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ASSESSMENT OF SEASONAL VARIATIONS IN THE PHYSICO-CHEMICAL COMPOSITION OF SEWAGE IRRIGATION WATER AROUND PATHAKADAPA AREA OF YSR DISTRICT, ANDHRA PRADESH

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ABSTRACT

An investigation was carried out during 2019-2020 to characterize and study the seasonal changes in the composition of sewage water used for irrigating rice fields in Pathakadapa area of YSR district. Results depicted certain seasonal variations in physico-chemical characteristics of sewage water. Effluents collected in different time intervals were dark in colour with appreciable quantities of suspended and dissolved solids with high values of BOD and COD. The sewage effluent had alkaline pH and high EC with appreciable quantities of Cl^{-1}, SO_4^{2-}, CO_3^{2-}, HCO_3^-, Na^+, K^+, Ca^{2+} and Mg^{2+} and variable amounts of heavy metals. A marked seasonal variation in composition of sewage water was observed and further, with distance from the source the constituents were decreased in all the directions. Sewage water registered heavy metals Cu, Mn, Cd, Pb and Ag more than the permissible limits of FAO (1985).

KEY WORDS: Sewage water, effluents, characterization, seasonal variations, heavy metals.

INTRODUCTION

Rapid growth in population leads to urbanization and industrialization which resulted in diversion of larger amounts of fresh-water in to domestic, commercial, and industrial sectors, generating greater volumes of wastewater (Gurjar and Kaur, 2018). Today, due to the constraint in availability of the freshwater for irrigation, wastewater especially sewage water is being used for irrigation of agriculture fields in arid and semi-arid regions. It has been estimated that typical wastewater from domestic sources could supply all the nutrients that are normally required for agricultural crop production (FAO, 1992). Out of 30 million tonnes of waste water produced annually all over the world, 70 per cent is consumed as an agricultural fertilizer and irrigation source (Rattan *et al.,* 2005). Hamilton *et al.* (2007) reported that globally around 20 million ha of land being irrigated with reclaimed wastewater, and the amount would increase markedly during the next few decades as water stress intensifies.

Sewage water has a high nutrient load, suspended solids heavy metals and many other toxic chemicals which may be hazardous and affect the soil quality, plant growth and development. Waste water not only contains nutrients that enhance the growth of crop plants but also has micronutrients and heavy metals *viz*., Zn, Cu, Fe, Mn, Pb, Ag, Cr, Co and Cd which may readily be absorbed by crops grown on these soils.

Kadapa, the largest corporations of Rayalaseema region of Andhra Pradesh disposes 100 million liters per day (MLD) of waste water on average. Irrigation water scarcity in summer which coincides with the peak crop water requirement of summer rice, result in farmers interest to use sewage water discharged into the KC (Kurnool-Kadapa) canal as an unconventional water resource to directly irrigate the paddy crop approximately in 10,000 ha. Therefore a study was conducted at Pathakadapa with an objective to characterize and assess the seasonal variations in the composition of sewage water.

MATERIAL AND METHODS

Experimental site

The study of characterization of waste water was carried out by collecting the effluent samples from the point sources near Watergandi, Modameedipalli, Vukkayapalli, Obulampalli of YSR district having geo-coordinates as detailed in Table 1.

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Table 1. Geocordinates of the point sources of sewage water in study area.

S. No.	Discharge point	Latitude (North)	Longitude (East)
1.	Modameedipalli	14° 31' 841"	78° 50' 760"
2.	Vukkayapalli	14° 29' 240"	78° 51' 020"
3.	Water gandi	14° 32' 172"	78° 50' 838"
4.	Obulampalli	14° 31' 657"	78° 50' 479"

Sample collection

Sewage water samples were collected in air tight polythene containers of one litre capacity at periodical intervals from Patha Kadapa area in four radiant directions during summer (April – June) and winter (October to December). Immediately after the collection, suitable preservatives were added to prevent the microbial degradation and sealed. The samples were brought to the laboratory at Agricultural Research Station, Utukur, Kadapa for detailed analysis.

Sewage water analysis

Parameters like pH, EC were determined potentiometry and conductometry, total dissolved solids by gravimetry. BOD and COD by titrimetry. Heavy metals (Fe, Zn, Cu, Mn, Pb, Hg, Cd and Cr) in the water samples were measured by using AAS. The other estimations for the characterization of sewage water were carried out by following standard procedures laid out by Tandon, 1998.

