

## Quantitative and Qualitative Survey of some Household Solid Wastes Collected from Residential Areas in Baghdad City

Sedik A. K. Al-Hiyaly<sup>1</sup>, Saba Riad Khudhaier<sup>2\*</sup>, Ahmed S. A. Altae<sup>2</sup>  
& Mohanad R. Dheyab<sup>2</sup>

<sup>1</sup>Environmental Research Center, University of Technology, Baghdad, Iraq

<sup>2</sup>Department of Biology, College of Science, Al-Mustansiriya University, Baghdad, Iraq

\*Corresponding author: dr.sabariad@uomustansiriyah.edu.iq

**Abstract:** This work was designed to examine household solid wastes. Ten various homes in five different residential sites within Baghdad city were subjected to this study. All related information via survey sheet were taken from each examined home prior collecting the municipal solid wastes (MSW). Each home waste sample was assessed after being left to dry in terms of solid waste quantity and components. The obtained results showed clear differences between homes and residential sites particularly in waste quantity and components. Obviously, the overall mean of generated municipal solid waste per day (capita) was found to vary significantly from maximum of 1.085 kg/d in the first residential homes to minimum of  $0.635 \pm 0.095$  kg/d in the fifth residential homes but, the total average mean was 0.818 kg/d. On the other hand, waste components as food residuals, glass, paper, cans and plastics were also found to vary clearly giving over all mean weight of  $0.522 \pm 0.083$ ,  $0.065 \pm 0.026$ ,  $0.096 \pm 0.015$ ,  $0.090 \pm 0.019$  and  $0.059 \pm 0.027$  kg/d, respectively.

**Keywords:** Municipal solid waste, Residential homes, Food residuals, Glass, Paper, Cans, Plastics

### Introduction

The capita of generated municipal solid waste is well documented worldwide and thoroughly assessed in various countries and found to vary significantly (Kumar et al., 2016) and found that the average generated MSW was 0.74 kg/person/day which varies from a minimum value of 0.11 to a maximum value of 4.54 kg/person/day (World Bank, 1999). Nationally, several works have examined generated MSW capita in various provinces where it was reported to vary from 0.62 kg /person/day in Basrah province to 0.68 kg/person/day in Mosul province (Al-Rawi & Al-Tayyar, 2013; Abbas, 2016). It seems obviously that generated MSW capita is significantly affected by several factors such as income and age (Irwan et al., 2013), socio-economic variables (Liu & Wu, 2011), consumption patterns (Liu et al., 2019), residential area (Astane & Hajilo, 2017) and even home type (Wang & Nie, 2001). Also, the components of generated MSW is greatly varied, which in

general are food residues (organic waste), paper, glass, metals, plastics and others (Banar & Özkan, 2008; Ahsan et al., 2015). In the past, MSW was a great challenge that needed proper and effective cost handling and controlling (Ejaz et al., 2010) due to significant impacts on both public health and environment (Hoang & Fogarassy, 2020). However, various works have shown that certain MSW components such as food residuals which were successfully used in producing methane gas to be utilized for transporting, cooking, heating and electricity while plastic wastes have shown considerable ability in producing energy (Rawat et al., 2016; Antelava et al., 2019). So, the current study was designed to assess MSW capita and the most waste components in five residential areas within Baghdad city. Each area was represented by ten different homes.

### **Material and Methods**

A total of random 50 different homes situated in five various residential areas at an average of 10 homes in each area was subjected to this work. A daily generated MSW of each home was collected at a single day during June 2019 after brief survey of each studied home including resident number, economic and educational levels. Each home generated MSW was first collected and left to dry under natural conditions after discarding other types of waste such as fabrics, electric and electronic equipment, and garden wastes. The dried MSW was weighted using portable hanging electronic digital scale (LCD Weighting Scale 50 kg Kitchen) and thereafter, the waste was isolated into main components such as food residues, paper, glass, cans, and plastics where each waste type was weighted. The obtained results were analyzed and MSW capita was calculated for each home and also the overall mean was assessed.

### **Results and Discussion**

Total daily generated municipal solid wastes, family size, capita/day and weight of solid waste components of all examined homes of five residential sites within Baghdad city are given in Table 1 while the overall means of these variables are presented in Table 2.

