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MUNCIPAL SOLID WASTE SOURCE AND DISPOSAL PRACTICES IN RESIDENTIAL AREAS OF MYSORE CITY, KARNATAKA, INDIA – A CASE STUDY

Kshema R. and Dr. S. Basavarajappa*

Department of Studies in Zoology, University of Mysore, Manasagangothri, Mysore -570 006, Karnataka, India.

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Corresponding author: Dr. S. Basavarajappa

Department of Studies in Zoology, University of Mysore, Manasagangothri, Mysore -570 006, Karnataka, India.

ABSTRACT

Mysore is a third most populous city in Karnataka, provides shelter for diversified population with different socio-economic standards. It has rich, vibrant history and heritage, attracting good number of tourists every day. People from different parts of India and the world would like to reside in Mysore city and expecting good and clean environment around the year. To record the municipal solid waste produced from different residential houses, 18 wards were selected randomly and 144 residents (40% male and 60% female) were met personally during January to April, 2018. The municipal solid waste origin, source, production, collection, storage, isolation, transportation and disposal were collected along with the status of respondents by using pre-tested questionnaire. The bio-degradable waste from 18 vegetables, 11 fruits, seven kitchen items and 14 paper types and non-biodegradable waste from 29 plastic items, 15 metals and 14 electronic items appeared at every residential house. Quantity of municipal solid waste recorded from edible and non-edible items varied considerably. Moreover, the quantity of municipal solid waste produced from nuclear and composite families varied considerably. However, 3.8 and 17.5% respectively the nuclear and composite families didn't provide the information about municipal waste produced per day. However, the daily using few domestic commodities made with different raw materials such as plastic, iron, woolen, cotton, rubber and paper etc, were difficult to isolate separately as edible or non-edible waste which were commonly appeared as waste every day at residential houses. Overall, eight items such as three from edible items (i.e., vegetables, fruits and kitchen), five from non-edible items (i.e., plastic, paper, metal, electronic and others) which contributed 96.9% non-edible items and 3.1% edible items recorded as municipal solid waste at residential houses in Mysore. Despite the clean city status three times, Mysore is still experiencing hardships to manage municipal solid waste and it demands regular survey and solid waste analysis to be conducted to develop strategies to control waste and maintain good environment amidst clean cities.

KEYWORDS: Source of municipal solid waste, disposal, residential areas, Mysore.

INTRODUCTION

The solid waste cause pollution in air, water and soil,[1] its management is very essential[2-3] to maintain clean environment at human inhabited places in different parts of the world. Several researchers[2,4-5,3,6] have studied the solid waste management at urban centers in different parts of the world including India.[7] Have studied the solid waste in urban areas of Tanzania.[8] Have reported the household waste in The Netherlands.[9] Have studied the household solid waste in Kuwait. [10]Have published the report on solid waste and its management in China.[11] Have studied the e-waste in Ghana.[12] Has studied the characteristics and management of municipal solid waste in Nigeria.[13] Have investigated the status, problems and challenges of municipal solid waste management in China.[14] Has assessed the current status of solid waste management in Gondar town of Ethiopia.

However, in India,[2-4,6,9,15-19] have reported the solid waste management in different urban centers of India. Later,[20] have studied the municipal solid waste and its management practices in Dhanbad-Jharia coalfield.[21] Has reported the Delhi municipal solid waste and its management.[22] Have studied the solid waste assessment and management in Indore city.[23] Have evaluated the municipal solid waste management in Tripunithura municipality of Kerala.

[24] has reported the municipal solid waste management in Mumbai.[25] Have identified the characteristics and management of municipal solid waste in Allahabad.[19] Have provided information on the status of municipal solid waste management in metro cities, state capitals, class I cities and class II towns in India.[26] Have assessed the municipal solid waste management in Pondicherry.

Further, in Karnataka, [27] have studied the solid waste management in sub-urban areas of Bangalore.[28] Have reported the electronic waste management system in Bangalore.[29-30] Have studied the municipal solid waste management in Mysore city.[31] Have reported the zero waste management system in Kumbarakoppal area of Mysore. All these reports suggested the general aspects of solid waste and its management at different parts of Karnataka, India and world as a whole. However, specific reports on the source, collection, isolation, storage and disposal of solid waste produced from different sectors of urban areas are lacking. Recently,[32] have reported the solid waste source, collection, isolation, storage and disposal exclusively from food supplying centers in Mysore. Similarly,[33] have reported the waste source, collection, isolation, storage and disposal by health care centers in Mysore. However, reports especially from households in residential areas are wanting. Hence, the present study was undertaken.

