



## Households Solid Waste Generation and Disposal in Some Selected Communities in Ejisu–Juaben Municipality, Ghana

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### Authors' contributions

This work was carried out in collaboration between all authors. Authors WA and AA designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors WA and RA managed the literature searches, analyses of the study performed the spectroscopy analysis and author AA managed the experimental process. All authors read and approved the final manuscript.

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### ABSTRACT

To reduce or curb solid waste management challenges in Ejisu–Juabeng Municipality of Ghana, it is incumbent to quantify the solid waste composition generated at source (household level) and current disposal methods. Kwamo, Ejisu and Fumesua were selected based on the premise of commercial activities, population and historical background. Data was collected through mix approach such as field investigation, survey, face-to-face interviews and the use of semi-structured questionnaire. The study observed high levels of putrescible waste in all the selected towns. The highest mean quantity of solid waste generated was observed in Ejisu, followed by Kwamo and Fumesua respectively. The mean per capita waste generations were 0.2 kg per day for Kwamo, 0.2

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kg per day for Ejisu and 0.3 kg per day for Fumesua respectively that falls within the national average per capita waste generation of 0.5 kg per day. The influence of socio-economic factors and availability of communal waste receptacles on waste generation and disposal has been discussed. Workable integrated solid waste management within the Municipality has been proposed.

*Keywords: Solid waste; municipality; skips; integrated solid waste management.*

## 1. INTRODUCTION

Solid waste management is an important facet of sustainable development for all nations and has been greatly supported by global initiatives. Agenda 21 of the Rio-declaration on environment and development have stated that environmentally sound management of wastes is an environmental issue of major concern in maintaining the quality of the environment and achieving environmentally sound and sustainable development in all countries [1]. However, efforts that aimed at enhancing solid waste management are usually inefficient and unproductive especially in developing countries like Ghana.

Solid Waste Management (SWM) is big challenge faced by economically sound (developed) countries and developing countries. Solid waste management system needs to be planned, designed and operated based on the composition and the quantity of solid waste generated [2]. Solid waste generation rates has increased due to rapid population growth, changing lifestyles of people, development, and consumption of products with materials that are less biodegradable have led to the diverse challenges for municipal solid waste management (MSWM) in major cities in the world [3]. In 2004, 2.6 billion people in the world lacked access to basic sanitation. Out these, 2 billion live in rural areas. Over the past 15 years, progress has been relatively limited and the number of people without sanitation has decreased by only 98 million. In meeting the millennium development goal sanitation target, over 1.6 billion more people need to gain access to improved basic sanitation over the coming decade with developing countries being the main challenges. This will possibly reduce the unserved population by 800 million, from 2.6 billion in 2004 to 1.8 billion in 2015 [4].

In Ghana, about 82% people lack access to improved basic sanitation [5]. It is evident that Ghana government is faced with challenges of waste management. This is largely due to

constant increase and changes in waste constituents. Moreover majority of the municipalities have limited records on waste generation, characteristics and its origin in Ghana. Inadequate information causes decisions regarding proper solid waste management to be centred on assumptions and inferences, which has resulted in its inappropriate management with serious consequences for the environment [6]. For instance, plastic bags used and disposed of by consumers and through waste management activities, not only creates environmental problems, but also reinforces the perception of a wasteful society [7].

Lack of appropriate planning, resource constraint, inadequate governance and ineffective management of solid waste especially insufficient collection and improper waste disposal has been a major concern for many rapidly growing cities in developing countries such as Ghana [8]. In Africa, difficulty of solid waste management is a major concern, as its one of the major challenges in the promotion of sustainable production and consumption in the region [9]. Very little waste generation and disposal studies have been done in the peri-urban areas. This leaves the waste management authorities in these areas with limited information to properly plan its operations and to effectively manage solid waste. For purposes of urban development planning, the amount and kind of solid waste that is generated at source (household level) must be known. It is envisaged that for proper integrated solid waste management to be put in place, the characteristics of the solid waste generated must be known [10].

