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Environmental Impacts of Polyethylene Generation and Disposal in Ilesha City, Osun State, Nigeria

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Abstract: *The quantity and generation rate of solid wastes in Nigeria is increasing over the years with lack of efficient and modern technology for its management. The field research was approached through extensive literature search, administering of questionnaire, interview and personal observation by selecting seven daily markets in Ilesha for data collection. The study was carried out to examine the effects of improper handling and disposal of domestic wastes on the lives and health conditions of people of Ilesha and its environ. A simple random sampling was used to select the market. The selected markets are Idasa, Adeti, Idi-Ose, Oja-Oba, Korede, Irojo and Sabo. Out of the total sample size of 300, 60% of them were females and while40% were males. The study sample randomly included 49% of students leaving in the study communities, 25% of the respondents were operating private businesses while 17% were in the civil service category. However, 9% of the respondents included in the study sample were unemployed. The percentage of respondents who had no education was 7%, tertiary (47%), secondary (37%), primary (5%) and vocational education (4%). In a multiple response, almost all household within the municipal agreed that plastic waste created diversity of problems. 47% indicated that plastic waste silt gutters, 37% said plastic waste creates unsanitary environmental conditions, 30% was of the view that plastic wastes serve as breading grounds for mosquitoes, 20% said they cause animal death while 23% said they pollute water bodies. Also, nearly 15% indicated that plastic wastes affect human health and 19% said they affect agricultural soils. Indiscriminate polyethylene disposal has constituted environmental nuisance and degradation. For market cleaner and sustainable environments, vigorous enlightenment campaign, proper collection techniques and recycling among others are recommended.*

Keywords*: Environmental impacts, polyethylene generation, disposal, recycling, seasonality.*

1. INTRODUCTION

During the flourishing of civilisations from 300-1000 D.C., solid waste in capital and large cities were placed in large pits with layer of soil cover [2, 5]. The municipal refuge is referred to as any waste generated by the domestic and industrial sectors in the municipality. The municipal solid waste is heterogeneous in nature and it contains papers, plastics, rags, metals, glass pieces, ashes and compatible matters [13]. In addition, other substances like scrap materials, waste papers, dead animals, discarded chemicals, paints, hazardous hospital waste and agricultural residue is also categorized in municipal solid waste [19]. Till date, the biomedical waste generated from clinics, hospitals, nursing homes, pathological laboratories, blood banks and veterinary centers have also been disposed along with municipal solid waste at dumpsite. Increasing population growth accompanied by rapid urbanization and industrialization has resulted in dramatic increases in the volume of wastes generated by modern societies. Increase in economic activities and food consumption by humans and changing lifestyles generate a massive volume of domestic wastes which creates a critical problem in the developed and developing countries of the world [21]. In traditional African society, with lower population figures, the native leave was sufficient for all that the individual needed to wrap [9, 12]. In 1979, cities and towns in Nigeria generated an estimated 6 million tonnes of solid waste while it was about 48 million tonnes in 1997.

More than 25% of the municipal solid waste is not collected at all; 70% of the Nigeria cities lack adequate capacity to transport it [6]. Solid waste management has emerged as a major environmental threat for cities in developing countries worldwide. In a survey released by UNDP in 1997, 151 mayors from around the world ranked solid waste disposal problem as their second most urgent urban challenges surpassed only by unemployment and followed by urban poverty [1, 2]. In fact, solid waste poses various threats to public health and adversely affects flora and fauna as well as the environment especially when it is not appropriately collected and disposed [8, 11]. Besides the above-mentioned effects of solid wastes, they result in emission of toxic chemical to the atmosphere and to the soil whenever they are degraded or burnt. The trees absorb these toxins through their root system which retards growth rates and consistently results to death