MATERIALS AND METHODS

Study area: Mysore is located at the foot hill of Chamundi hills between 11º40' to 12º40' N. latitude and 75º57' to 77º15' E. longitude with the elevation 770 meters mean sea level [34]. The city experiences tropical monsoon which is a product of the interplay the two opposing air masses of the south-west and the north-east monsoons. Over the greater part of the District, summer is languorously warm and winter is bracingly cool. By and large, Mysore city climate is agreeable and cool with equable temperatures due to salubrious climate. Further, it is housed with more than one million local populations[35] and becomes third most populous city in Karnataka. The literacy rate in Mysore is higher (82.8%) than that of the State average. Moreover, Mysore has a rich, vibrant history and heritage, attracting good number of tourists every day. Thus, Mysore has provided shelter for diversified population with different socio-economic conditions. Hence, people from different parts of India and the world liking to reside in Mysore city. Hence, it is called retired persons and aged people paradise.

Methodology: To record the municipal solid waste produced from different residential houses, primary and secondary source related to the origin, source, production, collection, storage, isolation, transportation and disposal of waste was collected from various people who have different socio-economic conditions. The study area, number of study sites and status of respondents selected during the present investigation is depicted in Table 1. People were met in their households and interviewed by using pre-tested questionnaire. Information on municipal solid waste segregation and disposal was collected as per[36]. Out of 65 wards in Mysore city, 18 wards were selected randomly and 144 residents (40% male and 60% female) were met personally during January to April, 2018 to collect the data on municipal solid waste and its disposal [32-33]. Collected data was complied systematically and analyzed by following standard methods as per.[37]

RESULTS

Per cent waste produced from edible items: Commonly occurring waste from edible items is depicted in Table 2. Bio-degradable waste from 18 vegetables, 11 fruits and seven kitchen items have recorded and these entire waste items per cent occurrence is given in Table 2.

Per cent waste produced from non-edible items: Around 43 non-edible items were commonly appeared as waste. Of all, 29 and 14 type plastic and paper waste respectively appeared at every residential house. Per cent occurrence of plastic and paper waste is given in Table 3. In addition, metal, electronic and other non-specific materials also produced from non-bio-degradable waste at residential houses. Total 15 metals, 14 electronic items and their per cent occurrence is shown in Table 4.

Quantity of waste produced from nuclear and composite families: In Mysore, the nuclear family has three to four individuals and composite family has minimum five to maximum ten individuals. Amongst nuclear families, highest (33.8%) families have produced < 0.5 kilogram waste every day and it was followed by 25.9% of the houses produced 0.5 to 0.6 kilogram and one kilogram waste produced every day by the 25.9 and 24% of the nuclear families respectively (Table 5). Besides, 9.6 and 2.9% of the nuclear families respectively produced one to 3.4 and 3.5 kilogram wastes per day (Table 5). However, 3.8% of the nuclear families didn't provide information about the amount of waste produced. Similarly, amongst composite families, highest (32.5%) families have produced one to 1.9 kilogram waste every day and it was followed by 2.9 and three to 4.9 kilogram wastes every day by 20 and 17.5% of the composite families respectively (Table 5). In addition, 12.5% composite families have produced more than five kilogram of waste per day (Table 5). However, 17.5% of the composite families didn't provide the information on amount of waste produced per day (Table 5).

Quantity of waste recorded from edible items: Commonly used 18 vegetable items have contributed 477 gram waste per day and that accumulated to 174.106 kilogram waste per year at every residential house in Mysore (Table 6). Similarly, from 11 fruits, 857 gram waste per day and that accumulated to 312.805 kilogram waste per year from the residential houses. Further, from eight cooked, extra or unused food items of the kitchen has generated considerable quantity of bio-degradable waste every day in residential houses. Quantity of

different cooked food items appeared from kitchen as waste is given in Table 7. Total 533 gram kitchen waste per day and that accumulated to 194.545 kilogram per year from the residential houses in Mysore (Table 7).

