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Application of Municipal Solid Waste as a Soil Nutrients Booster Humic Acid and its Analysis through FTIR and GC-MS

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ABSTRACT: Since expanding urbanization, industrialization an enormous amount of metropolitans' municipal solid waste (MSW) is produced in the nations and disposal and segregation cost of MSW increases, there are severe issues for developing and low-income countries, therefore very large space is required for the disposal of MSW. Hence it can use in the cropland, whose fertility is reduced; MSW can be used to increase the nutrient content in the soil. The collection of samples for the present study, at two MSW dump area as Kundrapara site (KS) and Potiya site (PS). Samples had been collected from open windrow method at the different depth of 0ft, 1ft, 2ft, 3ft, 4ft, and 5ft. The physical properties are the percentage of moisture, pH, electrical conductance, salinity, and organic carbon and chemical parameters are macronutrients (N, P, K, Ca, Mg) and micronutrients (Cu, Fe, Zn, Mn) have been determined by the Flame photometer and Atomic absorption spectrophotometer. Other than this both sites of MSW (KS and PS) were analyzed through Fourier Transform Infrared (FTIR) spectrophotometer and Gas Chromatography-Mass Spectrometer (GCMS). It's compared to normal soil. Spectra of both sites of MSW have indicated that the presence of complex organic compounds (humic acid) and the high concentration of total organic carbon and micronutrients and macronutrients at depth of 5ft of MSW. So MSW can be used as a soil nutrients booster.

Keywords: FTIR; GC-MS; humic acid; Municipal solid waste; nutrient; organic carbon.

Abbreviations: MSW, municipal solid waste: PS, Potiya site: KS, Kundrapara site: FTIR, Fourier Transform Infrared spectrophotometer: GC-MS, Gas Chromatography-Mass Spectrometer: EC, Electrical Conductivity.

I. INTRODUCTION

At this time, the Earth planet generates concerning 1.3 billion tones of solid waste per annum. This volume is predicted to extend to rise to 2.2 billion tones by 2025. The value of the administration of solid waste can increase from today's annual $205.4 billion regarding 375.5 billion in 2025. The cost increase for the management of municipal solid waste is a severe issue for developing and low-income countries [1, 2]. The growing stage of Municipal Solid Waste (MSW) is a critical problem in all residential areas of the world. A high charge of the boom of the population and in the increase per-capita profits have resulted in stable waste an extreme pollutant to soil and water. This is dangerous in the case of developing nations where big quantities of MSW are dumped randomly [2, 3]. MSW is ineffective, unnecessary, discharged as an outcome of human activity. Most usually, they are solid, semi-solid or drinks in packing containers thrown out of houses, business or industrial premises. Any more research gave by the poor supervision of waste has been contaminating the world's seas, stopping up channels, creating floods, and transmitting diseases, therefore MSW can be utilized in agriculture land [4]. In the prevailing duration of time, the massive quantity of MSW creation has posed a hazard to the eco-friendly ecosystem inside the city areas. In India, around three lakh tons of stable waste is generated day by day from the fundamental city center [5-7]. MSW management is crucial trouble in the largest part of the urban cities in India due to the production of its vast amount and non-availability of appropriate and gainful technologies for the treatment and disposal [8]. Srivastava *et al.*, (2020) investigated the MSW converted into vermicompost by vermicomposting method, but in this paper established has been that putrescible MSW can be used as a soil nutrient [9]. There is a need to discover worth- a full and beneficial alternative manner that may help in maintaining the nutrient level in the soil through recycling device, manage environmental pollutants and particularly ideal to Indian Condition [10]. Municipal solid waste (MSW) contains mainly kitchen and yard waste and it has been adopted by many municipalities [11]. In recent years, municipal solid waste has been added to agricultural land to improve soil fertility [12]. In the environment a lot of living being that can change over MSW into significant plant supplements and natural matter [13]. The constructive outcome of MSW on numerous types of soils and plants has been regularly revealed in the writing [4, 6, 7, 10, 12, 13, 15, 16]. This can be done by adopting the technology of composting. This degraded product, which appears like soil (humus) which has excessive in N, P and K is a great medium for growing plant and seed germination [14]. Municipal Solid Waste could provide as a precious organic matter resource given the shortage of organic nutrient sources [15]. Consequently, the focal intent of this work is to study the MSW of PS and KS waste as compared to normal soil, to investigate the possibilities of conversion of MSW into enriched humic acid and organic carbon to evaluate their nutritional quality by Flame photometer, Atomic absorption spectrophotometer, FTIR and GC-MS, techniques.

II. MATERIALS AND METHODS

A. A sampling of Municipal solid waste

The study was carried out in the dump field of 10 years old Potiya site (PS) and 50 years old Kundrapara site (KS). These sites are situated at district Durg in Chhattisgarh state. Samples were taken out by an open windrow pile system from each site of gradual depth are 0ft., 1ft., 2ft., 3ft., 4 ft., and 5ft [17, 20].

B. Reagents

Reagents are prepared in double distilled water and stored in airtight glassware collected from three repetitive zones. Samples had been solar-dried, crushed, sieved and stored in an airtight bottle [17, 20].

C. Analysis of municipal solid waste

Municipal Solid Wastes were analyzed through various spectrophotometers shown in Table 1. The environmental temperature was measured on-site at 42ºC in the summer season.