[5]. Solid waste management has gained notoriety in Nigeria today because of its visibility and the embarrassment it has constituted to the image of the nation [1, 6]. Only few state capitals in Nigeria have been able to put in place fairly sustainable urban waste management programmes. It is therefore a common site to find mountains of waste scattered all over our cities for days or even weeks with no apparent effort displayed at getting rid of them, even with the attendant risk of air and groundwater pollution. Besides, when generated, land was generously available for the disposal of waste. Hence simple disposal techniques such as return to land use of adjacent field, and indiscriminate burning and dumping were adopted for waste disposal [6, 7]. Unfortunately, these techniques could no more accommodate the present waste disposal problems because of rapid population growth and industrialization which are the two major factors competing for land [2, 10]. The two major factors have greatly increased the volume of polyethylene generation meaning that the coming generation will have to face and contend with unprecedented environmental problems and challenges. Until recently, polyethylene wastes were disposed to landfills after their use. This disposal creates environmental pollution and space problem because they are not biodegradable easily on like other materials. The land gets littered by polyethylene bags garbage presenting an ugly and unhygienic seen. They find their way into the city and drainage system resulting to blockage case in convenience, difficult to maintaining the drainage with increased cost [22].

The existing landfills are neither well equipped nor well managed and are not lined properly to protect against contamination of soil and groundwater. To resolve environmental pollution caused by polyethylene wastes in Nigeria, we have to adopt a new management of discarding process (i.e. re-cycling them) instead of throwing them into the land as landfills. Recycling consists in processing post-consumer materials to produce raw materials for new products. It can be widely used and will help to increase plastic recovering percent because increasing knowledge about property change will increase the demand for recycling of the polyethylene material. The environmental control of polyethylene waste by recycling method will help in transforming the waste into reusable products thereby reducing the quantity of waste in Nigeria environment. Urban waste disposal is the responsibility of various municipalities, local government and/or city cooperation [6]. In most developing nations, urban waste disposal systems are anything but functioning. Where they function however, they are grossly inadequate despite today's technological know-how and renewed efforts towards effective waste disposal. Table 1 indicates percentage of solid waste generated in most cities in south west Nigeria and their sources.

Table 1: Main sources of municipal solid waste in south-western Nigerian cities

City	Domestic (%)	Commercial (%)	Agricultural (%)	Industrial (%)
Abeokuta	73.90	17.50	8.20	0.50
Ado-Ekiti	78.90	14.30	4.10	2.70
Akure	70.30	18.60	6.30	4.80
Ibadan	66.10	20.30	2.20	11.40
Igede-Ekiti	75.10	11.00	12.40	1.00
Ijebu-Ife	79.50	14.00	3.50	3.00
Ile-Ife	67.40	28.40	1.00	1.10
Iyin-Ekiti	79.60	2.20	11.60	6.60
Ode-Omu	91.20	1.80	5.90	1.10
Osogbo	68.20	23.50	2.10	6.20
Oyo	90.50	6.50	2.00	3.00
Mean	76.42	14.37	5.39	3.76

Source: Olanrewaju and Ilemobade [17]; Olubanjo and Fasimirin [18]

Polyethylene materials are those materials made from a chemical compound known as polythene$(C-H)_n$and is manufactured from the polymerization of ethylene$(C-H)_n$. Polyethylene refers to products from the main groups of polythene, High Density Polythene and Low-Density Polythene. Polyethylene are chemical substance that possess toxic properties, resist degradation, bio-accumulate and are transported through air, water and migratory species, across international boundaries and are ultimately deposited far from their place of release, where they can accumulate in terrestrial and aquatic ecosystems[2].Basically, polyethylene is an odorless, translucent solid, commercially available in pellet form which is convertible to derivative products such as the polythene bags. It is very resistances to chemical attack. They possess certain qualities and properties which make them readily usable; these include high tensile, stiffness, compressive strength and impact resistance [3, 22].Human activities generate many by-products which are generally seen as useless and discarded as wastes [21]. These massive amounts of wastes subsequently find their ways into the ground, air and water every year [4]. Polyethylene materials are used widely in many low performance consumer products for wrapping, storage of beverages, toys and also high-performance products like car components, bullet proof suits and other products [15, 22]. They have substituted ferrous, wood and ceramic materials in many applications for which reason, polyethylene consumption has increased exponentially in the past decades. The average per capital solid waste generation in Nigeria has increased from 0.32 kg/day in 1971-1973 to 0.48 kg/day in 1994. Daily per capital generation of municipal

solid waste in Nigeria ranges from about 100 gm in small towns to 500 gm in large towns. The EPRIT in 2005 showed that 23 big Nigeria cities generate 19 million tons of solid waste every year. But now urban centers of Nigeria produce 120,000 tons of solid waste each day; it is expected that it will reach 300 million tons per annum by the end of 2047 [6]