Inadequate facilities for solid waste collection services coupled with poorly financed waste management; funds for the operation of urban waste management services are mainly from the central government and donors [11]. The problem is compounded by the inability and sometimes the unwillingness by urban community to pay for waste collection services to enable management to accrue enough funds to

manage the waste. Hence, the need to identify and quantify solid waste generated within three urban towns and to assess and evaluate the current waste disposal methods. One of the most accurate approaches for characterizing waste composition consists of collecting waste at its generation source and directly sorting it out into types of materials [12].

Solid waste generated in Ghana has tremendously increased over the years, largely due to economic development activities involving rapid production and consumption of goods and services. It was estimated that the total municipal solid waste generated has increased from about 2,200,000 metric tons in 1984 to about 3,730,000 metric tons in 2000 in the country [13]. Waste quantification refers to the analysis of the total quantity of waste by weight or volume in the entire waste stream. Composition of solid waste studied in 1997 by the Accra Metropolitan Assembly revealed that about 65% of the waste stream consists of organics and inert material arising from the practice of hand-sweeping sand constituted about 17.1% of the waste stream. The combination of organics and inert material accounted for about 82% of the waste [14]. Quantification and characterization of solid waste generated assumes great significance which will enable accurate assessment of waste load and encourage proper planning of solid waste management system in a particular locality.

It is undisputable fact that the understanding of waste management processes in Ejisu–Juaben Municipality is key for the proper design of any remedial measures to keep pace of waste generation. This is hampered currently by a dearth of reliable waste generation and characterization data. Assessment of all the elements involved in solid waste management is necessary to the identification of deficiencies that exist in the existing management strategies in the study areas and enable a change or restructuring in the management system.

## 2. METHODOLOGY

Mix method approach was employed to evaluate households' solid waste generation and disposal in Ejisu, Kwamo and Fumesua in the Ejisu–Juaben Municipality.

### 2.1 Study Areas

The present study was carried out in three selected communities (that is Ejisu, Fumesua

and Kwamo) in the Ejisu-Juaben Municipality (Fig. 1). The area lies within latitudes 1° 15'N and 1° 45'N and longitude 6° 15'W and 7° 00' W, with a land area of 637.2 km<sup>2</sup>. The Municipality over the last decade have experienced rapid population growth, making the typical rural Ejisu-Juaben district now a fast growing peri-urban Ejisu-Juaben Municipality. Currently rural/urban ratio has been estimated to be 3:2. For instance, the 2000 National Population and Housing Census put the population of the Municipality at about 124,176 people comprising 59,286 males and 64,890 females with an average between 1984 to 2000 census growth rate of 2.5%. It was predicted from the 2009 estimated population of 155,270 that, by 2013 the Municipality would have an estimated population of 189,744. The population trend in the study areas is summarized in Table 1.

**Table 1. Population trend in the study areas**

Town	Population in census year		
	1984	2000	2010 (Estimate)
Ejisu	5133	10923	14016
Kwamo	1764	5470	6472
Fumesua	1518	4576	5872

The Municipality had a relatively high population density of 195 km<sup>2</sup> in the year 2000 that made it the sixth most populous area in the Asante [15]. The Municipality has become a “dormitory” of the Kumasi Metropolis as large number of people live in the Municipal area but commute to Kumasi to work.

### 2.2 Sampling Procedure and Data Collection

Sample size (*S*) considered for the research was estimated using the formula  $S = N/(1 + N)e^2$  where *S* is sample size, *N* is the total number of households in the study areas and *e* is the error margin at 10% with confidence level of 90%. The estimated number of sampled households was 100. The total household size from the three towns was 6,938 partitioned by percentage as 59% for Ejisu, 23% for Fumesua and 18% for Kwamo based on the individual number of households in each town. A multistage sampling technique was employed for the data collection where households were systematically sampled from every compound house in various communities.