III. RESULTS AND DISCUSSION

A. Physical Properties of municipal solid waste

The physical properties of MSW PS and KS are shown in Table 2. At the time of sample collection, it was observed that temperature extended from 32ºC to 35ºC in PS, whereas 34ºC to 35ºC in KS. The increment of temperature is because of the expansion of microbial movement due to the high accessibility of supplements [16]. Simultaneously starting moisture content in PS was 1.2 % at 0ft but 18.0% at 5ft. Similarly in KS was 0.46% at 0 ft but 5.7% at 5ft. Moisture content is necessary for the microbial decay of the MSW, which is reported by Sharma *et al.*, [7]. MSW-distilled (1:2) water suspension was used for the measurement of the pH. The highest pH values in PS and KS were 7.8 and 7.6 respectively, which indicates MSW of both sites are neutral towards minutely alkaline. Thus there is an increase in the depth as well as an increase in the pH of both sites samples. The role of pH values lies in the supply of soil nutrients, the solubility of nutrients, the physical breakdown of root cells and ion-exchange capability in the soil. Diverse factors leaching action of waste, environmental conditions may be responsible for pH [17]. The highest electrical conductivity was 0.82 dS/m at 5ft in KS and 0.55 dS/m at 5ft in PS. This is a vital indicator of MSW appropriateness; it affects crop yields, crop suitability, plant nutrient availability and activity of soil microorganisms, which influence key soil approach [15, 9]. Marta Dominguez studied the MSW has higher salinity due to the salts cannot be leached from the foundation region and collect at the surface [12]. Infiltration water also can interact with underlying bedrock that weathers liberating salts which creates salty seeps where it exists which is supported in this paper because the highest value of salinity in PS was 1.1 dS/m at 5ft and on the other hand in KS was 1.3 dS/m at 5ft observed. The high concentration of total organic carbon in MSW has many advantages, as it discharges supplements for plant development, improves the creation of chelates and other soluble organic complexes and gives physical soundness to the soil [18]. The highest value of total organic carbon in PS was 2.0kg^{-1} at 5ft of MSW, whereas the total organic carbon in KS was 2.7 kg^{-1} at 5ft of MSW. The high concentration of total organic carbon in PS, KS had a due to 10 years and 50 years' oldest sites respectively.

Table 1: Instruments are used in various parameters.

Name of instrument	Parameters
Portable soil testing kit and(model no.112)	Physical properties of MSW pH, Electrical Conductivity (EC), Salinity.
Flame photometer (model no.-3L411), EDTA titration method	Macronutrient (N, P, K) and Ca and Mg
Atomic absorption spectrophotometer (model no.-VV2203)	Micronutrient (Zn, Fe, Cu, and Mn.)
Fourier Transform Infrared spectrophotometer (FTIR) model no.-3L411 Perkin Elmer spectrum (Version 10.03.06) The infrared area was (4000 - 400^{cm-1})	Organic functional groups.

Table 2: Physical properties of municipal solid waste.

Physical properties ↓	PS (10 Years Old) Municipal solid waste sample Depth → 0ft.	1ft.	2ft.	3ft.	4ft	5ft.	KS (50 Years Old) 0ft.	1ft.	2ft.	3ft.	4ft	5ft	Normal soil control
Temperature (ºC)	32	32	33	33	34	35*	34	33	33	33	34	35*	30
Moisture %	1.2	1.9	11.5	14.6	17.2	18.0*	0.46	0.63	0.9	1.3	2.4	5.7*	0.03
pH	7.2	7.3	7.5	7.6	7.8	7.8*	6.8	6.9	7.3	7.3	7.5	7.6*	6.2
EC(dS/m)	0.09	0.18	0.27	0.46	0.46	0.55*	0.26	0.30	0.32	0.35	0.49	0.82*	0.03
Salinity	0.2	0.5	0.5	0.8	1.0	1.1*	0.4	0.4	0.4	0.5	0.7	1.3*	0.04
Organic Carbon (kg^{-1})	1.4	1.7	1.8	1.9	1.9	2.0*	2.0	2.2	2.3	2.3	2.4	2.7*	0.09

PS- (Potiya site), KS- (Kundrapara site). At the sampling time, the atmospheric temperature was- 42ºC (summer season). Asterisk* shows in depth of 5ft are the highest value of physical characteristics.

B. Chemical Properties of municipal solid waste

Analysis of Macronutrients: The chemical properties of MSW in PS and KS are shown in Table 3. Macronutrients N, P, K and Ca, Mg are the fundamental component for the development of green plants and can be used as soil macronutrients. Nitrogen is a vital plant supplement, which advances foliar development and increment yield [20]. The highest value of Nitrogen was 501.8kg /ha. at 5ft in PS, whereas on the other hand, Nitrogen was 250.8 kg /ha at 5ft in KS. Mineralization and nitrification of organic Nitrogen can be explained by an equation as mentioned below:

$$OrganicNitrogen \xrightarrow{Nitrosomonas} Nitrite \xrightarrow{Nitrobacter} Nitrate$$

$$2NH_4^+ + 3O_2 \longrightarrow 2NO_2^- + 2H_2O + 4H^+$$

$$2NO_2^- + O_2 \longrightarrow 2NO_3$$

Past writing examines [16] have reported that Phosphorus is especially helpful in fortifying root development. In the present study as the depth increases, the concentration of Phosphorus increases and the most elevated estimation of Phosphorus was 615.8kg/ha at 5ft in MSW of PS and for KS, it was found 635.5 kg/ha at 5ft. the process of mineralization of Phosphorous shown as below-