Polyethylene is found in the entire streets, nooks and crannies of Osun State. They therefore pose serious environmental problems to inhabitants especially where solid wastes are deposited in both urban and rural areas. A lot of studies abound that focus attention on solid waste generation and disposal in Nigeria cities. However, there are few research works on the environmental impact of polyethylene generation and disposal in Nigeria. Aziegbe, [3] examined the seasonality and environmental impacts of polyethylene generation and disposal in Benin City, Edo State, Nigeria. His work was however siting specific. Till date, there is not known research work with focus on the generation and disposal of polyethylene and its environmental impact status within the contexts of aesthetics and environment in Osun State and with particular attention to Ilesha City, Nigeria. This knowledge gap specifically represents the focus of this study.

Therefore, this paper investigates the seasonal variation in generation and disposal of polyethylene papers in Ilesha municipal witha view to comparing the quantity of polyethylene generated and disposed of both at homes and market centers, and, also examines the risks posed by polyethylene to human health and environment.

2.MATERIALS AND METHOD

2.1StudyArea

The research was carried out in Ilesha in Osun State, Nigeria. It is located between latitudes 6℃ 17’ and 6℃ 26’ of Southwest, and longitudes 5℃ 351 and 5℃ 411East (Figures 1 – 5). It is a commercial as well as industrial town with some daily markets. Ilesha is found on the equatorial climatic belt precisely with summer rains and winter dryness. Although there is hardly any month without rainfall, the concentration is between the months of March to June (raining season) and, the dry season is prevalent between the months of (November to February). Humid tropical climate is prevalent in the area, marked by the alternating wet and dry seasons. The mean annual rainfall is well above 2000mm with relative humidity that is above 70%. Temperature is high throughout the year with a mean of 28℃ [20]. This is relatively high temperature, no doubt, permits the demand for cold sachet water, ice cream as well as soft drinks. The physiographic settings of the area of study include the climate, drainage pattern, topography, and vegetation. The topography is gentle in some areas with water divide in the northeastern and southeastern part. The area is well drained with many rivers, some of which are seasonal. The drainage patterns observed includes dendritic, parallel, and trellis.

Field mapping and integration of different maps by GIS software was carried out for the purpose of this research, the following software packages and maps were used: ILWISS 3.1, topographic map of the area and Satellite images were acquired and processed using the software. This imagery has the coverage of 180 km by 180 km and spatial resolution of 28.5 m. The topographical map of Ilesha: 243 NW, NE, SW, SE were glued together to produce the base map. The sub-map has the minimum X and Y UTM value of 681461.37 and 828663.01 respectively which are on the southwestern corner and the maximum X and Y UTM value of 720215.83 and 851908.92 respectively on the northeastern corner of the sub-map. Landsat ETM+7 imagery was geo-referenced with the topographical maps of the area [20].

