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Extraction and characterization of humic acid from vermicompost and farm yard manure

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Abstract

A lab experiment was conducted to extract humic acid from locally available organic wastes like vermicompost and FYM by following standard alkaline extraction method. Extracted humic acid was subjected to characterization by analyzing total acidity, E₄/E₆ ratio, pH, EC, CEC, total organic carbon and total macro and micro nutrients. After characterization the results showed that the humic acid extracted from vermicompost is significantly superior over the humic acid from farm yard manure. Humic acid from vermicompost has higher recovery per cent (5.20), total acidity (5.5 meq g⁻¹), E₄/E₆ ratio (4.73), pH (4.25), EC (0.25), CEC (380 cmol (p⁺) kg⁻¹), total OC (360.80 g kg⁻¹), C:N ratio (13.14), total N (2.80%), P (0.045%), K (0.28%), S (0.95%), Ca (0.20%), Mg (0.12%), Fe (3400 mg kg⁻¹), Mn (523 mg kg⁻¹), Cu (121.5 mg kg⁻¹) and Zn (272 mg kg⁻¹).

Keywords: Humic acid, extraction, characterization

Introduction

Organic matter is considered as the "Life of Soil" due to its importance in maintaining soil fertility and its depletion is a major concern to food security in the years to come. Hence, there is a need to improve the soil fertility in a sustainable manner by utilizing locally available organic sources. Since transportation and application of organic manures is a laborious process, use of humic substances extracted from locally available organic wastes in crop production is a better option.

The term total humic substances (humic acid + fulvic acid + humin) is synonymous with the soil organic matter. Humic acid is insoluble in water and hence it is manufactured in the commercial form as potassium humate. Humic acid can be extracted from various resources like lignite, coal, vermicompost, farm yard manure etc., besides its natural persistence in soil humified organic matter has strong impact on soil fertility and influence on soil physico-chemical properties. Organic matter becomes a vital part in both crop production and soil fertility. Humic acids are heterogeneous, which include macromolecules, functional groups, hydrophilic and hydrophobic groups. Humic acid hydrophilic groups promote hydration and thus increase the water retention capacity in soils. It is the main fraction of humic substance and the most active component of soil and compost.

Material and methods

A lab experiment was conducted to extract and characterize the humic acid from locally available organic sources namely vermicompost and FYM.

Extraction of humic acid

Ten grams of air dried organic sample was weighed in to 250 ml conical flask, 50 ml of 0.1 N NaOH was added and shaken for 24 hours. The dark coloured supernatant solution was collected by centrifugation process. The extraction procedure was repeated thrice by using 50 ml of extractant each time for complete extraction of the humic acid. Supernatants were pooled to a volumetric flask, the pooled supernatant coloured solution was centrifuged at 15,000 rpm for 15 minutes to ensure complete removal of fine colloidal clays. The clay was discarded and the coloured supernatant was collected in a 250 ml beaker. The pH electrode was dipped in the coloured supernatant solution and 2 N HCl was added till the pH was lowered to 2 for precipitating humic acid. It was stirred well and allowed to stand at room temperature for 24 hours. The supernatant (fulvic acid) and the coagulate (humic acid) were collected separately. The collected coagulate was dried on a hot water bath (Stevenson, 1994) [1].

Characterization of humic acid

Total acidity of humic acid was determined by barium hydroxide method as given by Schnitzer and Gupta (1964) [2]. The degree of humification and aroma activity of humic acid were measured using E_4/E_6 ratios. A known quantity of sample (@ 0.2 to 0.4 mg/ml) was taken and dissolved in 10 ml of 0.01 M NaHCO_3 solution. The absorbance at 465 gives E_4 value while 665 gives E_6 value were measured in spectrophotometer and the absorbance ratio was recorded.

PH of the humic acid was determined in 1:50 humic acid to water ratio by potentiometric method (Sparks, 1996) [3].

Electrical conductivity of the humic acid was determined in 1:100 humic acid to water ratio by conduct metric method (Sparks, 1996) [3].

Cation exchange capacity of the humic acid was determined by modified BaCl_2 triethanolamine method.

The loss in weight of the crucible after heating with humic acid represents the organic matter content of the humic acid (Tiessen *et al.* 1981) [4]. Total organic matter and organic carbon content were calculated by using following formula.

Total organic matter = 100 - Ash content (%)

Total organic carbon = Total organic matter/1.724

The total nitrogen content of the humic acid was determined by Kjeldhal digestion and distillation method as outlined by Tandon (1998) [5].