From the obtained results, it seems that there were clear differences between capita of generated MSW of examined homes and areas where the highest mean value ( $1.085 \pm 0.154$  kg/day) was recorded in homes of first residential area, while the minimum mean value ( $0.635 \pm 0.095$  kg/day) was in homes of the fifth residential area (Figure 1).

Table 1: Total daily generated municipal solid wastes (SW), family size, capita/day and weight of solid waste components of all examined homes of five residential sites within Baghdad city.

Residential Sites	Homes	Daily SW (kg)	Family size	Capita/day	Weight of municipal solid waste components (kg)				
					Food residuals	Glass	Paper	Cans	Plastic
RS1	1	2.850	3	0.950	0.490	0.100	0.115	0.175	0.070
	2	6.145	5	1.229	0.685	0.160	0.135	0.073	0.172
	3	5.570	6	0.928	0.500	0.120	0.065	0.090	0.150
	4	6.115	6	1.019	0.665	0.080	0.070	0.120	0.085
	5	6.715	5	1.343	0.725	0.148	0.151	0.162	0.157
	6	8.000	6	1.333	0.750	0.135	0.125	0.120	0.187
	7	6.570	6	1.095	0.613	0.077	0.088	0.153	0.164
	8	6.430	7	0.919	0.600	0.050	0.101	0.110	0.065
	9	8.570	8	1.071	0.782	0.103	0.053	0.116	0.017
	10	7.715	8	0.964	0.674	0.082	0.094	0.082	0.032
RS2	1	6.630	7	0.947	0.505	0.128	0.103	0.107	0.104
	2	6.145	6	1.024	0.543	0.072	0.133	0.154	0.120
	3	6.570	7	0.939	0.620	0.047	0.047	0.112	0.113
	4	7.285	8	0.911	0.596	0.112	0.096	0.098	0.009
	5	4.785	5	0.957	0.630	0.117	0.096	0.099	0.015
	6	8.570	10	0.857	0.561	0.027	0.110	0.091	0.086
	7	7.930	9	0.881	0.578	0.029	0.113	0.094	0.067
	8	9.020	11	0.820	0.538	0.095	0.088	0.087	0.012
	9	7.070	8	0.884	0.581	0.103	0.095	0.094	0.011
	10	8.785	10	0.879	0.578	0.108	0.092	0.093	0.008
RS3	1	1.715	2	0.858	0.527	0.027	0.214	0.053	0.037
	2	5.715	7	0.816	0.490	0.027	0.201	0.082	0.016
	3	6.140	7	0.877	0.455	0.079	0.097	0.132	0.114
	4	5.855	7	0.837	0.496	0.041	0.108	0.116	0.076
	5	5.785	7	0.827	0.544	0.101	0.083	0.086	0.013
	6	8.930	10	0.893	0.594	0.045	0.099	0.099	0.056
	7	7.860	9	0.873	0.567	0.061	0.096	0.087	0.061
	8	5.855	7	0.837	0.488	0.079	0.116	0.081	0.073
	9	9.350	11	0.849	0.538	0.098	0.103	0.088	0.022
	10	7.860	10	0.786	0.554	0.025	0.103	0.085	0.015
RS4	1	6.430	9	0.714	0.464	0.021	0.143	0.071	0.015
	2	7.570	10	0.757	0.439	0.076	0.114	0.077	0.051
	3	3.860	5	0.771	0.531	0.015	0.070	0.088	0.067
	4	7.000	9	0.778	0.528	0.023	0.073	0.091	0.059
	5	4.285	6	0.714	0.435	0.095	0.086	0.073	0.025
	6	2.145	4	0.536	0.392	0.063	0.033	0.038	0.010
	7	3.570	8	0.644	0.322	0.013	0.111	0.075	0.123
	8	4.630	7	0.661	0.406	0.016	0.134	0.08	0.025
	9	5.000	8	0.625	0.438	0.019	0.063	0.093	0.012
	10	5.540	8	0.693	0.483	0.063	0.018	0.049	0.080
RS5	1	2.145	4	0.536	0.429	0.010	0.054	0.038	0.050
	2	2.860	6	0.476	0.310	0.029	0.071	0.048	0.019
	3	3.570	6	0.595	0.387	0.024	0.119	0.048	0.018
	4	6.430	10	0.643	0.418	0.013	0.109	0.071	0.032
	5	7.430	11	0.675	0.459	0.020	0.064	0.079	0.053
	6	8.715	12	0.726	0.475	0.023	0.093	0.077	0.058
	7	1.570	2	0.786	0.512	0.046	0.097	0.103	0.028
	8	3.680	6	0.613	0.403	0.075	0.064	0.065	0.006
	9	2.985	4	0.747	0.489	0.091	0.075	0.079	0.013
	10	4.395	5	0.549	0.361	0.067	0.055	0.057	0.009

