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Generation and management of household municipal solid wastes in extension and town areas of Tiruvarur, Tamilnadu, Southern India

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Abstract

Growing population, fast urbanization, rising income, increasing economic activities, changing life style and consumption pattern have been increasing the generation of solid wastes especially in urban areas of India. We assessed the generation and management of household municipal solid waste in the extension and town areas of different socioeconomic classes (low, middle and high income groups) of Tiruvarur during 2004 -2005. The parameters of demography, monthly income and area of residence varied significantly among the classes except total population of the household which varied between areas. The community practices of the households of extension area indicated that they were better in solid waste management practices than that of the town area. Totally 24 different solid wastes were segregated and among these wastes the quantity of vegetable peels followed by food wastes and fruit wastes were the dominant solid wastes. Furthermore, the mean weight of envelope, ball point pen, plastic buckets, plastic toys, other plastics, glass, medicine bottles, light bulbs, building debris, fruit peels, cattle dung and waste batteries showed significant variations between areas and among the socioeconomic classes. In both areas 100% households failed to segregate, recycle and home compost the wastes generated. Hence, we suggest the households to segregate the wastes and recycle the inorganic wastes and home compost the organic wastes and thereby reduce the quantum of waste generation. In addition, we recommend the Tiruvarur municipality to adopt effective, efficient and scientific management of solid wastes by converting them into productive resources such as input for power generation, laying of plastic roads, vermicomposting and production of organic manures.

Keywords : community practices, socio-economic class, solid waste management, waste composition, waste quantification

INTRODUCTION

The explosion of population coupled with rapid urbanization, rising income and consumption and increasing economic activities have changed the life style of Indian society into "throw- away society". This new age of convenience and consumerism has brought about a sea change in the composition of wastes and has also resulted in an enormous solid waste generation (Rashid, 2007) which is an acute environmental problem. The per capita waste generation in urban areas varies with the size of population (NEERI, 2005) and has been reported to be of the order of 350 g to 400 g per day in average Indian towns (Kala and Khan, 1994).

Municipal solid wastes contain vegetables, toxic substances, compostable organic wastes and soiled wastes that arise out of various kinds of domestic and commercial activities (Patil, 2009). Municipal solid waste management is associated with the regulation of generation, collection, transfer and transportation, processing and disposal of solid wastes in an economically compatible manner adopting principles of economy, aesthetics, energy and conservation of resources (Buclet and Godard, 2000). Since municipal solid waste management has become the fundamental requirement for public health, Article 48-A of Indian Constitution entails this responsibility with the local governments which is an obligatory function. However, the current practices of uncontrolled dumping of waste on the outskirts of towns and cities have created a serious environmental and public health problem (Kumar and Gaikwad, 2004).

In India, totally 75 municipal corporations and about 1770 municipalities are involved in solid waste management (Ahamed and Jamal, 2000). A study by Rashid (2007) in Kashmir, India found totally, 14.89% households disposed their wastes into river or lakes, 14.98% dumped wastes into municipal bins and garbage dumps, 37.23% thrown on the streets, 21.47 % in the open spaces and 11.43 % used for household compost Rao (2007) reported that in which, about 94 percent of municipal solid wastes are still land filled. In India the Municipal agencies are reported to spend 5-25% of the budget on solid waste management which is Rs. 75-250 per capita per year (Kumar and Gaikwad, 2004). Though the management of solid waste is an obligatory

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duty of municipal bodies, yet in most of the Indian situations they failed to make adequate provisions for effective, efficient and scientific management of solid wastes (Sharholy *et al*., 2008).

Hence, we attempt to analyze the present practice of municipal solid waste management with reference to Tiruvarur municipal town area, Tamilnadu, South India and its extension area during 2004-2005. The main objectives of the present study are to assess the composition of solid wastes produced by the households of town and extension areas, the management strategies adopted by them and to suggest management recommendations for effective waste management strategies.

