Madras Agric. J. 90 (1-3) : 124-128 January-March 2003

Nature and characteristics of sewage effluents of Tamil Nadu

N. CHANDRASEKARAN AND B. RAJKANNAN
Dept. of Soil Science and Agrl. Chemistry, Tamil Nadu Agrl. Univ., Coimbatore - 641 003, Tamil Nadu

Abstract: A survey has been carried out in different districts and municipalities of Tamil Nadu, during 1995-'96 for characterising and assessing the suitability of sewage effluents for agriculture. The raw sewage, primary and secondary treated sewage representing separately for urban and domestic areas were collected and analysed in the laboratory with particular weightage for assessing their agricultural use. The pH, EC and water quality parameters remained well within the normal limits of irrigation water quality. The heavy metal content was also low. The urban raw sewage suffered from poor water quality parameters and relatively high content of heavy metals particularly Ni, Cr and Pb. However it carried considerable amounts of plant nutrients. The treated sewage effluent both primary and secondary level with regard to domestic and urban had certain beneficial effects, reduction in suspended solids/BOD and COD/ heavy metals and water quality parameters improvement could be observed.

Key Words: Sewage effluents, Water quality appraisal, Quality of irrigation water.

Introduction

The sewage is well known as a complex heterogenous multifaceted matrix. The physical, chemical and microbiological constituents are decided by varied kinds of raw materials that account for its origin and production. In the absence of large scale industries in rural areas, the sewage produced is largely from domestic activities and consequently the composition is not a very serious concern. Contrarily, urban sewage, an admixture of domestic and industrial waste water resulting in their composition more complex. In the present investigation interest was focused to know the nature and composition of the sewage and in this process a distinction was made between domestic and urban sewage. The practices of primary treatment or secondary treatment are being done to refine the sewage in certain farms. The changes in the composition due to treatments were also aimed in the study.

One among the point of gratification in the sewage effluent is the high nutritive value associated with it (Shende, 1988). Another point deserving emphasis is the content of heavy metals. Unfortunately, many sewage contain heavy metals from industrial sources in addition to those present in human wastes. Among heavy metals, the value of certain heavy metals by way of micronutrients is of added significance for crops. Most of the micronutrients presei in the sewage is in sufficient quantites to mee the crop need (Adhikari *et al.* 1992). The composition of sewage by and large, considerably influenced by the industries located withir the area of coverage. This is of great concern from the point of heavy metal concentration. In the present investigation, interest was tuned to know the type and concentrations of heavy metals.

Materials and Methods

In order to study the composition of raw sewage, representative samples from 18 locations (ten domestic and eight urban) were collected during 1995-'96. To represent primarily treated effluent, 11 samples (four domestic and seven urban) were collected. For secondarily treated effluent, samplings were done from three locations and the diluted sewage was collected from one place only.

These samples were analysed (AOAC, 1962) for physical and chemical nature with particular weightage for their agricultural use as irrigation water. Physical properties such as BOD and COD were evaluated and under chemical properties, pH and EC were estimated. The results are presented in the Table 1 to 3.

Table 1. Physico-chemical properties and agricultural value of raw sewage [illegible]

Parameter	pH	EC dSm^{-1}	Suspended solids (mg l^{-1})	BOD (mg l^{-1})	COD (mg l^{-1})	SAR	RSC (me l^{-1})	SSP	Potential Salinity (meq l^{-1})
Raw sewage-domestic	8.6	2.64	1462	321	542	4.73	-2.22	48.42	15.61
Raw sewage-urban	7.6	4.41	2318	390	755	8.23	-1.96	57.97	28.77
Primary treated sewage-domestic	8.45	1.65	428	235	370	3.45	-0.99	43.81	9.78
Primary treated sewage-urban	7.33	2.70	604	254	386	5.37	-1.96	50.63	15.87
Secondary treated sewage-urban	7.95	3.43	396	80	160	6.59	-5.73	53.55	24.93
Dilute sewage (1:4-sewage : Cauvery water)	7.10	1.93	625	80	160	2.92	-1.21	52.97	5.94

