



RESEARCH ARTICLE

ANALYTICAL CHEMISTRY

INDUSTRIAL SLUDGE AS A FERTILIZER SUBSTITUTE*Corresponding Author***P.V. S. MACHIRAJU**Dept. of Chemistry, P.R.Govt. College (Autonomous), Kakinada –
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ABSTRACT

The present study is aimed to characterize the sludge generated from paper, Sugar and Agro Oil industries to assess its agro potential to consider as fertilizer substitute. The parameters analyzed are pH, Electrical Conductivity (EC). Na, K, Ca, Mg, Nitrogen, Phosphorus, Percent Sodium, Sodium Absorption Ratio (SAR). Percent Sodium and SAR found to be with in the permissible limits indicating their suitability for irrigation purposes. NPK ratios are measured to estimate the manure potential. The levels of heavy metals Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb are with in the permissible limits compared to CPCB standards. Further studies have been carried out on germination and seedling growth of four vegetable crops *Abelmoschus esclentus*, *Cyanmopsis tetragonoloba*, *Lycopersicon esclentum* and *Solanum melongea* to assess the Agro potential of the sludge as composite with black soil.

KEY WORDS

Sludge, Sodium Absorption Ratio (SAR), Irrigation and Heavy metal.

INTRODUCTION

The agro-based Industries are the largest generators of pollution. It is caused mainly due to the wastewater and solid wastes generated during their manufacturing processes¹ However, the effluents are biodegradable because they contain mainly organic pollutants. These materials can be utilized as animal feed or manure or further refined to base produce useful and marketable products.

Elivera et al.,² have developed a technique for vermi composting of sludge from paper mill with "Eiseniaandri" where in the vermi compost produced was rich in nitrogen and phosphorus, low heavy metal concentration, high humic content and good stability and maturity. Agricultural land application studies on pulp and paper mill sludge in the Donnacona area of Quebec resulted in a significant increase in yield in respect of cereal and potato crops³. Physico chemical characteristics of lime sludge from paper mill and its impact on growth and production of rice was reported by Medhi et al.,⁴. Further the pot level experiments on growth and yields also revealed that 10-30% lime sludge applied in the soil has increased height of the plants, number of seeds and dry weight of rice.

The studies of Prabhakara Reddy et al.,⁵ made an attempt to utilize nutrient rich industrial and domestic organic wastes from sugar industry and municipal sludge along with farm yard manure as a control, for effective reclamation of degraded land. Organic carbon content ranged from 20 – 46 %; nutrient contents were: N – 0.37 to 1.69 %, P – 0.17 to 1.64 %, and K – 0.10 to 0.73 %. Nitrogen and phosphorus content was substantially high in sugar industry waste. Studies Lakshmi Bai et al.,⁶ are carried out on

the methodology to convert filter cake from sugar industry into bio-compost using two exotic, epigeic earthworms, *Eisenia foetida*, a Chinese species, and *Eudrilus eugeniae*, an African species. Results indicate, *Eudrilus eugeniae* can compost sugar factory waste filter cake into a useful organic fertilizer. A method Kim Young Gu⁷ was described for the preparation of calcium hydroxide fertilizer utilizing sludge from sugar industry. The studies of Molotilin, Yu et al.,⁸ revealed that pre lining sediment is rich in calcium, phosphorus, and protein and trace minerals (Fe, Zn, Mn, Cu) and contains no appreciable residues of heavy metal and pesticides. The optimum conditions obtained Lavini Lupa 9 for heavy metal extraction from sugar sludge incorporating the parameters like influence of the acid concentration employed, agitation time and liquid to solid ratio.

Large scale composting of oily sludge mixed with horse manure and bark to reduce the contents of total hydrocarbons in a mixture of oily waste, horse manure and bark were carried out by Froling et al.,¹⁰ and the studies revealed that the compost can be used as a final cover at the landfill for establishing of plants and grass. The use of oil-shale fires and lime shale as starting materials for the synthesis of soil fertilizers was described by Mangrich et al.,¹¹.

Keeping in view of the Agricultural and Industrial prospects of East Godavari region, Andhra Pradesh, India and the importance of demand and production of Paper, Sugar and Edible oils and the release of significant quantities of sludge, studies have been carried



out on Characterization to assess the Potentials and prospects for considering it as a fertilizer substitute.

MATERIAL AND METHODS

Sampling sites: The Paper, Sugar and Agro oil industries located in East Godavari district of Andhra Pradesh, India generating considerable quantity of Sludge are selected for the study. The sludge sample is dried at 105°C, powdered and used for analysis as per the standard procedures CPCB¹², Jackson¹³ and APHA¹⁴ for

the parameters P^H, Electrical conductivity, Calcium, Magnesium, Sodium, Potassium, Nitrogen, Phosphorous Percent Sodium and Sodium Absorption Ratio (SAR) and heavy metals like Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd, Pb. Sludge composites with black soil in 1:1 are employed for the pot level cultivation trials for studies on germination and seedling growth of four vegetable crops with black soil as control.