STUDY AREA

Tiruvarur municipality was established in 1914 when Tiruvarur was in the integrated Thanjavur district, Tamilnadu State, Tamilnadu. Then Thanjavur district was trifurcated into Nagapattinam, Tiruvarur and Thanjavur districts. Tiruvarur district lies between 10°14′ and 11°02′ North longitude and between 79°4′ and 79°8′East latitude. Tiruvarur district lies on the west of Nagapattinam, east of Thanjavur, North of Thiruthuraipoondi and south of Mayiladuthurai. Total area of Tiruvarur municipal town is 10.47 Km^2. The length of municipal road is 73.39 km and the length of highway roads is 18.75 km. The total number of wards in Tiruvarur municipality is 30 with 214 streets (Fig. 1). The total population of Tiruvarur town is 56341. The total number of residential are 10786 and commercial establishments are 2796 which includes 7 industries and 22 marriage halls. The total generation of solid wastes is approximately 18.6 metric tonnes per day which includes 16.74 metric tonnes of degradable wastes, 1.15 metric tonnes of non-degradable wastes and 0.71 metric tonnes of recyclable wastes (unpublished Tiruvarur Municipal Town Action Plan Reports 2003-2004).

MATERIALS AND METHODS

Area classification

The amount of solid wastes generated by the residents depends upon the location of the house. Hence, the study area Tiruvarur is classified into Extension and Town areas for data collection.

Extension area: The newly formed residential area adjacent to Municipal town which extends upto 3 km from the township. The households residing beyond 1km of the town and within 3km radius of the town were included in this category.

Town area: The households residing within 1km radius of the town were included in this category. All the 30 municipal wards were included under this category.

Socio-economic classification

The amounts of solid wastes produced by households are influenced by the income of the family. Therefore, the households are classified in the following categories based on the total income of the family. The total income of the households of the present study varied from rupees (Rs.) 1000 to 12,000. Hence arbitrarily the households are classified in the following ways.

Low income group: The average monthly income of this group is less than Rs. 5000

Middle income group: The average monthly income of this group ranged from Rs. 5000 to 10000

High income group: The average monthly income of this group is above Rs. 10000

Sampling

Totally, 150 households each from extension and town areas have been selected on convenient random sampling method. In each area the total sample covers 50 households each from low, middle and high income groups.

Data collection

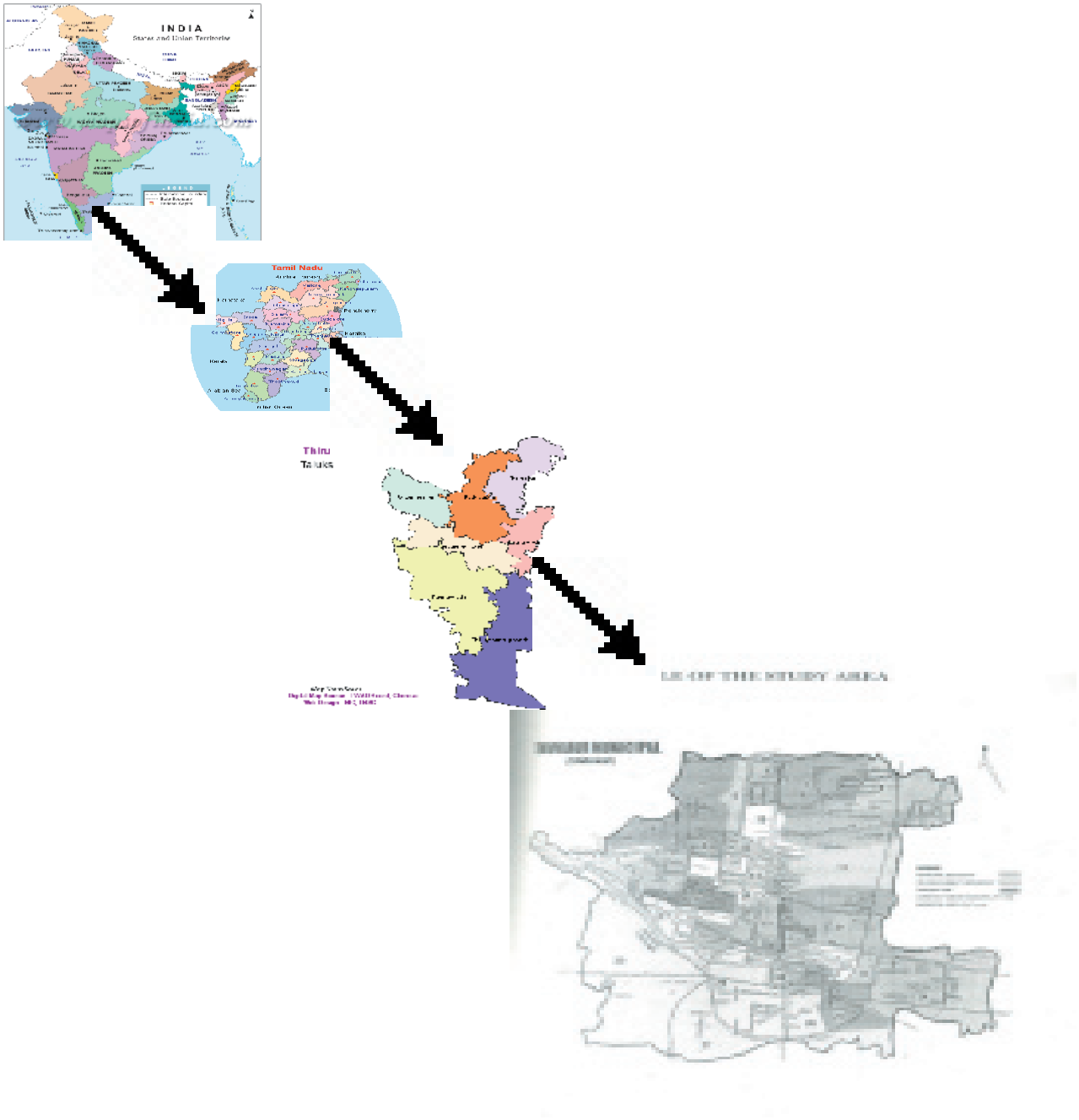
Totally 300 sample households both in extension and town areas were interviewed with pre tested schedule containing questions regarding demographic profile, economic indicators, house details and household waste management practices.