Quantity of waste from non-edible items: Daily using few domestic commodities made with different raw materials such as plastic, iron, woolen, cotton, rubber and paper etc, were difficult to isolate separately as non-edible waste. Such type of commodities were recorded separately as other waste and those included four plastic items, two each wooden and glass items and six cloth items, which were commonly appeared as waste every day at residential houses. Quantity of these waste items produced per day and year is depicted in Table 7. Table 8 shows the different type of plastic, paper waste and their quantity produced per day and year at residential houses. Around 29 items from plastic and 14 items from paper were commonly recorded as waste every day at residential houses. Besides, metals and electronic waste items also recorded as waste at residential houses in Mysore (Table 9). Total 15 items from metal and 14 items from electronic materials appeared as waste and their quantity produced per day and year is shown in Table 9. Overall, eight items such as three from edible items (i.e., vegetables, fruits and kitchen), five from non-edible items (i.e., plastic, paper, metal, electronic and others) have contributed for waste generation amidst residential houses in Mysore (Table 10). Per cent occurrence of these waste items varied considerably. Thus, 96.9% non-edible items and 3.1% edible items recorded as waste at residential houses in Mysore (Table 10).

Table 1: Study sites and number of respondents considered during the survey in Mysore.

Sl. No.	Name of study area	'n'	% Sampling	Sl. No.	Status of Respondent	'n'	% Sampling
1.	Agrahara	12	8.2	1.	Businessmen	44	30.1
2.	Akshyabandar	10	6.9	2.	Carpenter	03	2.1
3.	Chamarajapuram	10	6.9	3.	Doctors	03	2.1
4.	Ettigegoodu	10	6.9	4.	Drivers	05	3.4
5.	Hebbal	07	4.7	5.	Electrician	06	4.1
6.	Kumbarakoppalu	10	6.9	6.	Engineers	03	2.1
7.	Kukaralli	04	2.7	7.	Industrialists	08	5.5
8.	Kuvempunagar	10	6.9	8.	Lawyer	05	3.4
9.	Mahadeshwara Badavane	07	4.7	9.	Lecturers	04	2.7
10.	Mandimohal	08	5.5	10.	Medical Representatives	03	2.1
11.	Nazarbadh	10	6.9	11.	Nurse	04	2.7
12.	Ontikopal	07	4.7	12.	Others	30	20.6
13.	Paduvaralli	08	5.5	13.	Photographer	01	0.7
14.	Ramakrishna Nagar	05	3.4	14.	Plumber	07	4.8
15.	Ramaswamy Circle	10	6.9	15.	Street vendor	07	4.8
16.	Saraswathipuram	05	3.4	16.	Tailor	05	3.4
17.	T. K. Layout	05	3.4	17.	Teacher (High School)	04	2.7
18.	Vijaynagar	08	5.5	18.	Teacher (Primary School)	04	2.7
Total		146	100.0	Total		146	100.0

Note: 'n' number of observations.

Table 2: Per cent waste produced from edible items in residential houses.

Waste produced from edible items								
Vegetable waste			Fruit waste			Kitchen waste		
Sl. No.	Items	%	Sl. No.	Items	%	Sl. No.	Items	%
1.	Beans and carrot	7.2	1.	Apple peelings	1.2	1.	Chapattis	1.8
2.	Beet root peelings	4.7	2.	Banana	3.9	2.	Curry	6.2
3.	Brinjal	3.2	3.	Chikku fruits	2.8	3.	Decoction	0.4
4.	Bitter guard	3.3	4.	Grapes waste	0.9	4.	Egg shell	0.6
5.	Bottle guard	2.3	5.	Lemon peelings	2.3	5.	Non - veg bones	37.5
6.	Cabbage	5.9	6.	Musk melon	16.3	6.	Ragi ball	6.6
7.	Capsicum	2.4	7.	Orange	3.5	7.	Rice items	37.5
8.	Chilly	5.6	8.	Papaya peelings	18.7	8.	Sambar	9.4
9.	Coriander root	6.2	9.	Pomegranate peelings	5.5			
10.	Curry leaves	5.9	10.	Sweet orange	4.1			
11.	Garlic	3.2	11.	Water melon peelings	40.8			
12.	Ginger	3.3						
13.	Green leafy vegetables	8.8						

14.	Onion peeling	10.7						
15.	Potato peelings	5.0						
16.	Radish	3.7						
17.	Ribbed guard	7.3						
18.	Rotten tomato	11.3						
Total		100.0	Total		100.0	Total		100.0

Table 3: Per cent occurrence of plastic and paper waste from non-edible items at residential houses in Mysore.