Sludge from paper, Sugar and Agro oil industries is characterized and the data is presented in table-1

Table – 1

Characterization of Sludge from Paper, Sugar and Agro oil Industries

S.No.	Parameter	Paper Sludge	Sugar sludge	Agro-Oil Sludge
1.	pH	8.0	8.4	7.78
2.	Electrical Conductivity (µmhos/cm)	839	1078	4220
3.	Total Organic carbon (TOC) (%w/w)	70.42	27.79	61.31
4.	Sodium (mg/kg)	224	936	3130
5.	Potassium (mg/kg)	102	372	420
6.	Calcium (mg/kg)	3359	1070	10792
7.	Magnesium (mg/kg)	1925	2156	6045
8.	Kjeldahl nitrogen (mg/kg)	556	6524	980
9.	Total phosphorus (mg/kg)	6115	BDL	3255
10.	Percent Sodium (me/L)	2.88	14.45	11.49
11	Sodium Absorption Ratio (SAR) (me/L)	0.76	3.78	5.97

The heavy metal levels present in sludge are presented in table – 2.

Table - 2
Heavy metal concentrations in sludge

Heavy metal	Paper	Agro Oil	Sugar	CPCB Schedule-2 [rule 3(1) (b)] ¹⁵
Units:-	mg/L	mg/L	mg/L	mg/L
Cr.	BDL	451	27	5000
Mn	86	470	610	--
Fe	2760	7000	9900	--
Co	BDL	BDL*	BDL	5000
Ni	12	42	30	5000
Cu	15	13	72	5000
Zn	87	185	57	20000
Cd	3.7	5.4	5.2	50
Pb	50	79	312	5000

The details of NPK ratio which indicates the manure potential are presented in table – 3.

Table – 3
Ratio of N,P,K in Sludges

S.No	Industry	N:P:K
1	Paper	5.45:60:1.
2	Sugar	17.53: BDL: 1
3	Agro oil	2.33:7.75:1

An investigative study has been carried out on the germination and seedling growth of four vegetable crops such as *Abelmoschus esculentus* (Lady Finger), *Cyanmopsis tetragonoloba*

(Clustered beans), *Lycopersicon esculentum* (Tomato) & *Solanum melongea* (Brinjal).

The plant height data of the vegetable crops through pot-cultivation trials for a period of 20 days are presented in table-4.



Table- 4
Details of vegetable plant height on 20th day in soil and sludge composite with soil

Industry	Plant	Plant height in	Plant height in
		Soil	Soil+sludge
		(cm)	(cm)
Paper	<i>Abelmoschus esclentus</i>	15.0	17.0
	<i>Cyanmopsis tetragonoloba</i>	9.0	10.0
	<i>Lycopersicon esclentum</i>	7.0	5.0
	<i>Solanum melongea</i>	4.0	3.2
	Sugar	<i>Abelmoschus esclentus</i>	14
	<i>Cyanmopsis tetragonoloba</i>	9.0	12.0
	<i>Lycopersicon esclentum</i>	7.0	10.4
	<i>Solanum melongea</i>	4.0	7.0
Agro Oil	<i>Abelmoschus esclentus</i>	15.0	10.0
	<i>Cyanmopsis tetragonoloba</i>	9.0	7.0
	<i>Lycopersicon esclentum</i>	7.0	3.0
	<i>Solanum melongea</i>	4.0	3.8

RESULTS AND DISCUSSIONS

pH and Electrical Conductivity: The pH of the Sludge range from 7.78 to 8.40 which falls within the no problem range of 6.5 – 8.5 Ayer¹⁶. Soils with Electrical Conductivity greater than 4000 $\mu\text{mhos/cm}$ Thomas et al.,¹⁷, which has saline in nature and generally not recommended for irrigation purposes. When compared to these soils, the sludge generated from Agro oil Industry has an Electrical Conductivity value of 4220 $\mu\text{mhos/cm}$ is well above the permissible limits while the EC of paper and Sugar sludge are with in the permissible limits.

Percent Sodium and Sodium Absorption Ratio (SAR): Soils with percent sodium values greater than 60 are not suitable for irrigation purposes IS: 2296-1963¹⁸. Soils with sodium Absorption Ratio (SAR) values greater than 13 are generally not recommended for irrigation IS: 11624 –

1986¹⁹. The percent sodium and SAR for the sludges are within the permissible limits and can be considered for irrigation purposes.

Manure Potential: The sludges are found to contain N, P and K except Phosphorus in sugar sludge.

CONCLUSIONS

- 1) The Electrical conductivity (4220 $\mu\text{mhos/cm}$) of Agro Oil sludge is above the permissible limits while of Paper and sugar sludge is with in the permissible limits.
- 2) Percent sodium and Sodium Absorption Ratio (SAR) are with in the permissible limits.
- 3) The heavy metal concentrations are with in the permissible limits.



4) The pot level cultivation trials for a period of 20 days in respect of *Abelmoschus esculentus* and *Cyanmopsis tetragonoloba*, *Lycopersicon esculentum* and *Solanum melongea* vegetable crops revealed that the composite of sugar industrial sludge with black soil has Agro potential on the plant growth of all the four vegetable crops and the composite of paper industrial sludge with black soil has agro potential on two vegetable crops *Abelmoschus esculentus* and *Cyanmopsis tetragonoloba* while the sludge

composite of Agro Oil industrial sludge with black soil has no potential on the growth of all the four vegetable crops.

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