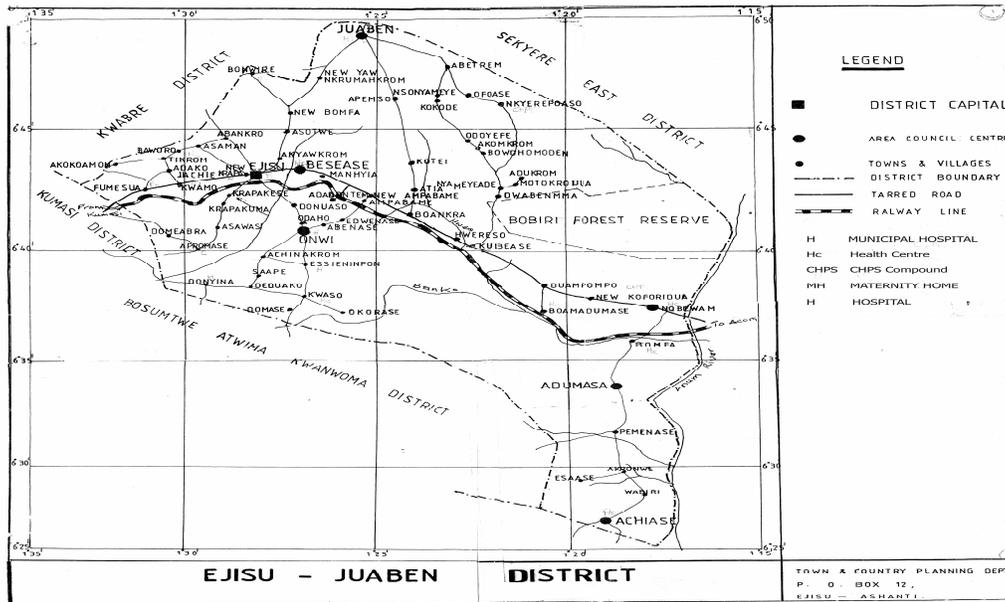


Fig. 1. Base map of Ejisu-Juaben Municipality

### 2.3 Solid Waste Characterization and Measurement

In the determination of the composition of waste by weight/day for every household, households sampled were given polyethylene bags to keep the waste they generate on daily basis. Households were given numbers and polyethylene bags distributed to them were tagged according to the numbers for easy identification. The polyethylene bags were collected daily (mornings) and gathered at a point where they were emptied for segregation and measurement for 14 days. Wastes obtained were sorted into different classes by hand with the use of protective gargets to identify the waste types and different components weighed separately using a spring balanced weighing scale to determine their quantities.

The per capita waste generation (PPWG) in the towns was calculated using the equation.

$$PPWG = \frac{WT}{14H}$$

Where *WT* is total weight of waste (kg) and *H* is the total number of households and 14 is the study period.

### 2.4 Statistical Analysis

The data was analysed using Microsoft excel, Statistical Package for Social Scientists (SPSS

version 16.0) and Statistix (version 9.0) and compared using single factor analysis of variance (ANOVA) at 95% confidence interval. One-way ANOVA was employed to test for variations in waste generation in the three towns. Linear regression analysis was used to establish the relationship between waste generation and socio-economic factors and results presented in charts, simple statistics and tables.

## 3. RESULTS AND DISCUSSION

### 3.1 General Characteristics of Respondents

In the three communities, 100% responses were received from females in Ejisu and Kwamo. Five percent (5%) of the respondents from Fumesua were males while 95% of the respondents were females. Thus waste handling is predominantly managed by females in the study areas. Similar trend has been reported by Afroz et al. [16] in their study in the Dhaka City, Bangladesh. The reason is attributed to the menial task nature of waste handling which could be managed effectively by weaker members in the household especially women and children. Thus, for improvement in sanitation behaviour, formal education for women in the society is of paramount importance since they are directly involved in handling waste in the households [17]. Out of the respondents interviewed, 21%, 14% and 25% in Ejisu, Fumesua and Kwamo

respectively had no formal education. The rest of the respondents have had some form of education, either up to primary, secondary or tertiary level. Majority of the respondents had completed JHS/Middle school in all the three towns. The distribution of educational levels shows varied understanding of waste management issues by respondents. It is interesting to note that little or no education could indicate limited knowledge or understanding in waste management issues.