Non-edible waste produced from					
Plastic items			**Paper items**		
Sl. No.	**Type**	**%**	**Sl. No.**	**Type**	**%**
1.	Black plastic covers	3.6	1.	Baby diapers	4.7
2.	Broken buckets	2.8	2.	Detergent covers	12.3
3.	Blue plastic covers	2.4	3.	Ice cream cups	4.5
4.	Body lotion plastic bottles	2.3	4.	Journals	6.0
5.	Coconut oil plastic bottles	3.4	5.	Magazines	5.7
6.	Empty salt packet	8.5	6.	Match box	5.8
7.	Empty milk packets	7.6	7.	Medicine slips	6.3
8.	Empty oil covers	4.8	8.	Note book	2.4
9.	Maggie covers	2.1	9.	Old calendar	8.9
10.	Old gasket	1.0	10.	Old photos	4.1
11.	Plastic water bottles	1.3	11.	Old text book	1.1
12.	Shopping covers	3.4	12.	Soap cover	12.7
13.	Tupper wears	2.0	13.	Sanitary pads	12.7
15.	Tablet covers	2.2			
16.	Used boost bottles	2.4			
14.	Used chips cover	2.4			
17.	Used comb	1.6			
18.	Used dalda packet	3.0			
19	Used detergent covers	7.8			
20.	Used horlicks bottles	2.7			
21.	Used knife handle	3.6			
22.	Used masala packet cover	2.6	14.	Tooth paste box	12.8
23.	Used plastic razor	2.7			
24.	Used pens	1.7			
25.	Used shampoo covers	7.1			
26.	Used soap boxes	2.2			
27.	Used tooth brush	6.0			
28.	Used tooth brush tube	5.3			
29.	Used tonic bottles	1.5			
Total		100.0	Total		100.0

Table 4: Per cent waste produced from non-edible items in residential houses.

Waste produced from non-edible items								
Metal waste			**E-waste**			**Other waste**		
Sl. No.	**Items**	**%**	**Sl. No.**	**Items**	**%**	**Sl. No.**	**Items**	**%**
1.	Aluminum can	3.1	1.	Induction stove	6.6	1.	Broken chair	4.9
2.	Broken utensils	15.7	2.	Old camera & its accessories	0.9	2.	Broken glass wear	1.1
3.	Christmas lights	6.3	3.	Old clock batteries	0.1	3.	Porcelain wears	1.8
4.	Copper wire	9.4	4.	Old key board	1.3	4.	Pouch	0.3
5.	Old batteries	2.1	5.	Old monitor	22.0	5.	Table cover	0.3
6.	Old bulbs	1.4	6.	Old mouse	0.3	6.	Unused old bed	80.9
7.	Old heater	22.0	7.	Old pen drives	0.2	7.	Teddy bear	1.4
8.	Old knife	3.8	8.	Old TV's	66.1	8.	Unused bags	2.3
9.	Rusted iron	12.6	9.	Unused calculator	0.05	9.	Unused cloths	1.1
10.	Unused bangles	2.1	10.	Unused CD's	0.5	10.	Unused shoes/slippers	0.7

11.	Unused hair clips	0.5	11.	Unused floppies	0.2	11.	Unused socks	0.03
12.	Unused earrings	0.2	12.	Unused ear phone	0.03	12.	Used pillow covers	0.9
13.	Used blade	0.3	13.	Unused mobile charger	1.3	13	Used pillow	3.2
14.	Used lighter	18.9	14.	Unused remote	0.3	14.	Wooden materials	1.1
15.	Used razor	1.6						
Total		100.0	Total		100.0	Total		100.0

Table 5: Quantity and per cent amount of waste produced in different residential houses.

Quantity of waste produce in					
Nuclear Family			Composite Family		
Sl. No.	Quantity per day (in Kg.)	% occurrence	Sl. No.	Quantity per day (in Kg.)	% occurrence
1.	Below 0.5	33.8	1.	1.0 to 1.9	32.5
2.	0.5 to 0.6	25.9	2.	2.0 to 2.9	20.0
3.	0.7 to 0.9	24.0	3.	3.0 to 4.9	17.5
4.	1.0 to 3.4	9.6	4.	5 and above	12.5
5.	3.5 & above	2.9	5.	Not known	17.5
6.	Not know	3.8	Total		100.0
Total		100.0			

Table 6: Quantity of vegetable and fruit waste produced per day in residential houses.