Quantification of solid wastes

Assessment of different solid wastes was made at the door steps of the sample households between 6.00 a.m. and 10.00 a.m. before the collection of daily wastes by municipal waste pickers (municipal worker who collects household and street wastes daily). The sample household wastes were segregated and weighed separately with a hand held balance and were recorded. Waste production is usually much higher in festival seasons. Hence, this assessment was made only during normal period excluding social and individual family festival periods to avoid bias in data collection. The solid waste is grouped into paper wastes (packing materials including carton boxes, paper based materials and envelopes), plastic wastes (polythene carry bags, plastic bottles, plastic buckets, plastic tumblers, plastic toys, plastic balls, ball point pens, and other plastics), glass wastes (light bulbs and medicine bottles), building debris including metals and wood wastes, kitchen waste (waste food, vegetable and fruit peels) other domestic organic wastes (old clothes, plant remains, cattle dung) and waste batteries.

Data analysis

The data were entered in window based Excel spread sheet. The data were expressed as mean 1 ±S.D for all the replicative variables. The differences between areas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and among socio-economic classes in the components of solid waste generation, demographic profile, economic indicators and house details were tested using two way analysis of variance. All the statistical analyses were done using Minitab (Ryan *et al.,* 1992) statistical package.

RESULTS

Profiles of households surveyed in Tiruvarur Municipality

Variations in the demographic profile, economic indicators and house details of different socio-economic classes of extension and town areas of Tiruvarur Town are given in table 1. The demographic profile varied significantly among different socio-economic classes sample and as well as between Town and extension areas (Two-way ANOVA; $p < 0.05$). The income among the socioeconomic classes varied significantly but not between areas. Data on the mean total housing area indicated that both smallest (755.2±331.4 sq. ft of low income group) and largest (2182.0± 602.4 sq. ft. of high income group) houses were in the extension area. There was a gradual increase in the mean housing area, building area and vacant area across the socioeconomic classes both in the extension and town areas. The differences in housing area, building area and vacant area varied significantly among the socioeconomic classes but not between extension and town areas (Table 1).

Community practices in solid waste management at Tiruvarur Municipality

Usage of dustbin

Generally households used some types of containers as dustbins for storing the daily solid wastes arising form the households. In the extension area, 65.33% of house holds had single dustbin, 31.33% had two dustbins and 3.33% had three dustbins inside the house for the whole house. Whereas in the town area 94% of households had single dustbin 5.33% had two dustbins and 0.67% had three dustbins.