Data on the number of people in the households were gathered and group into sizes. The highest percentage of household size was between 4-6 people in all the three towns with about 73% in Fumesua, 48% in Ejisu and 65% in Kwamo. The least household size was between 10-12 people which were observed in Ejisu. This could be due to the presence of the “Zongo” (community made of different settlers) community in Ejisu which was absent in Kwamo and Fumesua. “Zongo” communities seem to have large household sizes. The average household size calculated for the towns were 5 for Ejisu and Kwamo and 4 for Fumesua.

Occupations of respondents in the three towns were also investigated. Government workers (salary workers) constituted 5%, 23% and 20% of the respondents in Ejisu, Fumesua and Kwamo, respectively. Majority of the respondents were traders with 70% in Ejisu, 60% in Fumesua and 65% in Kwamo while 3% and 14% of the respondents in Ejisu and Fumesua respectively were engaged in farming activities. About 2% of respondents in Ejisu were unemployed and 20%, 3% and 5% in Ejisu, Fumesua and Kwamo respectively were involved in other forms of occupation. The monthly average income levels of respondents in the three towns were GH¢ 599.4, GH¢ 451.5 and GH¢ 474.0 for Ejisu, Fumesua and Kwamo, respectively. The occupational distributions give ideas on sources of income and could define the economic standings of respondents in each town.

### 3.2 Waste Types and Composition

The waste types identified in the waste streams were food waste, metals, paper, batteries, plastics, tins and cans, wood, textiles, fine residue, fruits, seeds and nuts and yard trimming (Fig. 2). Among the different types of waste generated in the study areas, food waste recorded the highest percentages in all the three towns representing 40%, 46% and 38% in Ejisu, Fumesua and Kwamo, respectively (Fig. 2). This

was followed by fine residue (15%, 13% and 23% in Ejisu, Fumesua and Kwamo, respectively), plastics (14%, 10% and 13% in Ejisu, Fumesua and Kwamo, respectively), paper (8%, 3% and 10% in Ejisu, Fumesua and Kwamo, respectively) and wood (4%, 7% and 3% in Ejisu, Fumesua and Kwamo, respectively). Batteries recorded least percentage in the solid waste stream in all the three towns constituting less than 1.2%. The waste types identified were similar to what has been reported by Fobil et al. [18] in Accra and Mensah [19] in Atwima-Nwabiagya district of the Asante Region of Ghana.

The composition of plastic waste is an important issue in the management of waste. This is because the types of plastic waste affects the technique in its disposal and is necessary for deciding on reuse, reduction and ultimately recycling of waste. The percent of plastic (10%) realised in the waste stream at Fumesua was the same as reported earlier by Mensah [20] but that of Ejisu and Kwamo were higher (14% and 13% respectively). Sustainable amount of waste types that could be termed recyclable waste (i.e. paper, glass, metals, plastics) were also identified. Among the waste types generated in the three towns 28%, 29% and 48% in Ejisu, Fumesua and Kwamo, respectively were recyclable waste. The quantity of recyclable materials observed in the study present opportunity for recycling ventures in the study areas by investors and the district assembly. Recycling of the waste can also reduce the amount of waste that has to be transported to the disposal sites. It may also encourage waste sorting among residents if the waste is bought as raw materials. This could also improve the economic standings of household in the study areas. If the district assembly institute recycling activities, it could serve as a plough back venture that could be used to fund waste management and even other sectors.