Table 2: Overall mean values $\pm$ SD of all examined variables with overall percentages.

Residential Sites	Capita	Mean $\pm$ SD				
		Food residuals	Glass	Paper	Cans	Plastics
RS1	1.085 $\pm$ 0.154	0.649 $\pm$ 0.093	0.106 $\pm$ 0.033	0.100 $\pm$ 0.03	0.120 $\pm$ 0.032	0.110 $\pm$ 0.06
RS2	0.910 $\pm$ 0.056	0.573 $\pm$ 0.036	0.084 $\pm$ 0.034	0.097 $\pm$ 0.021	0.103 $\pm$ 0.082	0.055 $\pm$ 0.046
RS3	0.845 $\pm$ 0.030	0.525 $\pm$ 0.040	0.058 $\pm$ 0.028	0.122 $\pm$ 0.044	0.091 $\pm$ 0.020	0.048 $\pm$ 0.032
RS4	0.689 $\pm$ 0.071	0.444 $\pm$ 0.059	0.040 $\pm$ 0.029	0.085 $\pm$ 0.039	0.074 $\pm$ 0.017	0.047 $\pm$ 0.035
RS5	0.635 $\pm$ 0.095	0.424 $\pm$ 0.059	0.040 $\pm$ 0.027	0.080 $\pm$ 0.022	0.067 $\pm$ 0.018	0.029 $\pm$ 0.018
Overall mean	0.833 $\pm$ 0.161	0.522 $\pm$ 0.083	0.065 $\pm$ 0.026	0.096 $\pm$ 0.015	0.090 $\pm$ 0.019	0.059 $\pm$ 0.027
Overall percentage		62.6	7.8	11.6	10.9	7.1

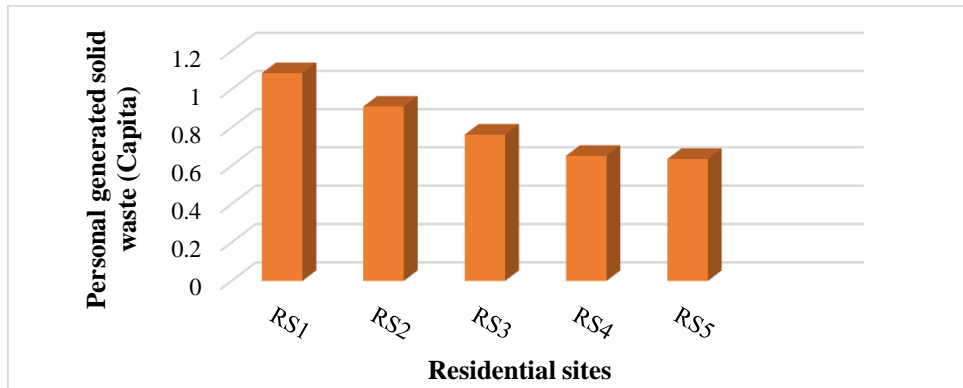


Figure 1: Personal generated municipal solid waste per day of all examined residential sites within Baghdad city.

In case of MSW components, food residues had the highest overall mean of 0.522 $\pm$ 0.083 kg/day followed by paper wastes (0.096 $\pm$ 0.015 kg/day), can wastes (0.090 $\pm$ 0.019 kg/day), glass wastes (0.065 $\pm$ 0.026 kg/day) and finally plastic wastes (0.059 $\pm$ 0.027 kg/day).