A known quantity of humic acid sample was taken in a 250 ml conical flask and was pre-digested by adding 10 ml of HNO_3 and keeping it overnight. Ten ml of diced mixture was added and heated on sand bath until a snow white residue was

obtained. The residue was cooled and diluted to a known volume with distilled water, filtered and made up the volume to 100 ml using distilled water. It was further used for elemental analysis of humic acid except N.

Results

The results of the humic acid extracted from vermicompost and FYM shows that Higher recovery of humic acid was obtained from vermicompost (5.20%) than from FYM (4.40%). pH (1:50) of humic acid extracted from FYM and vermicompost were 4.12 and 4.25, respectively which showed acidic nature of humic acid and EC (1:100) was 0.21 and 0.25, respectively from FYM and vermicompost which represents the high salt content of humic acid.

Higher total acidity (5.5 meq g^{-1}) and E_4/E_6 ratio (4.73) were recorded in the humic acid extracted from vermicompost than FYM which recorded 5.2 meq g^{-1} of total acidity and 4.41 E_4/E_6 ratio.

The elemental composition of humic acid extracted from vermicompost viz., OC (360.80 g kg^{-1}), N (2.8%), P (0.045%), K (0.28%), S (0.95%), Ca (0.20%), Mg (0.12%), Fe (3400 mg kg^{-1}), Zn (272 mg kg^{-1}), Mn (523 mg kg^{-1}) and Cu (121.5 mg kg^{-1}) were higher than FYM which showed OC (300.10 g kg^{-1}), N (2.38%), P (0.038%), K (0.20%), S (0.6%), Ca (0.16%), Mg (0.10%), Fe (2800 mg kg^{-1}), Zn (245 mg kg^{-1}), Mn (566 mg kg^{-1}) and Cu (114 mg kg^{-1}) content. C: N ratio of humic acid extracted from vermicompost was 13.14 while that of FYM was 12.60.

Table 1: Chemical composition of humic acid (HA) extracted from organic manures

S. No.	Particulars	HA from vermicompost	HA from FYM
1.	Recovery percentage (%)	5.20	4.40
2.	pH (1:50 Humic acid : H ₂ O suspension)	4.25	4.12
3.	EC (1:100 Humic acid : H ₂ O suspension) dSm^{-1}	0.25	0.21
4.	Total OC (g kg^{-1})	360.80	300.10
5.	CEC ($\text{cmol (p}^+) \text{ kg}^{-1}$)	380	320
6.	C:N ratio	13.14	12.60
7.	Total macronutrients		
a.	N (%)	2.8	2.38
b.	P (%)	0.045	0.038
c.	K (%)	0.28	0.20
d.	S (%)	0.95	0.60
e.	Ca (%)	0.20	0.16
f.	Mg (%)	0.12	0.10
8.	Total micronutrients (mg kg^{-1})		
a.	Fe	3400	2880
b.	Mn	523	566
c.	Cu	121.5	114
d.	Zn	272	245
9.	Total acidity (meq g^{-1})	5.5	5.2
10.	E_4/E_6 ratio	4.73	4.41

Discussion

Humic acid extracted from vermicompost recorded higher recovery per cent (5.20%) than FYM (4.40%). The results are in accordance with the findings of Satisha and Devarajan (2011) [6]. The humic acid extracted from the organic sources are dark brown to black in colour, which might be due to elemental configuration and melanin pigment.

pH of the humic acid extracted from both FYM and vermicompost was acidic in nature which might be due to the presence of carboxyl and phenolic-OH group, these findings are in accordance with Rajashekhhar *et al.* (2017) [7].

The higher electrical conductivity of humic acid from FYM (0.21 dSm^{-1}) and vermicompost (0.25 dSm^{-1}) was due to the

accumulation of higher concentration of salt as a result of decomposition of organic matter or higher organic carbon content and (Kumuda, 1987) [8].

Humic acid extracted from vermicompost exhibited higher total acidity (5.5 meq g^{-1}) than FYM. The higher acidity of humic substances could be attributed due to the occurrence of ionisable H^+ of carboxyl and hydroxyl groups found in aliphatic or aromatic rings of molecules and the present study is in accordance with that of Prasad and Sinha (1981) [9].

The E_4/E_6 ratio is a valid and informative index for characterization of humic substances with respect of aromaticity. In the present study, the E_4/E_6 ratio was high in the humic acid extracted from vermicompost than FYM and it

was in accordance with the findings of Rajashekhar *et al.* (2017) [7].

The elemental composition of humic acid was reflected by the nature of the raw material used for extraction. Vermicompost exhibited higher elemental composition than FYM and hence humic acid extracted from vermicompost was superior over FYM and it was selected for soil and foliar application in present study, similar findings were observed by Atiyeh *et al.* (2002) [10].

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