The study revealed high percentages of organic waste in all the towns with Fumesua representing 69%, Ejisu 54% and Kwamo 49%. The findings were similar to what has been reported by [21] in Accra and Mensah [20] in Atwima-Nwabiagya. The high percentage of organics in the study area implies that, the people depend mostly on organic foods and this could be as a result of the peri-urban nature of the areas [22]. The high putrescible waste being generated in the study areas require prompt conveyance of waste containers to avoid the incidence of flies and stench from rotting of waste which could impact

negatively on the environment [23]. The high organic waste produced in these areas can be composted to serve as manure to boost agriculture in the study areas.

### 3.3 Waste Generation Rates

The observed mean quantity of solid waste for the three towns was 814.6 kg (1,629.2 m<sup>3</sup>) for Ejisu, 455.9 kg (911.8 m<sup>3</sup>) for Fumesua and 252.7kg (505.4 m<sup>3</sup>) for Kwamo, respectively over the two (2) week period. Thus, the solid waste generation rates were 58.2 kg/day, 32.6 kg/day and 18.1 kg/day in Ejisu, Fumesua and Kwamo, respectively. The study observed significant differences between the total waste quantities generated during the study period in the three towns. However, no significant differences were observed in the per capita waste generation in Ejisu and Kwamo as compared to Fumesua. The per capita waste generation rates were 0.2 kg/person/day, 0.3 kg/person/day and 0.2 kg/person/day in Ejisu, Fumesua and Kwamo respectively. Fumesua had the highest per capita generation per capita per day with Kwamo and Ejisu having the same per capita waste generate rates. There were significant differences in the generation rates per households in all the towns. The similarity of waste generation rate between Ejisu and Kwamo could be explained by the fact that, the towns are located within the same geographical area and therefore lifestyles of the inhabitants could be similar. On the other hand, Fumesua had high percentages of literates than Ejisu and Kwamo and this might have influenced their lifestyles and hence their waste generation rates.

Additionally, Fumesua also had relatively high percentage of government workers and their economic backgrounds might have influence their purchasing power and probably translated to the relatively high waste generation rates. Thus the waste generation within the study areas could be explained by other socio-economic factors such as household size, education, cultural patterns and personal attitudes and income as identified by Al-Momani [24]. It is however interesting to note that the per capita waste generation in all the three towns were below 0.5 kg/person/day which are within what has been reported by Lardinoi et al. [25] as the per capita waste generation rate for low income groups in Accra. This suggests that the people in the study areas may fall within the low income group. This was confirmed by the Municipal

Assembly's description of the study areas as low income areas [20,22].

The relationships between waste generation and some socio-economic factors were investigated. The linear regression analysis of the data showed no significant relationship ( $P > 0.05$ ) between education and waste generation rate in all the towns. Waste quantity had a positive correlation with household size in Ejisu. Thus as the household size increased, waste quantity also increased. The strength of this relationship was estimated to be 26.6%. Similar finding was reported by Afroz et al. [16] in Dhaka, Bangladesh. However, there were no correlation between household size and waste quantities in Fumesua and Kwamo. As income increased, waste generation rate increased in Kwamo, but decreased in Ejisu and Fumesua. The inverse relationship between household size and waste generation in Fumesua and Kwamo has also been reported by other researchers in other study areas [19,26,27]. Monthly income had negative correlation with waste generation in Ejisu and Fumesua but was positive in Kwamo. Both negative [16] and positive [27] correlation between income and waste generation has been reported. Generally, the relationship between waste generation and socio-economic characteristics of respondents was not significant in all the three towns ( $P > 0.05$ ) (Table 2). A unit change in any of the socio-economic factors affect change in waste generation by 2.9% in Ejisu, 12.3% in Fumesua and 6.3% in Kwamo depending on the relationship that exist between the socio-economic factors and waste generation (that is whether negative or positive). Education negatively correlated with waste generation in all the towns. This finding agrees with what has been reported by Afroz et al. [16] but contradicts report by Omole and Alakinde [27]. This indicates that, income and household size were the only significant factors that could probably influence waste generation in Ejisu while income is the only influencing factor affecting waste generation in Kwamo. Thus economic standing of people leaving in the study areas could possibly influence consumption patterns, thereby reflecting in their lifestyles and translating into waste generation.