Vegetable waste				Fruit waste			
Sl. No.	Items	Quantity per		Sl. No.	Items	Quantity per	
		Day (g)	Year (Kg)			Day (g)	Year (Kg)
1.	Beans and carrot	15.0	5.475	1.	Apple peelings	10.0	3.650
2.	Beet root peelings	25.0	9.125	2.	Banana	33.0	12.045
3.	Brinjal	55.0	20.075	3.	Chikku fruits	24.0	8.760
4.	Bitter guard	45.0	16.425	4.	Grapes waste	8.0	2.920
5.	Bottle guard	40.0	14.600	5.	Lemon peelings	20.0	7.300
6.	Cabbage	30.0	10.950	6.	Musk melon	140.0	51.100
7.	Capsicum	4.0	1.460	7.	Orange	30.0	10.950
8.	Chilly	6.0	2.190	8.	Papaya peelings	160.0	58.400
9.	Coriander root	10.0	3.650	9.	Pomegranate peelings	47.0	17.155
10.	Curry leaves	5.0	1.825	10.	Sweet orange	35.0	12.775
11.	Garlic	10.0	3.650	11.	Water melon peelings	350.0	127.750
12.	Ginger	10.0	3.650				
13.	Green leafy vegetables	55.0	20.075				
14.	Onion peeling	0.5	0.183				
15.	Potato peelings	4.5	1.643				
16.	Radish	16.0	5.840				
17.	Ribbed guard	46.0	16.790				
18.	Rotten tomato	100.0	36.500				
Total		477.0	174.106	Total		857.0	312.805

Table 7: Quantity of kitchen and other waste produced per day in residential houses.

Kitchen waste				Other waste			
Sl. No.	Items	Quantity per		Sl. No.	Items	Quantity per	
		Day (g)	Year (Kg)			Day (g)	Year (Kg)
1.	Chapattis	10.0	3.650	1.	Broken chair	1500.0	547.500
2.	Curry	33.0	12.045	2.	Broken glass wear	340.0	124.100
3.	Decoction	2.0	0.730	3.	Porcelain wears	550.0	200.750
4.	Egg shell	3.0	1.095	4.	Pouch made with plastic	100.0	36.500
5.	Non - veg bones	200.0	73.000	5.	Table cover made with plastic	110.0	40.150
6.	Ragi ball	35.0	12.775	6.	Unused old bed	25000.0	9,125.00
7.	Rice items	200.0	73.000	7.	Unused Teddy bear	440.0	160.600
8.	Sambar	50.0	18.250	8.	Unused bags made with plastic	700.0	255.500
				9.	Unused cloths	330.0	120.45

-			10.	Unused shoes/slippers	210.0	76.650
			11.	Unused socks	10.0	3.650
			12.	Used pillow covers	300.0	109.50
			13	Used pillow	1000.0	365.00
			14.	Wooden materials	330.0	120.45
Total	533.0	194.545	Total		30,920.0	11,285.800

Table 8: Quantity of plastic and paper waste produced per day in residential houses.

Plastic waste				Paper waste			
Sl. No.	Items	Quantity per		Sl. No.	Items	Quantity per	
		Day (g)	Year (Kg)			Day (g)	Year (Kg)
1.	Black plastic covers	2.0	0.73	1.	Baby diapers	16.0	5.840
2.	Broken buckets	1000.0	365.0	2.	Detergent covers	4.0	1.460
3.	Blue plastic covers	2.0	0.73	3.	Ice cream cups	9.0	3.285
4.	Body lotion plastic bottles	16.0	5.84	4.	Journals	50.0	18.250
5.	Coconut oil plastic bottles	15.0	5.475	5.	Magazines	69.0	25.185
6.	Empty salt packet	3.0	1.095	6.	Match box	10.0	3.650
7.	Empty milk packets	4.3	1.569	7.	Medicine slips	1.5	0.547
8.	Empty oil covers	6.0	2.190	8.	Note book	189.0	68.985
9.	Maggie covers	0.7	2.555	9.	Old calendar	56.0	20.440
10.	Old gasket	20.0	7.30	10.	Old photos	3.0	1.095
11.	Plastic water bottles	50.0	18.25	11.	Old text book	200.0	73.000
12.	Shopping covers	2.0	0.73	12.	Soap cover	15.0	5.475
13.	Tupper wears	400.0	146.0	13.	Sanitary pads	7.0	2.555
15.	Tablet covers	2.0	0.73	14.	Tooth paste box	15.0	5.475
16.	Used boost bottles	25.6	9.344				
14.	Used chips cover	0.76	0.277				
17.	Used comb	12.0	4.38				
18.	Used dalda packet	12.0	4.38				
19	Used detergent covers	1.75	0.638				
20.	Used horlicks bottles	26.2	9.563				
21.	Used knife handle	100.0	36.50				
22.	Used masala packet cover	2.2	0.803				
23.	Used plastic razor	6.0	2.19				
24.	Used pens	9.0	3.285				
25.	Used shampoo covers	1.2	0.438				
26.	Used soap boxes	24.0	8.76				
27.	Used tooth brush	8.0	2.92				
28.	Used tooth paste tube	25.0	9.125				
29.	Used tonic bottles	13.0	4.745				
Total		1789.7	653.240	Total		644.50	235.242