$$RH_2PO_4 + H_2O \longrightarrow ROH + H_2PO_4^- + H^+$$

Apart from all this, Potassium is also in high quantity. Potassium was the most elevated estimation of about 919.8 kg/ha. in MSW of PS at 5ft and Potassium was 1079.8 kg/ha in MSW of KS at 5ft. Steps of mineralization of Potassium [23, 16] is represented as below-

$$K^+ \text{ ions soil solution} \xrightarrow{fast} \text{readily exchangeable}$$

$$K \longrightarrow \text{slowly exchangeable } K \xrightarrow{veryslow} K \text{ lattice}$$

Presence of Ca and Mg and the ratio of calcium to magnesium is also an important factor in determining the availability of a nutrient. Calcium stimulates root development and influences the uptake of another nutrient and the ratio of Ca and Mg is particularly important in determining nutrient availability [18, 7]. The highest value of Ca was 900 ppm at 5ft of MSW of PS and 450 ppm at 5ft of MSW of KS. Magnesium concentration also increases with depth. The highest value of Mg is 330 ppm at 5ft of PS as well as 160 ppm at 4 and 5ft of MSW of KS.

Analysis of Micronutrients: Micronutrients such as Zn, Fe, Cu, Mn. Zinc helps to make acetic acid in the root to prevent rotting. It is used to control blight and allows dead twig on trees to shed off. Perceived Zinc deficiency is often only symptomatic [24]. Its value increases with increasing depth in KS. The highest value of Zn was 4.7 ppm at 5ft of MSW. While the PS has, a Zn standard was 5.0 ppm at 1ft of MSW. Iron plays an important role in photosynthesis, chlorosis, unhealthy yellow shading to their leaves. Fe is additionally vital for some enzyme function in numerous plants [12]. The most elevated estimation of Fe was 36.9 ppm at 5ft of MSW in PS and as well as 24.6 ppm at 5ft of MSW in KS. Copper is an essential fellow component lack of it can cause hindrance in development and decrease in trim yield. KS has a high estimation of Cu it was 18.0 ppm at 5ft of MSW, whereas 33.2ppm at 5ft of MSW of PS. Manganese promotes germination and functions in the metabolism of plant growth [12]. Its value increases with increasing depth in PS. The highest value of Mn was 83.8 ppm at 5ft for PS while 55.9 ppm at 5ft of KS.

Table 3: Chemical properties of municipal solid waste.

	PS (10 Years Old)						KS(50 Years Old)						
Macronutrient (k.g/ha) ↓	→ **Depth** 0ft.	1ft.	2ft.	3ft.	4ft	5ft.	0ft.	1ft.	2ft.	3ft.	4ft	5ft	**Normal soil** control
Nitrogen (N)	125.4	188.1	188.1	250.8	250.8	501.8*	125.4	162.7	188.1	188.1	188.1	250.8*	37.5
Phosphorus(P)	278.7	450.1	500.2	572.8	602.4	615.8*	195.6	226.0	353.3	437.5	455.4	635.5*	40.0
Potassium (K)	8 96.0	896.6	917.6	918.4	918.5	919.8*	591.0	675.4	709	806.3	1046.1	1079.8*	60.0
Calcium (Ca)	230.0	320.0	330.0	470.0	630.0	900.0*	150.0	200.0	200.0	240.0	280.0	450.0*	55.0
Magnesium (Mg)	30.0	80.0	170.0	260.0	230.0	330.0*	50.0	90.0	130.0	150.0	160.0	160.0*	25.0
Micronutrient (ppm) ↓ Zinc (Zn)	4.1	4.3	4.4	4.5	4.7	5.0*	4.1	4.2	4.4	4.4	4.5	4.7*	1.2
Iron (Fe)	16.7	19.8	19.9	20.9	23.9	36.9*	11.9	16.9	21.9	23.0	23.4	24.6*	12.2
Copper (Cu)	8.18	14.8	17.14	24.7	33.2	33.2*	5.9	9.3	9.8	10.1	10.2	18.0*	4.2
Manganese (Mn)	10.6	11.5	36.2	36.7	49.2	83.8*	11.3	15.3	15.7	18.6	26.0	55.9*	8.7

PS - Potiya site, KS- Kundrapara site. Asterisk* shows in depth of 5ft is highest value of chemical characteristics.