### 3.4 Solid Waste Handling and Disposal

Waste disposal in the study areas is handled by a private waste management company (Zoom Lion Company Limited) and the sanitation unit of the District Assembly. These institutions were

responsible for ensuring effective collections and final disposal of the waste in the study areas. The respondents were asked a number of questions on their perception on waste handling and disposal in their communities. It was found out that 69%, 86% and 70% of the respondents in Ejisu, Fumesua and Kwamo respectively had no knowledge on recycling of waste. Additionally, all the respondents interviewed at Fumesua and Kwamo did not sort their waste before disposal while only 13% in Ejisu sort their waste occasionally for harmful materials that could harm children who are sent on waste disposal errands. Thus waste sorting is not a common practice among residents in the study areas. Similar observation was made in Tamale Metropolis in Ghana [28].

Waste sorting is not common practice because the systems of waste collections are not

designed to include source separation of waste and therefore adequate facilities are not provided to households to source separate their waste. Solid wastes generated within the communities were stored in different containers including baskets, plastic/metal waste bins, polythene bags, wooden boxes among others. Plastic/metal bins were the most widely used waste receptacle by respondents in Ejisu (59%).

Polythene bags were mostly used in Kwamo (50%) while dustbins were mostly used in Fumesua (53%). The receptacles used for waste storage in the study areas were similar to studies carried out in Nima, a suburb in Accra [29]. With the exception of the dustbins, none of the waste storage containers used by the people had covers. A considerable amount of the rubbish was also put into polythene bags before kept in the storage containers; an observation similar to

