
Compost Quality				
24.	Compost Quality Index (CQI)	4.68 – 7.86	6.17	0.42
25.	Compost Quality Class	Good to Very Good		

[1]CMI : Compost mineralization index; [2] per gm moist soil.

Evaluation of compost quality

Qualitative evaluation of compost samples was done in terms of physicochemical properties, nutrient content, microbial potential, stability and phytotoxicity parameters (Table 1).

Physical Parameters

Average moisture was varied from 57.88 to 67.82 percent, which may be placed in the high value range (40 to 50) as suggested by Evanylo, (2006). All the compost samples appeared dark brown in colour with an earthy smell, deemed necessary for mature compost (Epstein, 1997). Water holding capacity of 184 to 232 percent, may be placed in the high value range (standard range of 100 to 200 with preferred value of >100) as suggested by Evanylo, (2006). The water holding capacity may be attributed to the abundance of humus particles in the compost (Trautmann and Krasny, 1997) and the addition of such compost in soil helped in retaining soil moisture during the dry months.

Physicochemical Parameters

The pH value of the compost samples ranged between 7.09 and 7.69, with a mean of 7.23, which was well within the stipulated range for good quality and mature compost (Jime´nez and Garcia 1989). Electrical conductivity of the compost samples ranged between 1.23 and 4.47 with a mean of 2.08 dSm^{-1}, indicating its high nutrient status at the same time being safely below (< 4.0) the stipulated range for saline toxicity. The organic matter content of compost is a necessity for determining the compost application rate to obtain sustainable agricultural production. Organic carbon content in the compost samples ranged between 28.01 and 31.32 %, with a mean value of 29.87 %, which met the standard value of >19.4% suggested by Australian Standard 4454 (AS 1999) for nursery application. Cation exchange capacity (CEC) is one of the most important properties of compost and is usually closely related to fertility. The CEC of the compost samples ranged between 178 and 237 cmol(p+) kg^{-1}, which is comparable with values obtained for good quality compost (Seal *et al.* 2012).

Fertility Parameters

The total nitrogen content in the compost samples ranged between 1.79 and 2.28 percent, which was well above the reference range (1.0 to 2.0 percent) suggested by Watson (2003). The high N value with respect to standard range might indicate higher fixation of atmospheric N within compost heap during *Novcom* composting process (Seal *et al*, 2012). Total Phosphate (0.86 to 1.10 percent) and total potash content (1.02 to 1.37 percent) were also higher than the minimum suggested standard (0.6 to 0.9 percent and 0.2 to 0.5 percent respectively) by Watson (2003). In comparison to total NPK value obtained by other workers working with water hyacinth composting with different composting process (Dhal et al 2012) clearly showed higher nutrient value obtained in case of *novcom* compost This indicates intense biodegradation in case of *Novcom* compost resulting in minimum loss and appreciation of initial value (in case of N) contribute to the comparatively higher nutrient in the final compost samples as also evidenced by Bera *et al*, 2013. C/N ratio varied from 13: 1 to 15: 1 indicates all the compost samples were mature and suitable for soil application.

Microbial parameters

The microbial population, their biomass and activity, are the key parameters that can also be used to elucidate the composting process. In open-air composting processes, colonization of microbes in compost material occurs naturally during heap construction as well as at the time of turning of heap. Total count of bacteria, fungi and actinomycetes in per gram moist compost sample was 39 x 10^{16}, 31 x 10^{14} and 27 x 10^{14} c.f.u. respectively. Such high generation of microbial population might have been possible due to the generation of an ideal micro atmosphere within composting heap as influenced by the application of *Novcom* solution.

Stability and Phytotoxicicty Parameter

Microbial respiration formed an important parameter for determination of compost stability. Mean respiration or CO_2 evolution rate of all composts (1.89 to 3.23 mg/day) was more or less within the stipulated range (2.0 - 5.0) for stable compost as proposed by Trautmann and Krasny (1997). The phytotoxicity bioassay test, as represented by germination index provided a means of measuring the combined toxicity of whatever contaminants may be present (Zucconi *et al.*, 1981). Germination index value of >1.0 as obtained in case of *Novcom* compost indicated not only the absence of phytotoxicity (Tiquia *et al.*, 1996) in the compost but moreover, it confirmed that the compost enhanced rather than impaired germination and radical growth (Trautmann and Krasny, 1997).

Compost Quality Index

In order to classify the different types of compost, four specific quality parameters (which were combination of one or more properties that regulate the nutrient mineralization from compost as well as its post soil application affectivity) were taken up to formulate Compost Quality Index (Bera *et al*, 2013). Classification of compost as per quality will enable the producer to get a fair idea about any compost choice and taking decision for soil management

accordingly. Compost quality index value of the *Novcom* compost varied within 4.68 to 7.86, which classified as good to very good.

CONCLUSION

Study of *Novcom* composting method and evaluation of the quality of the end product indicated that this is an effective way out towards production of good-quality compost using not only water hyacinth but any type of biodegradable on-farm waste. Also from the practical point of view, the minimum infrastructural requirement and speedy biodegradation under *Novcom* composting method makes the process most convenient for common farmers' community. At the same time, the presence of a very large and diverse population of self-generated micro organisms in the end product, i.e. *Novcom* compost, indicated its effective post soil application.

Photo 1: *Novcom* Compost heap prepared from water hyacinth in the day of initiation at KVK, Howrah.

Photo 2: Mature *Novcom* Compost heap (after 21 days) prepared from water hyacinth at KVK, Howrah.

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