C. Fourier Transform Infrared (FTIR) spectra

The FTIR spectra of normal soils are shown in Fig.1 and the FTIR spectra of MSW of PS and KS at 0ft, 1ft, 2ft,3ft, 4ft, 5ft are simultaneously shown in Fig. 2-7 respectively. The high intensity of peaks were 3622.4cm^{-1} (secondary and tertiary O-H alcohol stretching) were obtain in normal soil, 3621.1 cm^{-1} to 3621.6 cm^{-1} in MSW of PS(0ft-5ft) and 3621.3 cm^{-1} to 3621.8 cm^{-1} in MSW of KS (0ft-5ft).3420.7 cm^{-1} Hydroxy group of bonded O-H stretching present in normal soil, similarly Hydroxy group of bonded O-H stretching 3402.0 cm^{-1}to 2417.9 cm^{-1} presents in MSW of PS (0ft-5ft) and 3408.0 cm^{-1} to 3417.5 cm^{-1} strong peaks were obtained in MSW of KS (0ft-5ft). 3020.05 cm^{-1} O-H bond in the acid group and alkenes(C-H) stretching are present in 5ft of MSW of PS, but absent in MSW of KS and normal soil. In addition to this 2515.2 cm^{-1} to 2518.5cm^{-1}Carboxylic acid and derivative are present in MSW of PS(0ft-5ft) and 2516.5 cm^{-1} to 2518.1 cm^{-1} acid and derivative are present in MSW of KS (0ft-5ft), but absent in normal soil .1871.5cm^{-1} Aromatic compounds were present in normal soil and 1871.6 cm^{-1} to 1873.2 cm^{-1}Aromatic compounds were present in MSW of PS (0ft-5ft), whereas 1871.5 cm^{-1} to 1873.3 cm^{-1} Aromatic compounds were present in MSW of KS (0ft-5ft). Whereas 1630.2 cm^{-1} Quinone and conjugated ketones were present in normal soil, 1628.2 cm^{-1} to 1634.2 cm^{-1}Quinone and conjugated ketones were present in MSW of PS (0ft-5ft) and 1628.9 cm^{-1} to 1631.0 cm^{-1}Quinone and conjugated ketones were present in MSW of KS (0ft-5ft), as well as1526.8 cm^{-1} Secondary amine (N-H) bend and Aromatic nitro compounds were present in normal soil,1578.68 cm^{-1} to 1522.81 cm^{-1} Secondary amine (N-H) bend and Aromatic nitro compounds were present in MSW of PS (0ft-5ft) and 1573.97 cm^{-1} Secondary amine (N-H) bend and Aromatic nitro compounds were present in MSW of KS (0ft-5ft).1368.5 cm^{-1} Phenol was present in normal soil, 1385.74 cm^{-1} Phenol was present in MSW of PS at 5ft. And 1385.56 cm^{-1} Phenol was present in MSW of KS at 5ft. Apart from all this, Primary amine(C-N stretch), Polysaccharides were present in normal soil, 1019.44 cm^{-1} to 1036.9 cm^{-1}, similar functional groups were present in MSW of PS at 0ft to 5ft. 695.4cm^{-1} alcohol was present in normal soil, 627.13 to 695.7 alcohols were present in MSW of PS (0ft-5ft). And 641.6 to 695.4 alcohols were present in MSW of KS at 0ft to 5ft [22]. The strong peaks were present in MSW of KS as well as MSW of PS. simultaneously has been compared from normal soil. The spectra clearly show a high proportion of–OH, -COOH and Quinone and conjugated Ketones groups which are the maximum character and capabilities of soil humic material. Previous little literature according to the author [25] found functional groups of complex organic compounds (humic acid) present in MSW.

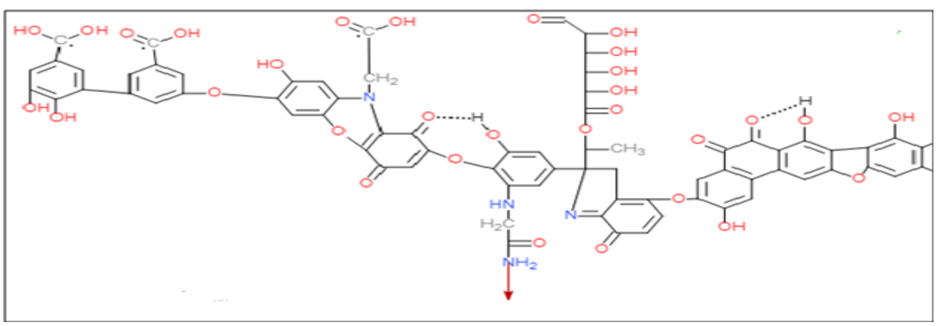
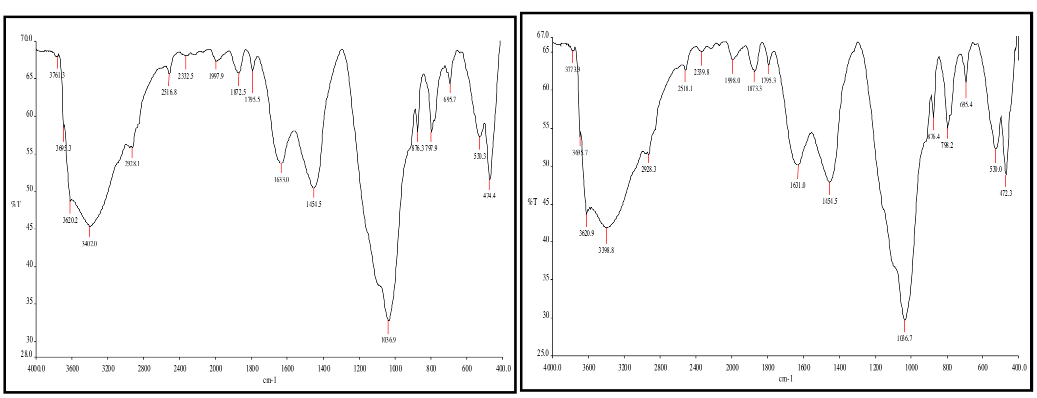
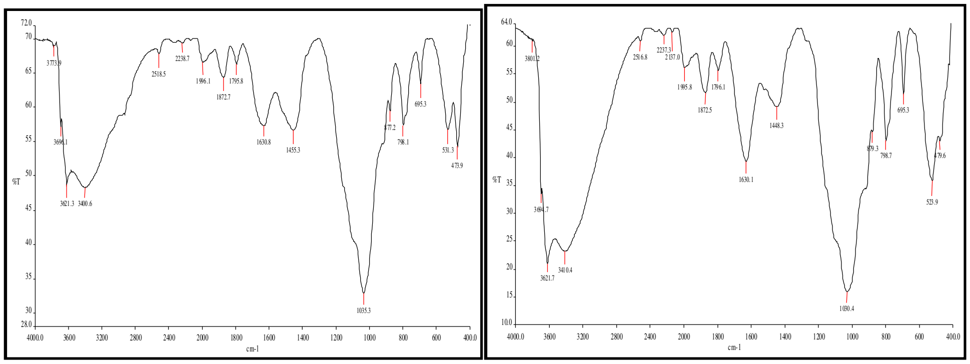