RESULTS AND DISCUSSION

The data so obtained over the two seasons *viz.*, summer and winter were presented in Tables 2 and 3.

Sewage water samples collected from the study area were analyzed for various physico-chemical parameters and were represented as values of summer and winter seasons. Amount of all the physico-chemical parameters were expressed in milligrams per litre (mg l^{-1}) except EC (expressed in dS m^{-1}) and pH.

The pH of sewage water was slightly alkaline during winter (7.93 to 7.62) and with exceptionally high in summer (8.18 to 8.27). The high pH might be due to hydrolysis of sodium containing compounds in the sewage water, anthropogenic activities (Velusamy and Kannan, 2016). Electrical Conductivity, a good indicator of total salt concentration in water can cause toxicity of a particular ion, affects osmotic pressure when recorded high. EC values during summer (1.54 to 2.69 dS m^{-1}) and winter (1.64 to 2.04 dS m^{-1}) exceeded the permissible limit (2.0 dS m^{-1}) given by FAO(1985). The high EC could be due to the presence of various inorganic soluble salts and chemicals in the effluents as reported by Saha *et al*. (2015) Berissa *et al*. (2019).

High TDS values were observed during summer (663 to 850 mg l^{-1}) than in winter (507 to 839 mg l^{-1}), well above the prescribed range of 500 mg l^{-1} (FAO, 1985), which were in accordance with the reports of Velusamy and Kannan, (2016). The presence of appreciable quantities of dissolved solids in the sewage water could attributed to the dissolution of minerals, nutrients that have dissolved in raw wastewater from households, industries, weathering or dissolution of soil and rocks along the stream that generates ions in water. (Bhat *et al*., 2018).

In both seasons biological oxygen demand (BOD) of effluents was more than the limits prescribed by ISI, 1985 for discharge into inland surface water and irrigation. This might be ascribed to the presence of large amounts of suspended and dissolved solids in the sewage water samples (Khan *et al.* 2017, Berissa *et al*. 2019). Further, the BOD values were decreased in winter (49-103 mg L^{-1}) than summer (79-214 mg L^{-1}) due to less biological activity and less availability of waste for degradation (Velusamy and Kannan, 2016).The mean COD values in both seasons and at four locations were within limits given by ISI, 1982 (500 mg L^{-1}). Similar results were made by Hidri *et al*. (2013) and Hanamantarao and Dasog, (2019). As like that of BOD, the COD of the sewage also recorded higher values in summer due to the presence of organics and inorganics in sewage water and its disintegration that consumes more oxygen than the biological degradation (Velusamy and Kannan, 2016).

Table 2. Chemical composition of sewage water at four locations of the study area during summer and winter.

Parameter	Watergandi		Modameedipalli		Vukkayapalli		Obulampalli	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
pH	8.21	7.51	8.24	7.39	8.27	7.62	8.18	7.56
EC	2.69	2.38	2.13	2.04	2.57	2.48	1.54	1.64
TDS	780	623	663	507	850	839	708	521
COD	272	152	452	290	106	55	246	130
BOD	160	103	214	157	79	49	127	78
Nitrates	0.25	0.09	0.54	0.21	0.40	0.13	0.52	0.13
Phosphates	4.54	3.52	5.29	5.36	9.67	8.53	4.91	4.58
Potassium	7.71	5.52	8.67	7.04	12.48	11.51	5.61	4.88
Calcium	44.00	30.63	37.75	27.00	43.98	34.75	36.38	21.00
Magnesium	11.83	5.13	13.30	10.20	17.55	16.98	17.13	10.20
Sodium	85.19	75.69	178.90	198.30	149.13	192.02	91.18	117.36
Carbonate	190.50	38.45	179.50	48.00	198.75	48.00	195.75	48.00
Bicarbonate	70.65	57.85	123.75	70.95	260.09	170.80	149.45	80.83
Chlorides	151.79	95.14	197.47	151.76	263.15	254.71	164.64	102.06
Sulphates	73.10	28.18	51.12	20.34	43.23	39.14	394.86	293.58

The present study showed relatively lower concentrations of NO_3-N in the effluent acceptable for irrigation (< 5 mg L^{-1}) as per FAO, 2003 standards. In general higher nitrates were observed during summer (0.25 to 0.54 mg L^{-1}) than in winter (0.09 to 0.21 mg L^{-1}). This might be due to the little usage of the nitrogen containing chemicals at households. While, phosphate content was found to go beyond the permissible limits (<5 mg L^{-1}) according to ISI, 1983 by recording a range of 4.54 to 9.67 mg L^{-1} in summer and 3.52 to 8.53 mg l^{-1} in winter. High phosphate concentration in the effluent was observed more prominently in Ukkayapalli (9.67 mg L^{-1}, 8.53 mg L^{-1}). This was due to the presence of phosphorous in sewage most likely be due to detergents and food residues and their breakdown products (Hidri *et al*., 2013, Bincy *et al*., 2015 and Velusamy and Kannan, 2016).