Results and Discussion

Raw sewage-domestic

The mean pH was 8.64 and EC was 2.64 dSm^{-1}. The slightly alkaline pH could be attributed to the detergents present in the sewage water. The EC value is obviously attributed to the salts used in the process of cooking and washings. Kiyoshi Moriana *et al.* (1989) had also reported that the composition of domestic sewage were the result of food, tap water, detergent and soap. It is a matter of gratification that the vital water quality parameters such as SAR and RSC were not unfavourable for agricultural use, the only point deserving attention is the marginaly enhanced SSP values which were again attributed to relatively high sodium content.

The nutrient value of the sewage was of added relevance. Apart from contributing to organic matter enrichment, the fertility value deserves emphasis. From the nitrogen, phosphorus and potassum constituents, a cm depth irrigation of sewage can be expected to supply nitrogen, phosphorus and potassum to the levels of 7.74, 2.08 and 2.65 kg ha^{-1}. From the fertility consideration, another feature was the supplementation of much added micronutrients as per the composition, a cm depth irrigation add to soil 584, 91.5, 401 and 59.2 g ha^{-1} of Fe, Mn, Zn and Cu. The fertility value by far was the result of admixture of faeces, urine, vegetable waste and animal waste etc. The fertility value of domestic sewage was also finds the support with the work of Bahri (1987) and Gladis (1995). While the fertility value remain favourable there can not complacency since the sewage also carried non nutritive heavy metals, many of them beyond critical limits, mention can be made of Cr, Ni and Pb perhaps the vessels employed served as a chief source of origin. As against the normal critical limits of 0.10, 0.20 and 5.00 mg l^{-1}, the raw sewage contained excess over the critical limits. The existance of excess heavy metals in the domestic sewage was also reported by Davis and Jackson (1975) and Bahri (1987). The point of concern is that the crop may grow well in view of high fertility value but also accumulates the above heavy metals in soil and plants and there by pose environmental problem.

The sewage possessed high fertility value based on the mean content of nitrogen, phosphorus and potassium, the contribution was to the levels of 11.3, 4.87 and 5.56 kg ha^{-1} cm of sewage. The micronutrient values were also relatively high by way of contributing 1.56, 0.24, 1.12 and 0.27 kg ha^{-1} of Fe, Mn, Zn and Cu also per every ha^{-1} cm of sewage irrigation. Consideration of the negative points for their diversion to agriculture use as

Table 2. Heavy metal contents of sewage effluents of Tamil Nadu (ppm)

Parameters	Zn	Cu	Fe	Mn	Pb	Cd	Cr	B	Co	Ni	Mo
Raw sewage-Domestic	4.01	0.59	5.84	0.92	0.87	0.22	1.42	0.19	0.14	1.00	0.07
Raw sewage-Urban	11.75	2.90	15.57	2.38	3.15	1.06	3.87	0.52	1.12	6.48	0.36
Primarily treated sewage-Domestic	1.62	0.43	3.76	0.36	0.29	0.11	0.36	0.12	0.07	0.50	0.04
Primarily treated sewage-Urban	2.07	1.54	7.18	1.22	1.95	0.54	1.64	0.18	0.37	3.44	0.18
Secondarily treated sewage-Urban	4.43	1.79	9.98	1.29	2.03	0.90	1.44	0.38	0.90	2.14	0.23
Diluted sewage (1:4 sewage : Cauvery water)	2.02	0.12	2.62	0.14	0.20	0.49	0.28	0.02	0.01	0.06	0.01

is the case with domestic sewage the non-nutriti heavy metal load was abnormally high and like to set in environmentally related problem. Adhika et al. (1992) also investigated the quality of urba effluent and invariably found their suitability fc irrigation and high content of non nutritive heav metals.