In extension area, 78.67% of households used plastic dustbins, 58.67% used bamboo bins and 18.67%, used wooden bins and in town area, 84% used plastic dustbins, 24.67% used bamboo bins and 0.67% used wooden bins.

Dumping of wastes

Totally, 96% of households had waste pits and 4% had no waste pits in the extension area. On the contrary 92.67% of the town households did not have pits and only 7.33% had waste pits. In extension area, 3.33% of the households did not dump and the remaining 96.67% dumped the garbage. On the other hand, in town area, 95.33% of sample households did not dump the garbage and 4.67% dumped in the garbage. In extension area, 97.33% of households cleaned their houses twice a day and 2.67% cleaned their house thrice a day. In town area, 100% of sampled households cleaned their houses twice a day.

Recycling and segregation of wastes

It was found that none of the households sampled both in extension and town areas recycle the garbages. Both in the extension and town areas, 99.33% of households did not resell the recyclable wastes like polythene and other plastic materials, and only 0.067% resold them. Further more, in both in extension and town areas, 100% of the sampled households did not make compost.

In the extension area, only 0.67% of households segregated the wastes and in town area 1.33% of households segregated. One hundred percent of the sampled households in the extension and 97.33% in the town area were satisfied with the cleaning operations of the local body (municipality).

Quantification of solid wastes generated in Tiruvarur Municipality

Total solid waste generation

The total mean solid waste generation of household was 108.75±29.71g/day. The mean weight of solid waste generation for the households was 112.5±28.34g/day in extension area and 105.0±30.65 g/day in town area (Table 2). The total mean solid wastes generated by different socioeconomic classes were 91.0±17.23g/day, 101.0±24.34g/day and 134.25±27.21g/day for low, middle and high income groups respectively. However, the total amount of solid wastes generated didn't vary signficiantly among the different socio-economic classes as well as between the two different areas (Two way ANOVA; $p < 0.05$; Table 2).

Composition of solid waste

Totally, 24 kinds of different solid wastes were segregated and the mean generation of these wastes among the three socio-economic classes of extension and town areas are given in table 2. Among these wastes the quantity of cattle dung was lowest in all the categories whereas the vegetable peels followed by food wastes and fruit peels were the dominant solid wastes. Remarkably, the plastics as a group alone (polythene carry bags, plastic bottles, plastic buckets, plastic tumblers, plastic toys, plastic balls, ball point pens, and other plastics) contributed almost 20% both in extension and town areas with a mean value of 23.15g and 19.60g respectively (Table 2). Among different kinds of wastes, the mean weight of envelope, ball point pen, plastic buckets, plastic toys, other plastics, glass, medicine bottles, light bulbs, building debris, fruit peels, cattle dung and waste batteries showed significant variations between areas and among the socio-economic classes (Two way ANOVA; $p < 0.05$).

Table 1. Variations (Mean ±1S.D.) in demographic profile, economic indicators and house details of different socioeconomic classes of extension and town areas of Tiruvarur, Tamilnadu, Southern India during 2004-2005

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* $p < 0.05$

However, the mean weight of the paper, plastic bottles, plastic balls, waste foods, vegetable peels and old clothes showed significant variations only among the socio-economic classes and not between the areas (Two-way ANOVA; $p < 0.05$; Table 2).

DISCUSSION

It is estimated from the present study that the annual mean waste generation was 39.69kg per household. At present, in Tiruvarur, the total generation of solid wastes of a household is 18.6 metric tonnes per day which includes 16.74 metric tonnes of degradable wastes, 1.15 metric tonnes of non-degradable wastes and 0.71 metric tonnes of recyclable wastes. Tiruvarur municipality at present is using five mini lorries, four autos, one power-tiller, one tractor and 14 tricycles and a team of 135 sweepers (73 males and 62 females) engaged in the collection and transportation of solid wastes. In addition, for transportation work, 2-3 workers are allotted per 1000 residence (Tiruvarur Municipality Unpublished Report). At present around 90% of generated waste is openly dumped at the municipal dumping site of 6.14 areas of land in Neivilakku Thoppu located at 2 km distance from the Tiruvarur Municipality. The present system of municipal solid waste management practiced by the Tiruvarur Municipality is not safe, effective and scientific. Large quantities of solid waste and higher degree of urbanization create greater scope for reuse, recycling, power generation, vermicomposting, home composting, laying of plastic roads, organic manure preparation from recyclable and organic wastes. This necessitates adequate resources, appropriate technology, integrated solid waste management and zero waste management systems for efficient municipal solid waste management. Therefore, the management of solid waste should be effective, efficient and scientific (Sharholy *et al*., 2008). Hence the households and municipality of Tiruvarur need to adopt strategies which are effective to regain wealth from these solid wastes.