Figure 1: Map of Nigeria showing Osun State

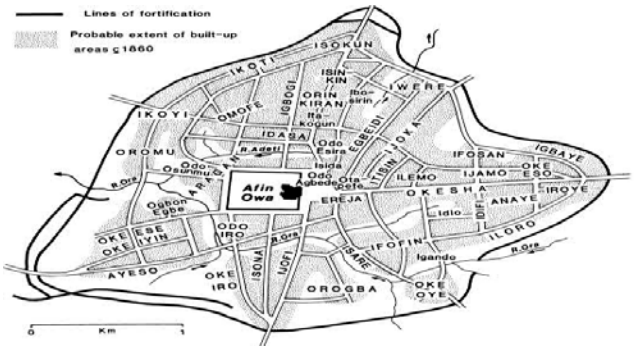

Figure 2: Map of Ilesha and its community boundary

Figure 3: Map of studying area showing the markets

Figure 4: Map of Ilesha and its community boundary

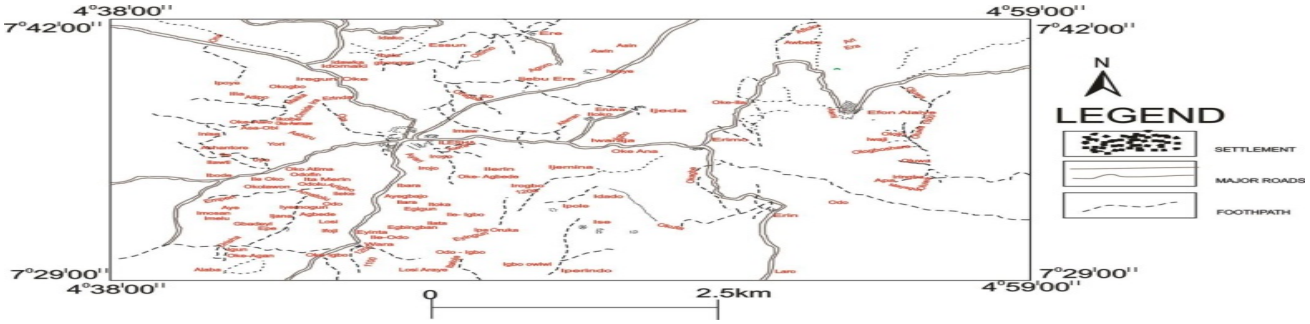

Figure 5: Location and accessibility map of the area of study

2.2 Field Research Approach

The field research was approached through extensive literature search, administering of questionnaire, interview and personal observation and employed on some selected markets in Ilesha for data collection on polyethylene generation and disposal. In each market, two areas measuring 30 m by 100 m were demarcated in such a manner that one was in the raw food section and other in the processed food items (provision stores) section. In each market, one of the sanitation personnel was made to sweep the demarcated areas daily and was instructed to always select the polyethylene from other wastes. These were stored in special refuge collection bins and were measured two weeks interval using Salter Thermo scale.

2.3 Demographic Characteristics

The population of the Ilesha municipality according to the 2015population census is 309,550. The sex distribution of males and females are 105,783 (48%) and 160, 767 (52%) respectively. There are about 213 communities in the municipality. The settlement pattern is predominantly rural (about 95%) with dispersed buildings [13].

2.4 Secondary Data Collection

Secondary data from books, articles, newspapers and the internet for review of literature. Data gathered from the municipal assembly included their coverage area in terms of waste management; the final destination of all waste gathered from the municipality as well as challenges confronting them. Data gathered also included assembly's partners in waste management. Other secondary data gathered from both the assembly and the municipal Assembly.

2.5 Primary Data Collection

Stratified multistage sampling, simple random sampling and convenience sampling were used. Direct observation was also employed to document the actual household waste management situation on the ground. Considering the time and resources available it was not possible to carry out the study in all the areas. Simple random sampling was therefore used to select seven daily patronised markets as the study site.

2.6 Questionnaires Administration

The main data collection tool was the structured and semi-structured questionnaire which was used in interviewing the market and the environment. A total of 300 questionnaires were self-administered to collect in-depth household information including demographic data, methods of waste management, level of awareness on plastic waste, problems of plastic waste as well as roles with regards to the reduction of plastic waste. Question asked were both closed and opened type depending on the information required.

2.7 Data Processing and Analysis

Data gathered through the questionnaire administration was checked for completeness, accuracy and consistency of responses in order to identity and eliminate errors. The data was then entered into the computer using Epinfo version 3.1software and then processed with Statistical Package for Social Sciences (SPSS) into statistical tables and charts for interpretation and further discussions.