Regarding residential sites, it was found that for food residues RS1 had the highest mean value (0.649 $\pm$ 0.093 kg/day) whereas the lowest mean value (0.424 $\pm$ 0.059 kg/day) was recorded in RS5 (Figure 2).

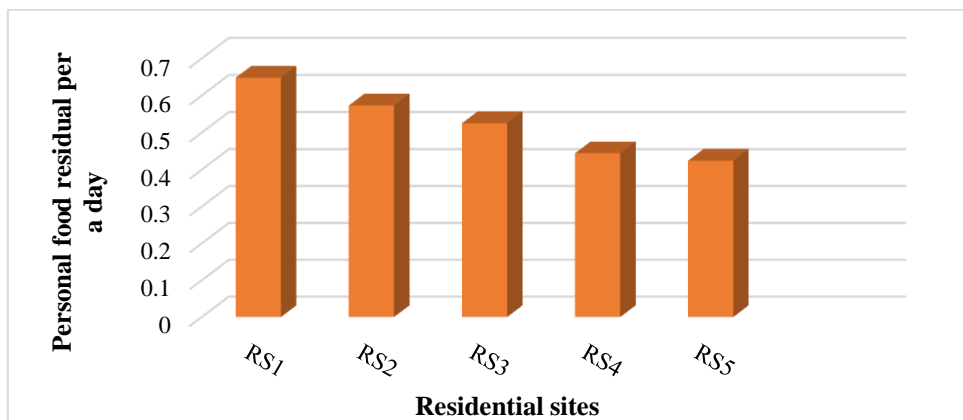


Figure 2: Personal food residual of generated municipal solid waste per day of all examined residential sites within Baghdad city.

Mean glass wastes were found to vary significantly where highest mean value of  $0.106 \pm 0.033$  kg/day and lowest mean value of  $0.040 \pm 0.027$  kg/day were recorded in RS1 and RS5, respectively (Figure 3).

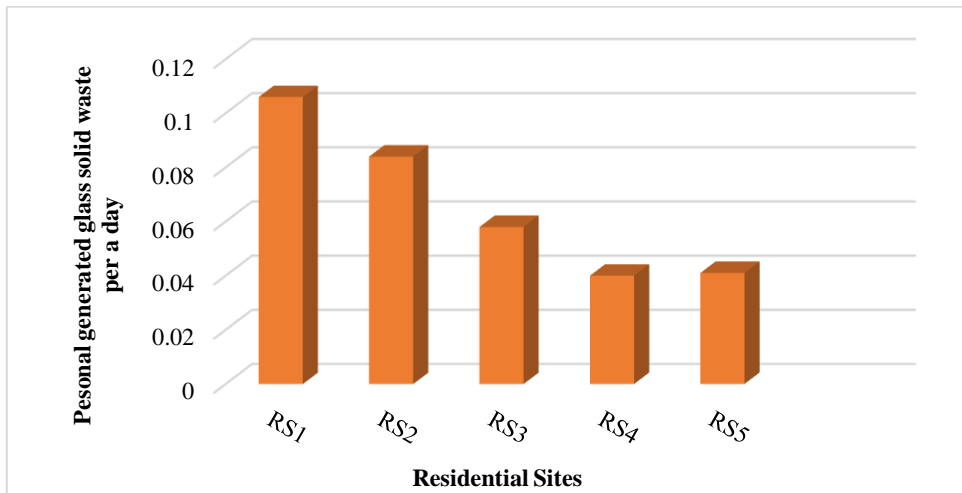


Figure 3: Personal generated municipal glass solid waste per day of all examined residential sites within Baghdad city.

In case of paper wastes, it was found that the highest mean value ( $0.122 \pm 0.044$  kg/day) was recorded in RS3 while RS5 gave the lowest mean value of  $0.080 \pm 0.022$  kg/day (Figure 4). However, these mean values were varied significantly.