Table 9: Quantity of metal and e-waste produced per day in residential houses.

Metal waste				E-waste			
Sl. No.	Items	Quantity per		Sl. No.	Items	Quantity per	
		Day (g)	Year (Kg)			Day (g)	Year (Kg)
1.	Aluminum can	50.0	18.25	1.	Induction stove	1500.0	547.50
2.	Broken utensils	250.0	91.25	2.	Old camera & its accessories	200.0	73.00
3.	Christmas lights	100.0	36.50	3.	Old clock batteries	12.0	4.280
4.	Copper wire	150.0	54.75	4.	Old key board	300.0	109.50
5.	Old batteries	35.0	12.755	5.	Old monitor	5000.0	1,825.00
6.	Old bulbs	23.0	8.395	6.	Old mouse	70.0	25.550
7.	Old heater	350.0	127.75	7.	Old pen drives	40.0	14.600
8.	Old knife	60.0	21.90	8.	Old TV's	15000.0	5,475.00
9.	Rusted iron	200.0	73.00	9.	Unused calculator	12.0	4.380
10.	Unused bangles	34.0	12.41	10.	Unused CD's	110.0	40.150
11.	Unused hair clips	8.0	2.92	11.	Unused floppies	50.0	18.250

12.	Unused earrings	3.0	1.095	12.	Unused ear phone	7.0	2.580
13.	Used blade	4.0	1.46	13.	Unused mobile charger	300.0	109.50
14.	Used lighter	300.0	109.5	14.	Unused remote	80.0	29.200
15.	Used razor	25.0	9.125				
Total		1,592.0	581.060	Total		22,681.0	8,278.570

Table 10: Overall waste produced in residential houses.

Residential waste produced					
Sl. No.	**Waste from**	**Quantity per**		**% occurrence**	**Overall %**
		Day (g)	**Year (Kg)**		
I. Edible items					
1.	Vegetables	477.0	174.106	25.6	0.8
2.	Fruits	857.0	312.805	45.9	1.4
3.	Kitchen	533.0	194.545	28.5	0.9
Total		1,867.0	681.456	100.0	3.1
II. Non-edible items					
1.	Plastic	1,789.70	653.240	3.1	3.0
2.	Paper	644.50	235.243	1.1	1.1
3.	Metal	1,592.0	581.060	2.8	2.7
4.	Electronic	22,681.0	8,278.570	39.4	38.1
5.	Other	30,920.00	11,285.800	53.6	52.0
Total		57,627.200	21,033.913	100.0	96.9
Grand Total (I + II)		59,494.200	21,715.369	200.0	100.0

Note: Data is based on Tables 6, 7, 8 & 9.

DISCUSSION

In India, various urban solid waste management systems are functioning around the clock for proper and safe disposal of waste produced from the residential areas [15]. The status of municipal solid waste management in metro cities, state capitals, class I cities and class II towns in India are encouraging [20]. The nuclear family had three to four individuals and composite family had minimum five to maximum ten individuals. Amongst nuclear families, 83.7% of the families produced solid waste in between <0.5 to one kilogram and 12.5% of the families have produced one to 3.5 kilogram solid waste per day. However, amongst composite families, the solid waste production was more. Around 32.5% of the families have produced one to 1.9 kilogram and 37.5% of the families have produced 2.9 to 4.9 kilogram solid waste every day. Around 12.5% of the composite families have produced more than five kilogram waste per day. Similarly, in Mysore, more efforts were made to have clean city status [32-33]. Obviously, different management processes are in use and hence it shows more perspectives[2] for better management of municipal solid waste at urban centers. Similar types of approaches were made by[23,20] for metro cities, state capitals, class I cities and class II towns in India. Hence, solid waste management studies are necessitated routinely in India and it is evidenced by the published reports [2-6]. The domestic solid waste generation is a continuous process at metropolitan cities,[6] its regular analysis help assess the current status and help suggest future directions for proper management [5,10,18,14]. From this, problems and challenges of municipal solid waste management could be realized[13] and accordingly, alternative approaches with specific strategies would be adopted for better management in urban centers [17, 23].