The sewage water collected in the study area from four locations during summer and winter seasons recorded appreciable amounts of sodium, potassium, calcium and magnesium. Among four cations, sodium registered relatively higher concentration than 70 mg L^{-1} (FAO, 1985) in both the seasons. The chemicals like caustic soda for washing, chlorine and hypochlorite in bleaching and powdered lime stone used by the corporation might be responsible for higher amounts of sodium. The findings are in agreement with earlier reports of Abbas *et al*. (2015), Velusamy and Kannan (2016), Maurya and Srivastava (2019). All the other cations *viz.,* potassium, calcium and magnesium were within the acceptable limits. These ions are observed at higher concentrations during summer than winter. The results are in agreement with earlier reports of Khan *et al*. (2017).

The sewage water collected in both the seasons contained very high chlorides, sulphates, carbonates and bicarbonates. The chloride concentration was higher than the permissible level (180 mg L^{-1}) affecting the quality of irrigation water. However, relatively higher chlorides were observed during summer (151.79 to 263.15 mg L^{-1}) than in winter (95.14 to 254.71 mg L^{-1}). Similar trend of seasonal variation was observed by Kaboosi (2017) Maurya and Srivastava, 2019. Higher sulphate

Table 3. Heavy metal composition of sewage water at four locations of study area during summer and winter

Parameter	Watergandi		Modameedipalli		Vukkayapalli		Obulampalli	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Iron	1.15	0.41	2.48	0.09	1.45	0.14	2.50	0.14
Manganese	0.54	0.36	0.39	0.04	0.22	0.04	0.53	0.03
Copper	2.82	0.67	8.07	0.64	3.20	0.49	4.82	0.84
Zinc	0.98	0.28	2.04	0.06	1.00	0.14	1.27	0.03
Cadmium	0.14	0.10	0.24	0.32	0.14	0.12	0.16	0.15
Lead	1.72	1.42	1.65	1.20	2.14	2.03	2.21	2.12
Silver	0.11	0.10	0.10	0.10	0.31	0.10	0.09	0.09

concentration was observed during both summer (43.23 to 394.86 mg L^{-1}) and winter (20.34 to 293.58 mg L^{-1}) which are above the permissible levels, FAO (1985). High sulphate concentration might be due to frequently used household detergents, drain cleansers, and animal wastes (Korostynska *et al*., 2012). The results are in conformity of the findings of Meena *et al*. (2016), Maurya and Srivastava (2019).

Heavy metals

Of the analyzed heavy metals Fe (0.09 to 2.48 mg L^{-1}) and Zn (0.030 to 2.00 mg L^{-1}) were well within the acceptable range of irrigation (FAO, 1985) in summer and winter. Relatively lower concentrations of heavy metals were recorded in winter. Fe (0.09 to 0.41 mg L^{-1}), Mn (0.03 to 0.36 mg L^{-1}), Cu (0.49 to 0.84 mg L^{-1}), Zn (0.03 to 0.28 mg L^{-1}), Cd (0.10 to 0.16 mg L^{-1}), Pb (1.20 to 2.12 mg L^{-1}) The heavy metals like Cu (0.49 to 8.07 mg L^{-1}), Cd (0.10 to 0.32 mg L^{-1}) and Ag (0.09 to 0.31 mg L^{-1}) were above the maximum permissible level in the sewage water in both the seasons (Table 3). As per FAO (1985) the recommended maximum concentrations of Fe, Mn, Cu, Zn Cd, Pb and Ag for use of waste water in agriculture are 5.0, 0.2, 0.1, 2.0, 0.01, 2.0, 0.05 mg L^{-1}, respectively.

CONCLUSION

Variations were found in the composition of sewage water during summer and winter. COD, Nitrates, potassium, heavy metals like Fe and Zn in sewage water were within the permissible limit prescribed for irrigation purpose. TDS, BOD, sodium, chlorides, sulphates and carbonate concentrations were above the permissible level for irrigation suggesting the restriction on the use of sewage water for certain crops.

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