Fig. 1. Structure of Humic acid.



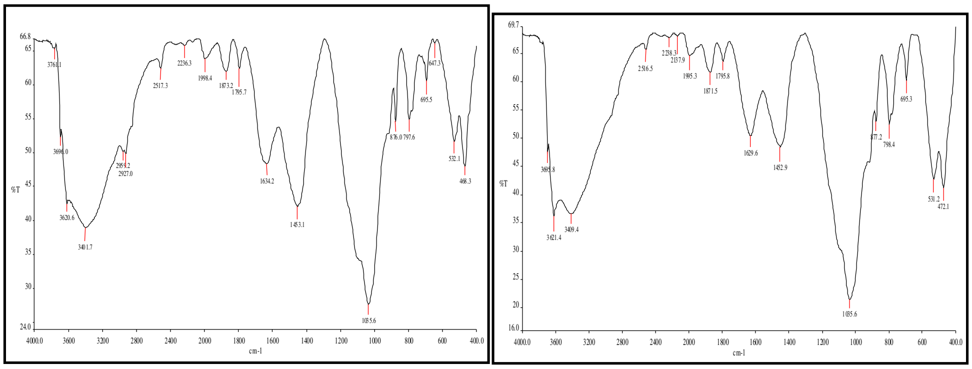
(a) (b)

Fig. 2. Fourier transforms infrared (FTIR) spectra at 0ft of MSW PS (a) and KS (b).



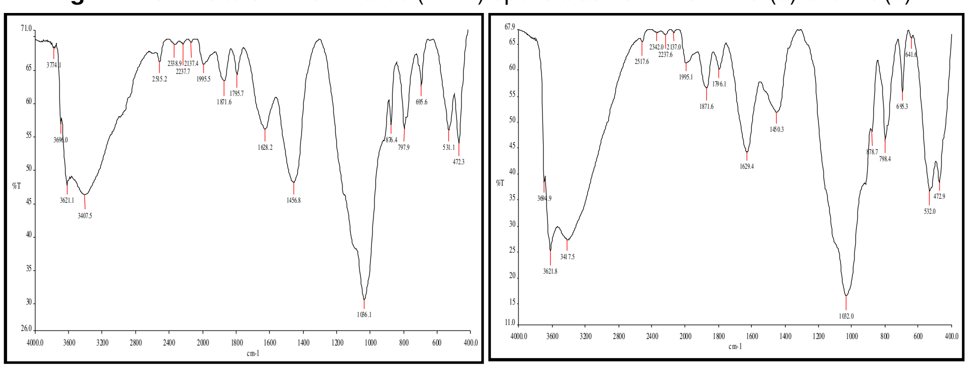
(a) (b)

Fig. 3. Fourier transforms infrared (FTIR) spectra at 1ft of MSW PS (a) and KS (b).



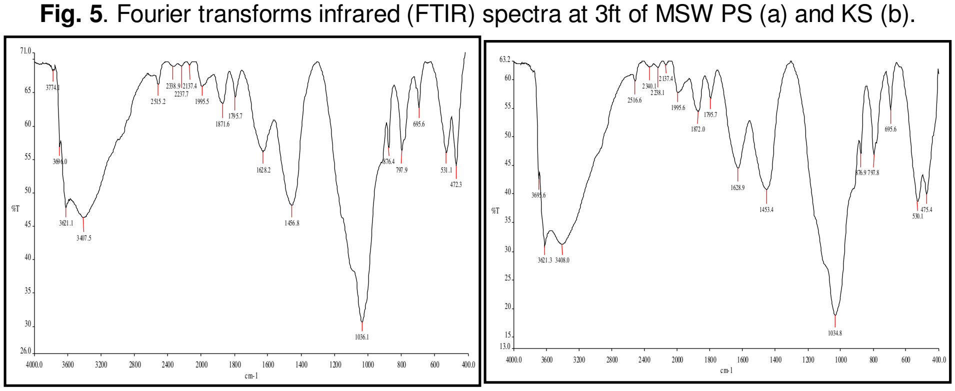
(a) (b)

Fig. 4. Fourier transforms infrared (FTIR) spectra at 2ft of MSW PS (a) and KS(b).