In Mysore, around 18 vegetables, 11 fruits and seven kitchen items have produced as bio-degradable waste. Total 43 non-edible items which included 29 plastic and 14 paper wastes along with 15 metals and 14 electronic items appeared at every residential house. Commonly used 18 vegetables, 11 fruits, and eight cooked, extra or unused food items from the kitchen room has generated good quantity of bio-degradable waste every day in residential houses. Further, from daily using domestic commodities made with plastic, iron, woolen, cotton, rubber and paper, good quantity of solid waste appeared as non-edible waste every day at residential houses. Besides, good quantity of metals and electronic waste items were appeared as non-biodegradable wastes at residential houses and put together 96.9% non-edible items and 3.1% edible items appeared as solid waste at residential houses in Mysore. Since, municipal solid waste possess specific characteristics,[24] certain solid wastes especially metal, rubber, glass, plastic and electronic waste materials need specific disposal sites and offer more scope for recycling [11, 37]. Proper plans are required to recycle non-biodegradable waste on unit-based pricing and make this as a remunerative income generating activity. Such types of efforts were made in The Netherlands for cost savings in unit-based pricing of household waste disposal [8]. Similarly, waste recycling was done in Canada[38] and The Lake Victoria Basin in Kenya [39]. Such types of efforts are wanting and unit-based pricing and remunerative income generating activities on municipal solid waste are to be taken up

seriously as there are good recycling potentials for municipal solid waste sustainable recycling [40-42]. Moreover, the bio-degradable waste could be used for composting [43]. However, there are many challenges appear while managing and recycling the municipal solid waste[44] due to non-availability of information on solid waste production. In Mysore, 3.8% of the nuclear families and 17.5% of the composite families didn't provide the information on amount of waste produced per day. This type of challenges should be solved by adopting innovative techniques, alternative approaches with better strategies on eco-friendly way as suggested by[45-48,23] for better solid waste management. Thus, integrated approach for sustainable solid waste management is need of the day for India in general[49] and developing cities like Mysore in particular. Similar type of studies were made for urban centers by [2, 6, 8, 10, 13, 14, 18,39, 41]. Thus, our observations are in agreement with the earlier reports published by the previous researchers in India and other parts of the world. Present study focused on the household solid waste origin, source, production and disposal of one of the fast growing cities in India.

SUMMARY

The nuclear family has three to four individuals and composite family has minimum five to maximum ten individuals. Waste from 36 edible and 43 non-edible items obtained from nuclear and composite families amidst residential areas. However, quantity of municipal waste production among the nuclear and composite families varied considerably. Bio-degradable waste was collected from 18 vegetables, 11 fruits, 7 kitchen items and 14 paper materials. On an average 477, 857 and 533gram bio-degradable waste produced per day by every residential house in Mysore. Non-bio-degradable waste was recorded from 29 plastics, 15 metals and 14 electronic materials along with considerable quantity of rubber and glass items. Total 17.5 and 3.8% of the nuclear families and composite families shown disinterest and didn't provide information on the waste and its disposal respectively. Overall, eight from edible items (i.e., vegetables, fruits and kitchen), five from non-edible items (i.e., plastic, paper, rubber, metal, electronic and others) have contributed for municipal waste generation amidst residential houses in Mysore. Altogether, 96.9% non-edible items and 3.1% edible items have produced bio-degradable and non-biodegradable waste at residential houses in Mysore.

RECOMMENDATIONS

Municipal waste segregation must be done at its point source in every residential house and should be properly stored in colour coded dustbins for their proper disposal. The bio-degradable and non-biodegradable waste should be placard with the bio-hazard mark while on the transit. The municipality attendants should interact with residents while collecting the waste and municipal authorities and other agencies that collect waste should update the residents periodically for safe disposal of waste regularly from their premise for land fill or other treatment.

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