3.RESULTS AND DISCUSSION

3.1 Monthly Variation in Polyethylene Generation and Disposal

The monthly distribution of polyethylene in all the markets combined is shown in Table 2. The pattern displayed showed a rise in polyethylene generation and disposal from January to April, which had the highest peak (Figure 6). Thereafter, there is a gradual declining trend until August (Figure 6), which experienced the least generation and disposal. The rise in trend continued again until the month of December, which had the second peak (Figure 6). Seasonal variation

showed that polyethylene generation was generally high during the dry season months of November to March with the highest occurring in March (Figure 6). There was a decline in the amount of polyethylene generated in the wet season from the months of April to October with the lowest occurring in the month of October (Figure 6). This is in agreement with the works of Omuta [16] and Akinro [2] who reported similar result for Akure city, south-west Nigeria when he observed that solid waste generation is higher during the dry season than in the wet season.

Table 2: Monthly variation in polyethylene generation and disposal

Month	Seasonal Variation
January	20.2
February	22.4
March	24.0
April	21.7
May	18.9
June	17.3
July	17.1
August	16.4
September	15.3
October	13.8
November	16.8
December	17.9

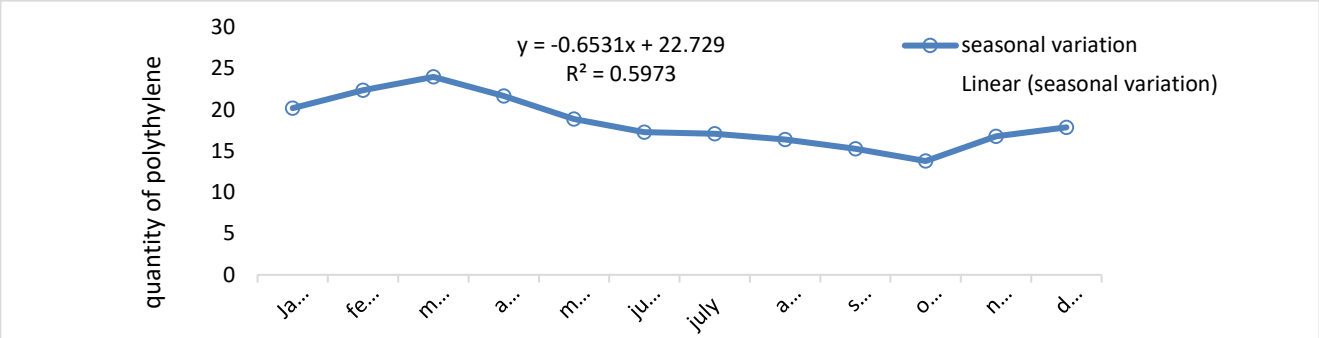

Figure 6: Variation in polyethylene generation and disposal

3.2 Polyethylene Generated on Market Basis

The mean polyethylene generated and disposed from the sampled markets in Ilesha is shown in Table 3. Idasa market, which is raw food market, generated the highest polyethylene among the sampled markets (Table 3). This was closely followed by Adeti market. Sabo market had the least weight of polyethylene generation and disposal. A similar pattern of monthly distribution of polyethylene was noticed in these markets as shown in Figure 7. While the least disposal occurred in Sabo market, the highest occurred in Idasa market. The reason that could be responsible for this is that the market population comprised of mainly men who depend almost entirely on food items wrapped with polyethylene. Another reason may be because the markets also serves as the motor park for transporters to Ibadan, Ilorin, and other parts of Nigeria, Though, they use a lot of polyethylene in the sales of their foodstuff, most of these are not deposited in the markets but are taken home. Moreover, most women cook their food at home and bring them to the market in plastic food containers thus reducing the rate of consuming polyethylene wrapped foods in the market. The polyethylene collected were sorted and counted. The result shows that table water sachet topped the list, followed by cream and biscuit wrappers.