The impact of population size on environment depends on the members and on their resource consumption. The urban population has increased from 56.9 million in 1947 to 274 million in 1997, and daily per capita waste generation increased from 295g to 490g whereas the total waste generation increased from 6 million tonnes to 48 millions tonnes in the same period (Pendse, 2006). It is stated that with the growth in size of urban population an enormous amount of solid waste is generated (Ahsan, 1999, Kumar, 2009). The per capita waste generation in urban areas varies with the size of population. In urban areas where the population is less than 0.1 million, 0.21 kg waste per capita per day is generated and in areas with a population of more than 5 million, 0.500kg waste per capita per day is generated (NEERI, 2000). Recent developments of Tiruvarur town and adjoining areas are rapid due to establishment of the national central university, government medical college, many private academic institutions and exploration of natural oil and gas. These and some other some developmental activities have resulted in the increase of the population of this area. Therefore, it is need of the hour to adopt sustainable practices in the solid waste management of this area.

The community practices such as usage of dustbin, dumping of wastes and recycling and segregation of wastes of the households of extension area indicated that they were better in solid waste management practices than that of the town area. The household profile of extension area indicated that this area has affluent people which might be the reason for their better awareness on the solid waste management practices.

In the present study, totally 24 different solid wastes viz., paper, packing materials, envelopes, polythene carry bags, plastic bottles, plastic buckets, plastic tumblers, plastic toys, plastic balls, ball point pens, other plastics, glass, light bulbs, medicine bottles, building debris wood wastes, waste food, vegetable, fruit peels, old cloths, plant remains, cattle dung and waste batteries were segregated. The number of different solid wastes is associated with the community recycling practices. In Tiruvarur, no household attempted any recycling strategies hence a larger composition of 24 wastes were recovered.

In the present study, the low income group (91.0±17.23g/day) generated less solid waste than that of high income groups (134.25±27.21g/day). According to Vinothini (2005), the variation in per capita waste generation is due to average household income, size of population, social behavior, climate and market for waste materials. As economic prosperity improves, the amount of solid wastes increases in terms of weight and volume and larger part of the waste will consist of "luxury wastes"such as paper, cardboard, plastics and heavy organic matter. In India, the higher income groups generate maximum wastes because they are consumerists lot (Kumar *et al*., 2009). On the other hand, the reason why the low income groups generate less wastes is that they reuse lots of reusable wastes (Narain, 2000).

Current quantification indicated that the vegetable peels followed by food wastes and fruit wastes were the dominant solid wastes of Tiruvarur area. It is well established that the vermiculture is an excellent tool for converting these materials into valuable resources as manure which also minimizes the solid waste pollution (Mani, 1996). Hence, it is suggested that the households can have vermicompost pits for recycling these solid wastes.

Table 2. Variations (Mean ±1S.D.) in different composition of daily solid wastes collected from various households of different socioeconomic classes of extension and town areas of Tiruvarur, Tamilnadu, Southern India during 2004-2005.