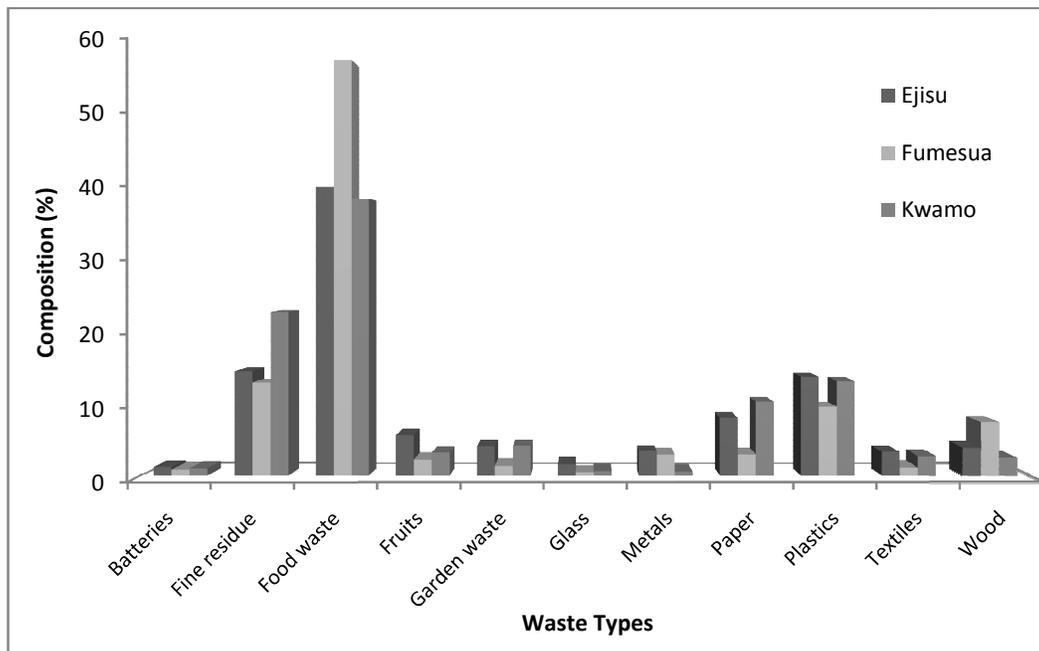


Fig. 2. Waste compositions and variations in Ejisu, Fumesua and Kwamo

Table 2. Correlation between waste quantity (dependent variable) and socio-economic factors

Independents variables	Coefficient (r)		
	Ejisu	Fumesua	Kwamo
Household size	0.266	-0.821	-0.029
Education	-0.513	-0.417	-0.417
Income	-0.002	-0.022	0.299
P-value	0.97	0.72	0.48
R-square	0.029	0.123	0.063

studies carried out in Accra by Boadi and Kuitunem [30]. These waste storage methods is one of the possible factors for indiscriminate disposal practises in the study areas, because much of the refuse fly out of the storage containers before reaching the sanitary points / sites.

Generally, it was realised that a greater percentage of the respondents relied on plastic/metal bins than other storage methods. This might be due to factors such as cost effectiveness (cheaper), availability and perhaps could store more waste. However, lack of covers and placement of bins close to kitchens and corridors in the house have serious health implication. The Ejisu-Juaben Municipality Assembly could provide standard dustbins at subsidized prices to inhabitants and offer education to residents on the need to store refuse in dustbins with covers in order to avert any health risk that may arise due to poor waste handling in the study areas. The more the households get educated and are aware of the side effects of unmanaged solid waste, the better they are likely to make the best choices in managing waste.

All the respondents in Kwamo used the communal containers as their mode of refuse disposal. In Ejisu, 98% of respondents depended on the communal containers as their means of disposal while 2% practiced open dump method of waste disposal. An example of the communal containers is shown in plate 2. About 77% of respondents in Fumesua practiced open dump disposal of solid waste while 5% dump in bushes and 18% depended on communal containers as means of disposal. This finding was in contrast with studies carried out by Benneh et al. [31] in Accra where they argued that because the capacity to handle all of the household waste generated was weak, about 83% of the population dump refuse in either authorized (open dump site) or unauthorized sites in their neighbourhood. The less dependency of the people of Fumesua on communal containers is as a result of a huge refuse dumpsite located within the town. It was observed from the survey that people relied heavily on EJBM facilities for their refuse disposal. None of the respondents depended on private waste collectors (contractors). The situation as presented above partly explains why the EJMA is unable to cope with disposal of solid waste in the study area. As majority of household depend on EJMA for their solid waste disposal, it puts pressure on facilities

and insufficient work force. It is therefore essential for the municipality to sort for funds or restructure its solid waste management system to handle the situation.

### **3.5 Frequency of Conveying Skips and Skips Sufficiency**

Responses obtained from respondents indicated that, skips positioned in the study areas were mostly lifted only when they were full to the brim and most at times overflows (Plate 1). Since most of the residents dispose their wastes in the mornings, it would be appropriate to lift the filled skips in the evening so that by morning, the skips would have been emptied to avoid the situation of waste overflows at the disposal sites since it takes an hour for the drivers to off load the skips at the dumpsite which is 11km from the study areas.

Respondents shared their views on adequacy of skips in the study areas. All respondents in Kwamo, 95% in Fumesua and 93% of respondents in Ejisu agreed that the skips were inadequate. Similar observations have been made by Edmunson [32] and Asamoah [33] about inadequate skips in other cities that have resulted in indiscriminate disposing of waste. It is important for the people to be provided with adequate sanitary facilities to promote good sanitation in the study areas. This could assist municipal assembly to enforce sanitation by-laws to punish offenders.