Table 3: Polyethylene generated on market basis

S/No	Name of market	Polyethylene generated (kg)/day	Standard Deviation	Rank
1	Idasa Market	53.21	8.3	1
2	Adeti Market	48.63	4.5	2
3	Idi-Ose Market	45.14	5.1	3
4	Oja-Oba Market	43.22	4.8	4
5	Korede Market	40.91	3.7	5
6	Irojo Market	38.72	4.3	6
7	Sabo Market	36.74	2.9	7

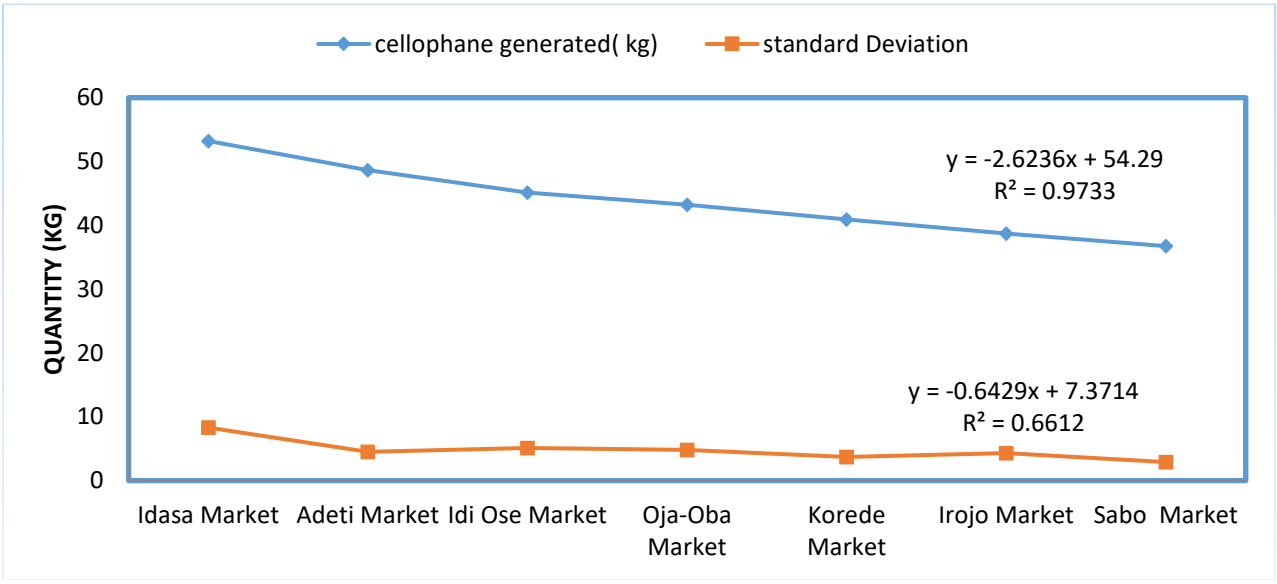

Figure 7: Polyethylene generated on market basis

3.3 Polyethylene Wastes Generated at Home and Market for Dry Season

The polyethylene collected were sorted and counted. The result indicated that sachet water topped the list because it is consumed throughout the year with a very little seasonal variation following by biscuit wrapper and ice cream (Table 4). The studied markets have no public portable water system where the traders can get their drinking water. As a result, majority of them depend on the sachet water on a daily basis. Some traders who take their drinking water to the market from home soon discover that the water becomes too worm and unfit for consumption in the afternoons particularly on dry season. Consequently, they resort to the cold sachet water that is being hawked all over the market. Ice cream wrappers exhibited the highest variation in this study. Their generation and disposal are readily compared both during the dry months and the heart of the wet season. Polyethylene for assorted items also exhibited high seasonal variation. This implies that its demand and consumption is almost uniform throughout the year. Ezechi *et al*. [6] reported similar finding for Aba, Nigeria. Ezechi *et al*. [6] noted that among the non-biodegradable solid waste generated, polyethylene is mostly affected by seasonality. Types of polyethylene generation at home and market also displayed a very interesting pattern as shown in Figure 8. It shows that polyethylene for assort items biscuit wrapper, followed by ice cream sachets and table water sachets in the market. At home, the trend displayed, when arranged in closely followed by biscuit wrapper, ice cream wrappers and table water sachets (Table 4). Polyethylene for assorted items ranked lowest in the market because they are used in wrapping items in the market but disposed of at home having removed the contained items for cooking or storage. The generation of table water sachet was lowest at home but highest in the market. This is so because most homes have refrigerator where they can store water for it to get cool/cold. The findings is in agreement with Yusuf *et al*. [23] study in Zaria, Northern Nigeria, where he reported that cool sachet water and ice cream are sold more at markets and schools.