Raw sewage-urban

From the results presented, the point whic goes in favour for the agricultural use is th the sewage is a rich source of organic matte (one litre of sewage carried 2318 mg of organi solids). Similar high quantities were earlier reporte by Marcos de Monte *et al.* (1989). Both pH and EC were not serious limitations for usin as irrigation water. However, specific cases o high acidity or alkalinity also were noticed du to the particular industrial effluent. The wate quality parameters SAR and RSC remained safe Perhaps the water quality parameter assuring wat problem was SSP owing to relatively more sodiu getting access into sewage. This finds the suppo with the work of Bharadwaj and Gaur (1985) who found high SSP in raw sewage.

Consideration of negative points for their diversion in almost all cases and hence associated effects such as clay sodium equilibration, specific ion effect of sodium are likely to operate such as clay sodium equilibration of urban sewage point to the fact that they are no doubt a potential source but continuous usage would set in such problems like salinity built up, sodicity development, ionic antagonisms did toxic accumulation of undesirable elements in the soil and plants. Similar findings were also reported by Adhikari *et al.* (1992).

Primarily treated sewage effluent-domestic

The process of primary treatment involves simple lagooning and subsequently natural oxidation where by the suspended colloidal particles of the sewage get partly or wholly coagulated and floculated. Both positive and negative effects occur from the point of agricultural use. The changes brought out in the positive direction are, the reduction of BOD and COD values occur through marginally the organic matter in the form of micro colloids still existed to be of value as organic source. There was considerable reduction in dissolved salts

Table 3. Nutritive and agricultural value of sewage of Tamil Nadu (ppm)

Parameters	Ca^{2+}	Mg^{2+}	Na^+	K^+	Total-N	No_3-N	NH_4-N	P
Raw sewage – Domestic	129.6	58.03	260.5	26.52	77.37	3.52	59.06	20.80
Raw sewage – Urban	190.4	66.23	555.1	55.62	112.5	12.95	84.27	48.73
Primarily treated sewage – Domestic	84.35	42.18	149.0	26.13	52.50	3.88	40.63	9.15
Primarily treated sewage – Urban	140.9	52.71	294.3	39.45	76.37	7.20	60.23	11.95
Secondarily treated sewage – Urban	175.5	54.76	388.5	60.19	65.58	11.51	52.57	9.85
Diluted sewage (1:4 sewage : Cauvery water)	42.40	12.84	84.18	4.29	24.16	1.10	18.20	9.42

with the range declining to 1.57 to 2.05 from 1.64 t0 3.04 dSm^{-1} observed under raw domestic sewage. The above is understadable because, considerable suspended materials along with salts get coagulated and settled. This result finds the support with the work of Marcos de Monte *et al.* (1989). The various water quality parameters were modified more favourably for agricultural use. The only noteworthy negative effect of treatment was the removal of coagulable organic substances which otherwise may serve as a good source of organic matter. However, the sludge itself can be recycled for agriculture, where harmful effects will not be produced. Similar views were also expressed by Panicker (1994).

Due to the primary treatment, the value of the sewage as a nitrogen carrier increased while P and K contents and also micronutrient concentration particularly Fe were marginally decreased. The non-nutritive heavy meals got reduced and thereby their link to environmental issues were minimised.

Primary treated sewage effluent-urban

From the results presented, the agricultural value of the urban sewage prior to their treatment leaves much to be desired. Apart from high BOD and COD values, the SSP and potential salinity values were relatively high. The primary treatment as in the case of domestic sewage brought about certain changes here as well. The desirable effects include reduction of BOD and COD, the reduction in EC and water quality parameters becoming more favourable.

The primary treatment as in the case of domestic sewage brought about certain changes here as well. The undesirable effect observed was that despite reduction in micronutrients and heavy metals, the levels were critical for use in agriculture. This was arisen due to the initial high load of heavy metals contributed by admixture of industrial waste waters. Similar findings were also reported by Marcos de Monte *et al.* (1989). The consideration of urban sewage revealed that there was refinement of the sewage and modification in the direction of enhanced suitability for agricultural use. But at the same time, the potential hazardous nature by way of carrier of sufficiently higher amounts of non nutritive heavy metals continued to exist warranting management strategies for exploitation.