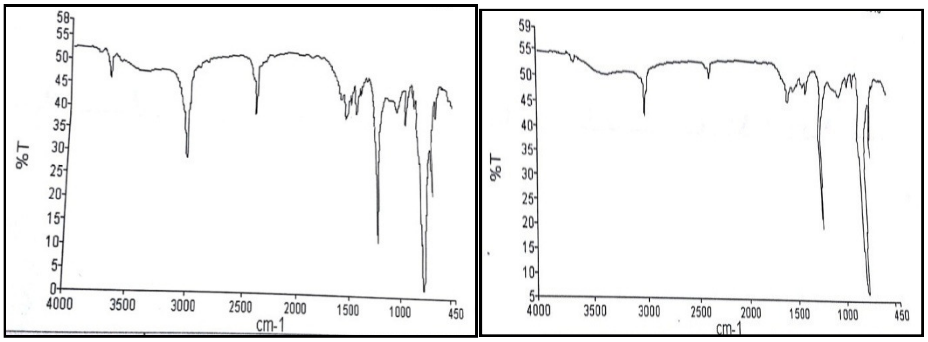
(a) (b)

Fig. 5. Fourier transforms infrared (FTIR) spectra at 3ft of MSW PS (a) and KS (b).



(a) (b)

Fig. 6. Fourier transforms infrared (FTIR) spectra at 4ft of MSW PS (a) and KS (b).



(a) (b)

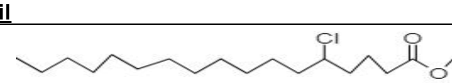
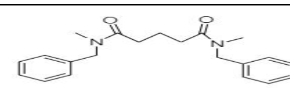
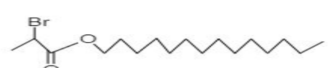
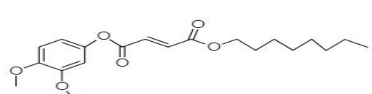
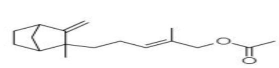
Fig. 7. Fourier transforms infrared (FTIR) spectra at 5ft of MSW PS (a) and KS (b).

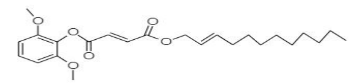
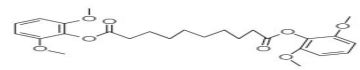
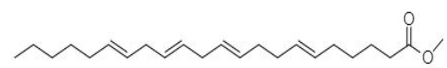
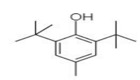
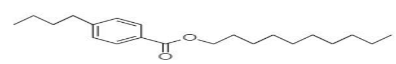
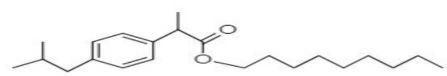
The result has the strong peaks of functional groups of complex organic compounds (humic acid) present in MSW. The equivalent data is supported in the present study. According to the reported study the structure of humic acid shown in 1.

D. Gas chromatography and Mass Spectroscopy (GC-MS)

The outcome of FTIR was additionally confirmed with the help of GC-MS spectroscopy. GC-MS information indicates that the presence of greater relative molecular mass substances in MSW of PS and KS with compare to normal soil has been shown in Table 4. In the same way, GC-MS spectra of normal soil, PS and KS have been shown in Fig. 8, 9, 10 respectively. The á•Santanol acetate has present in both MSW but not present in normal soil. The molecular formula of á•Santanol acetate is $C_{17}H_{26}O_2$ and molar mass is 262. The probability of this compound in MSW of PS and KS was 26.37, 32.65 respectively, values indicate that the higher probability of MSW of KS than MSW of PS. However, most of the various organic compounds were different in both MSW. Data from GC-MS spectra concluded that humic-like substances have been present in MSW, so MSW of both sites can be used as a soil supplement [24, 25].

Table 4: List of Compounds identified in GC-MS spectra by NIST Database including Compound Name, Molecular Formula, Molar mass (g/mol) in the MSW of PS, KS and normal soil.

Compound name	Molecular Formula	Molar mass (g/mol)	Probability	Structure
Organic compounds of Normal soil				
5-Chloroheptadecanoic acid, methyl ester	$C_{18}H_{35}ClO_2$	318	23.24	
8-Tetadecen-1-ol acetate	$C_{16}H_{30}O_2$	254	11.98	
Glutaricacid,diamide,N,N'dimethyl N,N'dibenzyl	$C_{21}H_{26}N_2O_2$	338	6.14	
2-Bromopropionic acid,tetraadecvl ester	$C_{17}H_{33}BrO_2$	348	5.18	
Organic compounds of MSW of PS				
Fumaric acid,3,4-dimethoxy phenyl octyl ester	$C_{20}H_{28}O_6$	364	33.55	
Santalol acetate(Z)	$C_{17}H_{26}O_2$	262	26.37	

Fumaric acid,2,6-dimethoxyphenyl dodec-2-en-1-yl ester	$C_{24}H_{34}O_6$	418	18.61	
Sebacic acid, di(2,6-dimethoxy phenyl) ester	$C_{26}H_{34}O_8$	474	4.28	
Organic compounds of MSW of KS				
Santalol acetate (Z)	$C_{17}H_{26}O_2$	262	32.65	
7, 10, 13,16-Docosatetraenoic acid, methyl ester	$C_{23}H_{38}O_2$	346	8.19	
Butylated hydroxytoluene	$C_{15}H_{24}O$	220	6.27	
4-Butybenzoic acid, decyl ester	$C_{21}H_{34}O_2$	318	6.03	
Ibuprofen, nonyl ester	$C_{22}H_{36}O_2$	332	4.74	

MSW-(Municipal solid waste), PS –(Potiya site), KS- (Kundrapara site). Structure draw by Chem draws JS sample page software.