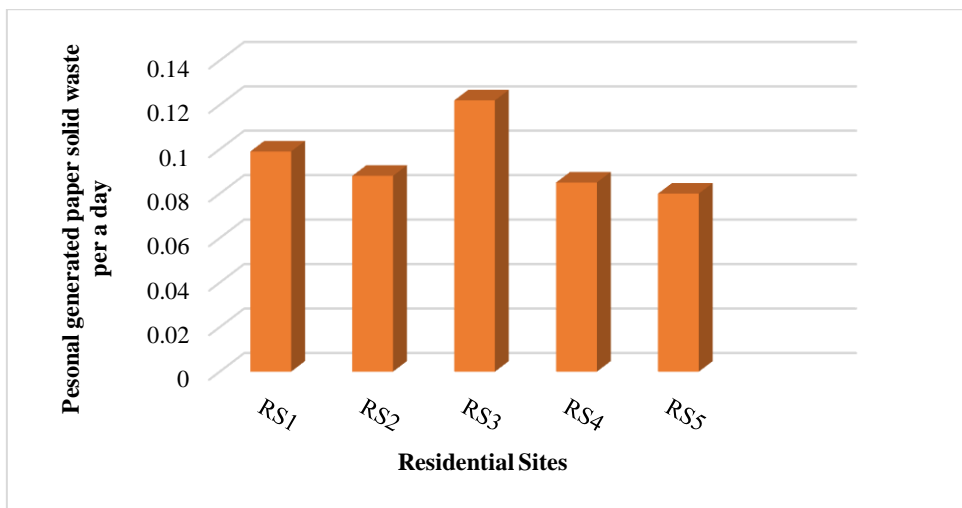


Figure 4: Personal generated municipal paper solid waste per day of all examined residential sites within Baghdad city.

For can MSW, it seems that there were clear differences between mean values where the highest ( $0.120 \pm 0.032$  kg/day) and lowest ( $0.067 \pm 0.018$  kg/day) mean values were recorded in RS1 and RS5, respectively (Figure 5).

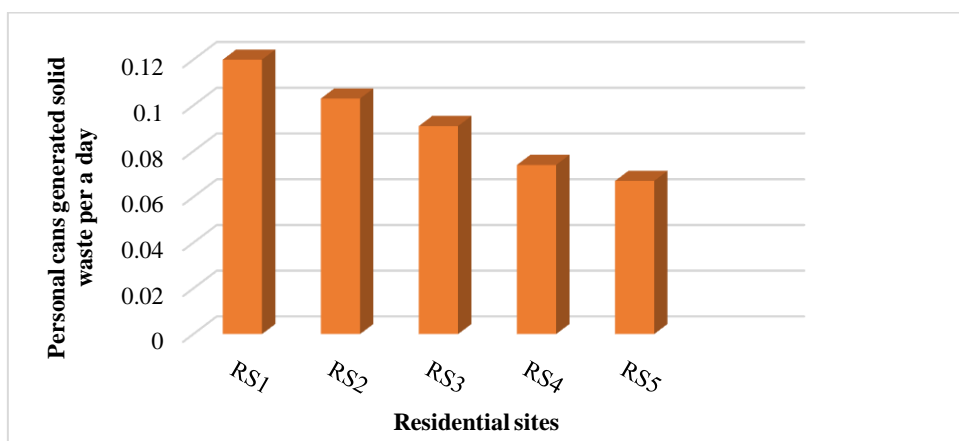


Figure 5: Personal generated municipal cans solid waste per day of all examined residential sites within Baghdad city.

Regarding plastic MSW, the apparent variation was detected where again highest ( $0.110 \pm 0.06$  kg/day) and lowest ( $0.029 \pm 0.018$  kg/day) mean values were recorded for RS1 and RS5, respectively (Figure 6).