Diluted sewage-domestic

Dilution of the sewage can be considered as one of the means of managing it for agricultural use. But this can arise only where plenty of water is available and feasible. In the present investigation, there was one isolated case namely. Mettur, where this practice is in vogue. The appraisal of the effect of 1:4 dilution revealed diminishing of salt concentration, BOD and COD values, favourable alteration of water quality parameters. The above effects are obvious, since the water used for dilution was of good quality in nature and the physical process of dilution tended to move the quality of the sewage more favourable for crop growth (Shende, 1988).

The appraisal of the effect of 1:4 dilution revealed diminishing of salt concentration, reduction of fertility value and minimising of pollution hazards. The process of dilution obviosuly transformed the sewage more closer to normal irrigation waters with added benefit of nutrient carriers.

Secondarily treated sewage effluent-urban

The secondary treatment involves further refining of primarily treated sewage by way of chemical and biological treatments including oxidation through aerators. As a result hazardous materials is further reduced in terms of heavy metals carrier and pathogenic nature. The results generated on the quality of secondarily treated sewage effluent and its relation to the original untreated sewage brought to light a phenomenal improvement in many respects. Not only the BOD and COD values diminished markedly but also the various water quality parameters got modified more favourably. The only issue was that the SSP values remained marginally high. It was apparent that the secondarily treatment undoubtedly transformed sewage into a highly potential irrigation source that could be employed with minimal hazards in the soils and plants. The reduction in hazardous nature of raw sewage due to secondary treatment was also reported by APHA (1981), Bahri (1987) and Panicker (1994).

References

Adhikari, Mitra, A. and Guptha, S.K. (1992). Post irrigation effect of sewage application on soil micronutrients and some heavy metals in north eastern fringe of Calcutta. Proc. Workshop on micronutrients. IBFCEP-HFC, Calcutta, pp.280-293.

APHA (1981). Standard method for examination of water and wastewater. American public health association, Washington.

AOAC. Association of official agricultural chemists (1962). Official and tentative methods of analyss of association of official agricultural chemists, Washington, pp.354.

Bahri, A. (1987). Utilisation of treated waste and sewage sludge in agriculture in Tunisia. *Desalinisation*, **67**: 233-244.

Bharadhwaj, K.K.R. and Gaur, A.C. (1985). Recycling of organic wastes. ICAR, New Delhi, pp.104.

Davis, J.A. and Jackson, J. (1975). Heavy metal in waste water in three urban areas. *J. Water Pollu. Control Fed.* **47**: 2292-2297.

Gladis, R. (1995). Influence of wastewater irrigation and graded levels of N and P on soil properties and response of fodder sorghum. M.Sc.(Ag.) Thesis, TNAU, Coimbatore

Kiyoshi Moriana, Tadahino Mor, Hidetoshi Anayashiki and Mituo Chino (1989). The amount of heavy metals derived from domestic wastewater. *Water Sci. Technol.* **21**: 1913-1916.

Marcos de Monte, Silva Souiza and Silva Neves, A. (1989). Effect of soil and crops of irrigation with primary and secondary effluents. *Water Sci. Technol.* **21**: 427-434.

Panicker, P.V.R.C. (1994). Recycling of human wastes in agriculture and aquaculture. *In*: Recycling of crops, animals, human and industrial wastes in agriculture. (Ed) H.L.S. Tandon, Fertiliser Development and Consultant Organisation. New Delhi, pp.68-70.

Shende, G.B. (1988). Status of wastewater treatment and agricultural reuse with special reference to Indian experience and research and development needs. Proc. FAO regioal seminar on treatment and use of sewage effluent for irrigation. Nicosia, 7, Oct. 1985, London.

(Received : February 2002; Revised : April 2002)