### **3.6 Payment Waste Collection Services**

Regarding door-to-door waste collection services, 82% from Ejisu, 57% from Fumesua and 70% from Kwamo were in support of this service. When asked whether the communities would like to engage the services of private waste collection agencies, about 65% of respondents from Ejisu, 62% from Fumesua and 50% from Kwamo showed interest to engage waste collection agencies. More than 80% of those in support think this could save them some time to attend to other business. The rest thought they were experts in waste collection and therefore there would be some consistency in the waste collection. The waste collection should however be done in the mornings. On the other hand, several reasons were given for those who were not interested to engage the services of waste collection agencies and this include inability to pay for their services (~78% from Fumesua, 43% from Kwamo and 14% from

Ejisu) and unreliability of the waste collection agencies (~43% from Kwamo and 29% from Ejisu). Majority of the respondents (~75% from Kwamo, 55% from Fumesua and 52% from Ejisu) also were of the view that waste disposal should not be charge based on the quantity of waste. Waste management agencies would have to restructure their system to address the concerns raised by the people.

When asked what amount of money the residents were willing to pay for the door-to-door

service, majority of the respondents in Fumesua (68%) and Ejisu (31%) suggested GHp 20 per head while those in Kwamo (50%) suggested GHp 10 per head. They were of the view that waste should be collected daily instead of the weekly collection. Generally, residents preferred daily payments to monthly payments. This is due to the fact that many of the people in the study areas had daily income and therefore would not be in the position to save for monthly payments for waste disposal. Also because the study areas were peri-urban in nature an appreciable number



**Plate 1. Open dumpsite located in Fumesua (one of the studied towns)**



**Plate 2. Skip filled to the brim in Ejisu (one of the studied towns)**

of the inhabitants were still keeping to rural life style and see payment for waste disposal as an unnecessary burden brought about by civilization. Although, all the respondents have high preference for door-to-door waste collection, the amount they prefer to pay for the services (that is GHp 20 and GHp 10 per day) seems inadequate in terms of labour involvement and cost of transportation.

#### 4. CONCLUSION

The present study observed high levels of organic waste generated in all the three towns. The per capita waste generation in the Ejisu and Kwamo was 0.2 kg/capita/day while Fumesua was 0.3 kg/capita/day which were below the national average per capita waste generation values of 0.5 kg/person/day. Majority of residents in the study areas did not consider waste as a useful resource and therefore did not practice waste sorting before disposal. On the payment for waste disposal, majority of respondents in Ejisu and Fumesua opted to pay GHp 20 while residents in Kwamo opted to pay GHp 10 per load for door-to-doors waste collection service.

High percentage of respondents in Ejisu and Kwamo depended on the communal containers which according to respondents were woefully inadequate while majority of the respondents in Fumesua practiced open dump system of waste disposal. The linear regression analysis revealed nominal relationship between socio-economic factors such as household size, income and education on waste generation and as such could not be a good measure for waste generation in the studied areas. The study has demonstrated that, information on improper solid waste and disposal services in the studied areas were inadequate as shown by the way household handled and disposed of solid waste. Therefore, the research revealed strongly that, the key factors affecting effective waste management in the study areas include inadequate skip supply for storing waste; high population to skip ratio; lack of routine collection of waste, poor methods of waste management and inadequate resources for waste management institutions to effectively collect the waste generated.

Based on the findings of the study, the following are recommended for efficient and effective management of solid waste in the study areas. The Municipality should employ the use of tricycles and motor cycles in the collection of refuse from homes to hauling point for

transportation. This would help minimize cost and ensure better containment of waste in the study areas to promote better financing and management of waste. Educating inhabitants on the need to pay for waste disposal and the implementation of the daily payment for door-to-door waste collection service would be more appropriate for the study areas. Strategies to improve household solid waste management in the studied areas must take into consideration all the deficiencies identified with the view of increasing knowledge on health and the environmental implication of improper waste management among the populace.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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