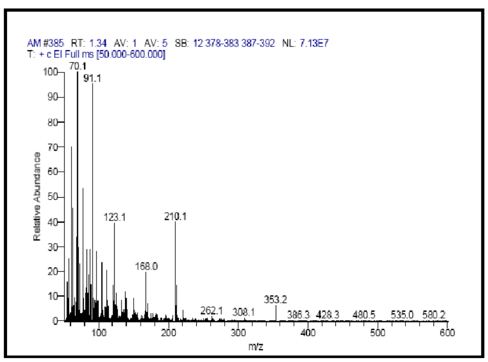


Fig. 8. GC-MS spectra of normal soil

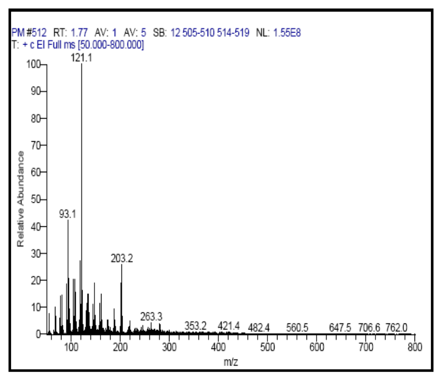


Fig. 9. GC-MS spectra of MSW Potiya site (PS).

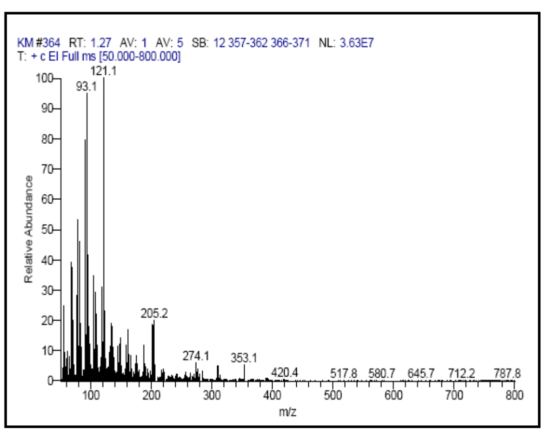


Fig. 10. GC-MS spectra of MSW Kundrapara site (KS).

IV. CONCLUSION

In the FTIR spectra of MSW, intensities of peaks range are which strongly confirms the presence of humic acid and its functional groups. Comparative analysis of GC-MS spectra of MSW of Potiya, Kundrapara, and normal soil results that MSW has high molecular weight organic substances and higher presence of the total organic carbon, which is one of the parameters for good MSW. Interpretation of physical and chemical properties of MSW and presence of N, P, K, Ca, Mg, Cu, Fe, Zn, and Mn at high concentration level indicates the presence of rich nutrient quality in MSW. Humic acid, micro, and macronutrients play a vital role to increases the soil's capability to hold water and make the soil appropriate for cultivation. Based on the above statements, it may be concluded that MSW can be used as organic fertilizer as a whole or in the form of additive in soil. It can be a better replacement for chemical fertilizers for agriculture purposes.

V. FUTURE SCOPE

– Complex organic compound present in municipal solid waste gets stabilized and converted into a simple compound. The use of mature solid waste composed gives a less economic option of fertilizer in place of costly chemical fertilizers.
– Aerial and groundwater contamination can be prevented.
– When composted municipal solid waste will be applied to the soil, it will help to counteract the gradual depletion of soil organic matter due to cropping.
– Literature shows that huge accumulation of municipal solid waste in the environment occupied large useless land areas and ultimately it degrades soil quality through leachates of it. The proposed technique may be able to minimize the above problem.
Thus proposed methodology gives an alternative utilization of municipal solid waste in an environmentally safe way.

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Conflict of Interest. The authors declare that they have no conflict of interest.