Table 4: Comparison between polyethylene wastes generated at home and market for dry season

Place/Types	Biscuit wrappers	Ice cream sachet	Pure water sachet	Total
Market Kg	62,998	55,859	78,478	164,335
%	38.335	33.991	27.674	100
Home Kg	54,875	42,010	40,985	130,870
%	41.931	30.572	27.497	100

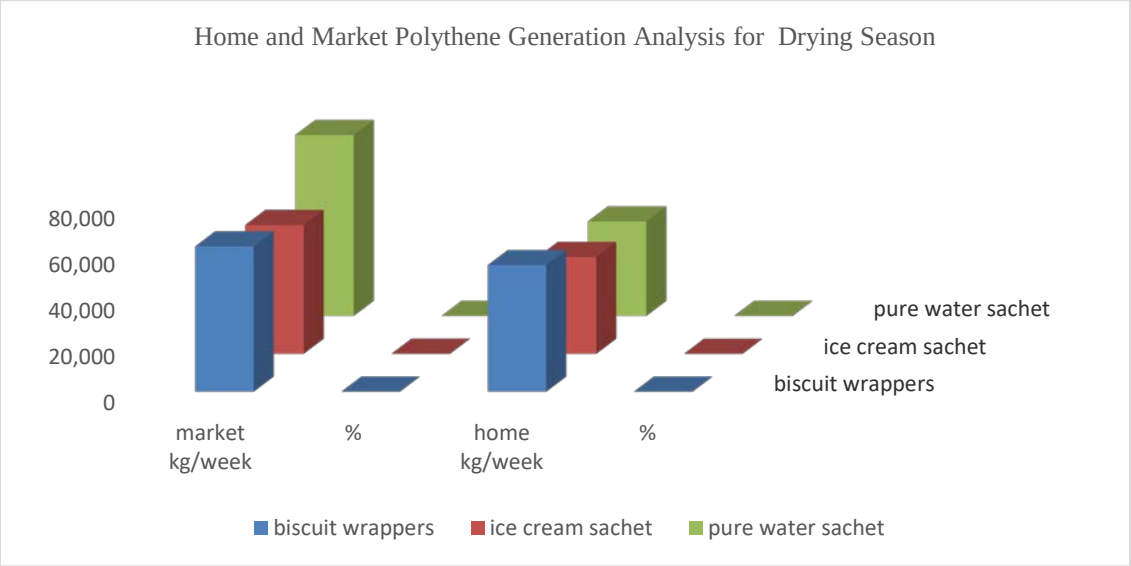

Figure 8: Showing the analysis of polyethylene generation during drying season

4. CONCLUSIONS

Based on the results of this research, the level of waste generation in Ilesha were relatively high and were found to be higher during the dry season months (November – March) than the wet season months (April – October) with the least in the month of June. None foodstuff markets dominated by male traders who depend solely on wrapped food items with polyethylene had the highest polyethylene generation. Polyethylene generation was also higher in the markets than at homes. The quantity and the rate of solid wastes generation in Ilesha have outgrown the capacity of nature to naturally absorb them. To prevent serious environmental disaster in Ilesha, priority should be given to waste management. For a cleaner and sustainable environment therefore, massive awareness campaign and enlightenment about the danger polyethylene poses to our environment should be vigorously carried out. Efforts of environmental scientists in the country are highly solicited in researching into all possibilities of making sustainable solid waste management in Nigeria. Government should reinforce waste collection and disposal systems in every state while strengthening and enforcing the appropriate laws. In order to improve the environment and reduced the negative impacts of polyethylene on the society, recommendation on public awareness on proper disposal of wastes in our cities (such as Ilesha) will prevent choked gutters leading to flooding. Also, eradication of breeding places for mosquitoes that causes hazardous diseases, establishment of recycling company in Nigeria to turn waste to wealth and research funding to develop a polyethylene that can be biodegradable, by government at various levels is inevitable.

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