Types of wastes	Extension area (n=150)				Town area (n=150)				Two -Way ANOVA	
	Low income group	Middle income group	High income group	Total	Low income group	Middle income group	High income group	Total	Class F-value	Area F-value
Paper	5.80± 1.90	6.30± 2.22	7.09± 2.47	6.37± 2.40	5.6± 164	5.90± 1.94	.28± 2.38	5.98± 202	5.02*	3.28
Packing materials	4.90± 0.71	5.10± 6.70	4.40± 1.64	4.80± 1.41	4.70± 187	4.60± 1.37	5.74± 3.17	5.01± 2.81	0.65	1.07
Envelope	4.60± 1.37	4.90± 0.71	4.70± 1.19	4.78± 1.13	5.00± 143	4.50± 1.52	1.80± 3.05	3.77± 202	24.47*	22.74*
Polythene carry bag	4.90± 0.71	5.10± 0.71	5.40± 1.37	5.13± 0.99	4.80± 174	5.00± 1.01	4.78± 3.50	4.86± 202	0.52	1.75
Plastic bottles	5.20± 2.47	3.80± 2.38	4.90± 2.14	4.68± 2.40	4.40± 2.39	7.20± 3.37	2.40± 3.99	4.67± 202	10.60*	0.01
Plastic buckets	4.30± 1.75	4.20± 2.11	3.60± 2.27	4.08± 2.06	2.40± 2.52	0.50± 2.08	1.20± 2.38	1.37± 2.50	6.56*	110.19*
Plastic tumbler	4.60± 1.37	2.60± 2.52	0.40± 1.37	2.58± 2.51	1.60± 2.35	0.10± 0.70	0.90± 1.94	0.87± 1.90	47.92*	62.69*
Plastic toys	1.60± 2.36	1.80± 2.42	0.00± 0.00	1.13± 2.10	3.60± 2.48	0.50± 1.52	1.60± 2.98	1.90± 2.70	19.18*	9.28*
Plastic ball	2.30± 2.52	0.60± 1.64	0.00± 0.00	0.97± 1.98	2.40± 2.52	0.20± 0.99	1.60± 2.76	0.97± 1.98	26.55*	3.58
Ball point pen	2.30± 2.52	2.30± 2.52	5.60± 1.64	3.40± 2.74	4.00± 2.02	1.04± 2.02	1.80± 2.81	2.28± 2.62	21.03*	17.95*
Other plastics	3.30± 2.96	0.70± 1.75	0.00± 0.00	1.38± 2.24	4.90± 2.77	1.20± 2.54	1.9 ± 3.73	2.68± 3.43	49.49*	20.48*
Glass	2.50± 2.58	0.60± 1.64	0.00± 0.00	1.08± 2.08	3.60± 2.68	1.50± 2.90	2.80± 4.06	2.68± 3.36	16.63*	27.99*
Light bulbs	0.70± 1.75	1.90± 2.83	0.30± 1.20	0.97± 2.14	6.7± 3.86	0.40± 1.70	2.40± 3.58	3.17± 4.11	28.15*	50.82*
Medicine bottles	4.10± 2.18	1.40± 2.85	0.20± 1.41	1.90± 2.76	2.40± 3.53	5.30± 3.83	2.10± 4.20	0.97± 4.14	15.27*	13.86*
Building debris	2.90± 2.49	1.30± 2.82	1.40± 2.27	1.87± 2.68	0.10± 0.71	0.30± 1.57	0.40± 1.70	0.27± 1.39	3.41	45.74*
Wood waste	0.00± 0.00	0.40± 1.37	0.50± 1.52	0.30± 1.19	0.50± 1.52	3.30± 1.57	0.00± 0.00	0.27± 1.27	0.22	0.06
Waste foods	2.10± 2.40	8.40± 2.76	10.26± 1.47	6.92± 4.19	3.90± 2.32	9.60± 1.37	9.48± 4.07	7.66± 3.87	210.68*	6.18*
Vegetables	28.30± 4.49	39.20± 4.78	41.30± 3.32	36.27± 7.12	29.10± 3.74	37.80± 5.81	39.20± 5.28	35.87± 2.96	178.08*	2.79
Fruits peels	3.20± 2.42	7.30± 3.06	10.04± 1.77	6.85± 3.74	4.70± 1.87	9.10± 2.61	9.70± 4.09	7.83± 3.73	122.94*	9.68*
Old clothes	4.70± 1.19	0.60± 2.18	0.01± 0.00	1.77± 2.58	1.60± 2.36	2.00± 3.45	0.40± 1.70	1.33± 2.35	49.63*	3.15
Plant remains	3.30± 1.19	0.10± 0.71	0.00± 0.00	0.13± 0.61	0.30± 1.19	0.30± 1.19	0.90± 2.61	0.50± 1.81	0.82	5.20*
Cattle dung	2.31± 3.38	0.00± 0.00	0.00± 0.00	0.77± 0.99	0.00± 0.00	0.00± 0.00	0.50± 1.82	0.17± 0.02	14.88*	10.98*
Waste batteries	5.10± 1.28	1.40± 2.27	0.00± 0.00	2.17± 2.62	3.70± 2.48	2.56± 3.50	2.00± 3.08	2.75± 2.96	57.97*	4.89
Total Weight	91.0± 12.12	101.5± 13.75	145.0± 20.82	112.5± 28.34	91.0 ± 21.29	100.5± 31.74	123.5± 28.75	105.00± 30.65	1.00	1.00