REFERENCES

[1]. Gokcekus, H., Kassem, Y., & Musa, M. K. (2020). Environmental impact of a municipal solid waste landfill in North of Iraq. *International journal of innovative technology and exploring engineering, 9*(3), 756-763.
[2]. Hoang, N. H., & Fogarassy, C. (2020). Sustainability evaluation of municipal solid waste management system for Hanoi (Vietnam) - why to choose the waste to energy concept. *Sustainability, 12,* 1-20.
[3]. Rana, R., Gangly, R., & Gupta, A. K. (2018). Physico-chemical characterization of solid waste management from the Tricity region of northern India. *J. Mater Cycl. Waste Manage, 20*(1), 678-689.
[4]. Almendro-Candel, M. B., Navarro-Pedreño, J., Lucas, I. G., Zorpas, A. A., Voukkali, I., & Loizia, P. (2019). The Use of Composted Municipal Solid Waste under the Concept of Circular Economy and as a Source of Plant Nutrients and Pollutants. In *Municipal Solid Waste Management*. *Intech Open*, 1-19
[5]. Mowa, E., Akundabweni, L., Chimwamurombe, P., Oku, E., & Mupambwa, H. A. (2017). The influence of organic manure formulated from goat manure on growth and the yield of tomato (*Lycopersicum esculentum*). *African Journal of Agricultural Research*, *12*(4), 3061-3067.
[6]. Zhang, M., Wang, W., Tang, L., Heenan, M., & Xu, Z. (2018). Effects of nitrification inhibitor and herbicides on nitrification, nitrite and nitrate consumptions and nitrous oxide emission in an Australian sugarcane soil. *Biology and Fertility of Soils*, *54*(6), 697-706.
[7]. Sharma, A., Gangly, R., Gupta, A. K. (2019). Spectral characterization and quality assessment of organic compost for agricultural purposes. *International journal of recycling of organic waste in agriculture*, 197-213.
[8]. Singh, D., & Kumar, A. [2017]. Geoenvironmental application of municipal solid waste incinerator ash stabilized with cement. *Journal of rock mechanics and Geotechnical Engineering*, *9*(2), 370-375
[9]. Srivastava, V., Vaish, B., Singh, R. P., & Singh, P. (2020). An insight to municipal solid waste management of Varanasi city, India, and appraisal of vermicomposting as its efficient management approach. *Environmental Monitoring and Assessment*, *192*(3), 191-196.
[10]. Haghighi, M., Barzegar, M. R., & da Silva, J. A. T. (2016). The effect of municipal solid waste compost, peat, perlite and vermicompost on tomato (*Lycopersicum esculentum* L.) growth and yield in a hydroponic system. *International Journal of Recycling of Organic Waste in Agriculture*, *5*(3), 231-242.
[11]. Cesaro, A., Conte, A., Belgiorno, V., Siciliano, A., & Guida, M. (2019). The evolution of compost stability and maturity during the full-scale treatment of the organic fraction of municipal solid waste. *Journal of environmental management*, *232*, 264-270.
[12]. Domínguez, M., Núñez, R. P., Piñeiro, J., & Barral, M. T. (2019). Physicochemical and biochemical properties of an acid soil under potato culture amended with municipal solid waste compost. *International Journal of Recycling of Organic Waste in Agriculture*, *8*(2), 171-178.
[13]. Wolka, K., & Melaku, B. (2015). Exploring selected plant nutrient in compost prepared from food waste and cattle manure and its effect on soil properties and maize yield at Wondo Genet, Ethiopia. *Environmental Systems Research*, *4*(1), 1-7.
[14]. Rastogi, M., & Nandal, M. (2018). Composting an emerging technology for solid waste management in India. In *Handbook of Research on Microbial Tools for Environmental Waste Management* (pp. 105-126). IGI Global.
[15]. Rastogi, M., Nandal, M., & Nain, L. (2019). Additive effect of cow dung slurry and cellulolytic bacterial inoculation on humic fractions during composting of municipal solid waste. *International Journal of Recycling of Organic Waste in Agriculture*, *8*(3), 325-332.

[16]. Iqbal, M. K. (2018). Composing of Municipal Solid Waste and Its Use as Fertilizer. *Soil Productivity Enhancement*, 35-55.
[17]. Gupta, N., & Agrawal, M. (2014). Improvement of Soil Physical and Chemical Properties with Municipal Solid Waste Compost Application in soya bean (Glycine max), Mung (Vignaradiate), Lentil (Lens culinaris) Seeds. *International Journal of Scientific Engineering and Technology*, *3*(12), 1418-1423.
[18]. Manohara, B., Belagali S. L., & Ragothama S. (2017). Study of decomposition pattern during aerobic composting of MSW by physicochemical and spectroscopic method. *Int. J. Chem. Tech Res*. *10*, 27-34.
[19]. Paradelo, R., & Barral, M. T., (2017). Availability and fractionation of Cu, Pb, and Zn in an acid soil from Galicia (NW Spain) amended with Municipal Solid Waste compost. *Span J. Soil Sci*. *7*, 17-25.
[20]. Gupta, N., & Agrawal, M. (2014). Influence of municipal solid waste compost on germination and seedling growth of Dicotylidon seeds. *American International Journal of Research in Formal Applied and Natural Science*, *1*(8), 51- 56.
[21]. Paradelo R., Villada, A., & Barral, M. T. (2018). Chemical fractionation of trace elements in a metal-rich amphibolite soil amended with municipal solid waste compost. *Waste biomass valor*, *9*, 1935-1943
[22]. Coates, J. (2006). Interpretation of infrared spectra, a practical approach. *Encyclopedia of Analytical Chemistry R.A. Meyers(Ed).*10815-10837. *John Willey & Sons Ltd.*
[23]. Al-Faiyz, Y. S. (2017). CPMAS 13C NMR characterization of humic acids from composted agricultural Saudi waste. *Arabian Journal of Chemistry*, *10*, S839-S853.
[24]. Monda, H., Cozzolino, V., Vinci, G., Spaccini, R., & Piccolo, A. (2017). Molecular characteristics of water-extractable organic matter from different composted biomasses and their effects on seed germination and early growth of maize. *Science of the Total Environment*, *590*, 40-49.
[25]. Javanshah, A., & Saidi, A. (2016). Determination of humic acid by spectrophotometric analysis in the soils. *International journal of advanced biotechnology and research*, *7*, 19-23.

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