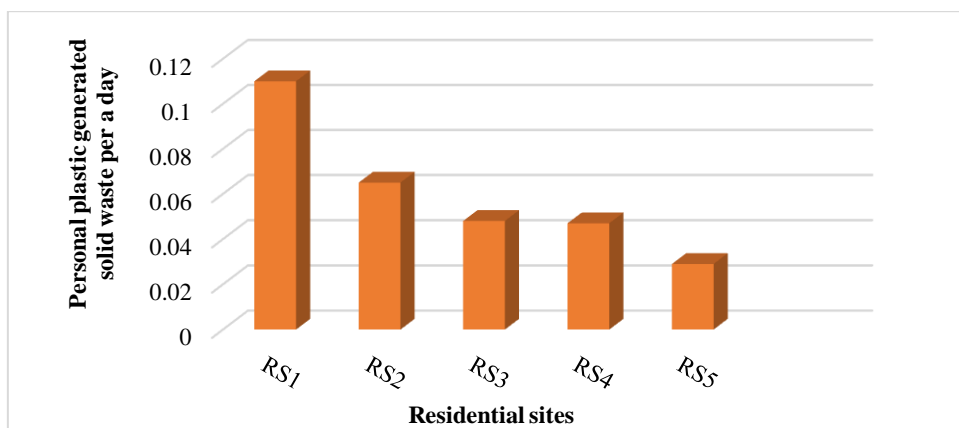


Figure 6: Personal generated municipal plastic solid waste per day of all examined residential sites within Baghdad city.

Finally, the overall percentages of MSW examined components showed that food residues had the highest percentage (62.6%) followed by paper wastes (11.6%), cans wastes (10.9%) and glass wastes (7.8%) while plastic wastes formed the lowest percentage which was 7.1% (Figure 7).

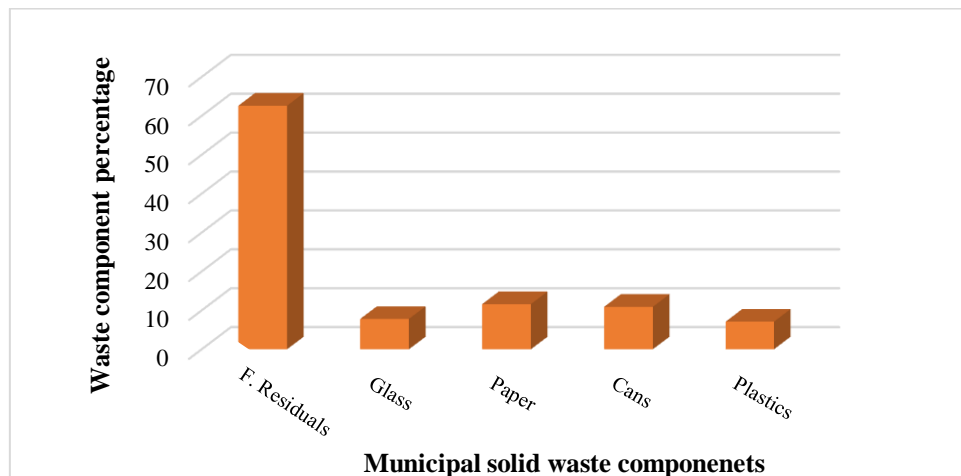


Figure 7: Percentage of personal generated municipal solid waste per day of all examined residential sites within Baghdad city.

This work results are almost similar to various findings of other investigations (Chantou et al., 2013; Ilyas et al., 2017), but they were much higher than those reported by some works (Ouigmane et al., 2018; Wegedie, 2018), and much lower than data reported in other works (Köse et al., 2007; Loboka et al., 2014). Obviously, such significant variations in generated MSW capita may be due to many factors such as socioeconomic status (Khan et al., 2016), income and education levels (Grover & Singh, 2014) and family size (Hocket et al., 1995).

These estimated MSW quantities may present significant trends in terms of utilizing such wastes as food residues to produce methane gas to be used in home needs, transporting and electricity production. Meanwhile plastic wastes can be used for energy producing while certain waste items such as paper, glass and cans can be, recycled to sustain environmental sources.

However, generated MSW food residues can be used in producing methane gas to be used in transporting means and electricity production (Singh & Singh, 2016; Zulkifli et al., 2019). Glass wastes are widely recycled in construction (Carvalho & Marques, 2014; Lu & Poon, 2019), while paper wastes are successfully recycled in various needs (Linzner & Salhofer, 2014; Piynenko et al., 2016), whereas beverage cans wastes are currently recycled worldwide (Fortelný et al., 2004; Harst et al., 2016). Finally, and most interestingly, plastic wastes may be recycled (Mølgaard, 1995) or used as a source of energy production (Nordi et al., 2017).

It seems that generated municipal solid wastes within Baghdad city can be utilized successfully when they are managed soundly and would be a good investment in terms of employment, health protection, environmental sustainability and energy sources.

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