Biodegradable and organic matter can be recycled effectively. For example, Trichy Municipal Corporation with land area of 146.9 km^2 and a population of 8.26 lakhs generated 380 tonnes solid wastes per day of which 290 tonnes are cleared and transported everyday. The organic content of the municipal solid waste of the Trichy city has been around 75-80%. It is estimated that using bio-methanation processes about 2.2 M.W of power, 35 tonnes of organic manures and 32 tonnes of incinerable wastes could be made available for sale per day. This could yield an annual income of Rs. 9.96 crores through sale of power, manure and incinerable wastes outputs (Anonymous, 2004). Such a type of management practices can be preferably adopted by the Tiruvarur municipality as well.

In the present study the group of plastic products contributed almost 20% both in extension and town areas with a mean value of 23.15g and 19.60g, respectively. Total plastic consumption was 7.5 million tonnes in India. The demand for plastics is increasing from household to industrial use at the rate of 22%. The annual per capita consumption of plastics in India is 2 kg compared to global average of 17.5 kg, the Asian annual average of 10 kg per capita as 45-60% of plastics wastes are brought back to recycling (Upathyay *et al*., 2005). Disposal of plastics has emerged as a major problem (Kumar *et al*., 2009). Plastics do not disintegrate when thrown away. They block sewage affecting health and hygiene. They accumulate all over the streets, roads, public places and can remain in the ground for more than 400 years preventing water and seepage into ground, obstructing photosynthesis and air circulation. Kawadia and Ahuja (2006) reported that in India, consumption of plastic and plastic waste recycling has increased. The total consumption of plastics rose from 18,89,000 tonnes in 1995-96 to 43,74,000 tonnes in 2001. These plastic waste recycling was 8,00,000 tonnes in 1995-96 and it rose to 20,00,000 tonnes in 2001. The plastic bag is made of from even low density polythene can be easily recycled upto a dozen times (Malik, 1998). But in many parts such as Tiruvarur, till date, no such attempt is made to recycle the polythene and plastics. Hence, households at Tiruvarur should recycle and reuse the waste plastic bags and waste polythene materials.

Furthermore, application of waste plastics in road laying has shown considerable reduction in use of bitumen and appreciable increase in life of roads. In addition, usage of plastics reduce the requirements of bitumen which would further reduce the cost upto more than 50% (Anonymous, 2005). Therefore, the authorities should adopt these strategies scientifically for recycling the plastics and this result in 'plastic free environment' which could be a bonus to the society.

There is no waste in the natural world. Every possible substance we use and throw away comes back as new and different material in two possible ways. One is discharged into the environment and another is reused or recycled (Mani, 1996). More than 4 crore tonnes of solid wastes and 6 billion cubic meter liquid wastes discharged from urban areas in India could be used to generate 1700MW power, which can be enhanced to 3650MW power by 2012 and 5200 MW power by 2017. This would help in reducing the amount of waste by 60-90% (Anonymous, 2007). Therefore, recycling of solid wastes reduces the volume of waste in solid waste management, reduces exploitation of natural resources, reduces pollution and finally supports the large number of families directly and indirectly involved in waste collection and recycling (Dhanalakhmi and Iyer, 1994). Hence, solid wastes have a greater scope for recycling. But the current, improper, unscientific and unplanned solid waste management fails to convert wastes into wealth or resources. Therefore, it is high time and inevitable to apply sustainable and ecofriendly technology to manage municipal solid waste to promote public health and sanitation in Tiruvarur Municipality as well.

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