INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 6 - V7I6-1181)
Available online at: https://www.ijariit.com

Expanded Polystyrene (EPS) waste: An Emerging monster in Lagos municipal solid waste

Aeneas U. Nebert
nebert4j@gmail.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Oluwatoyin E. Taiwo
toytaiwous@yahoo.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Jane Adamma Chukwudebelu
adadebelu@yahoo.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Nwauzor Onyinyechi Gloria
glo2chem@yahoo.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Ugo Uchechi
capitalucubed@yahoo.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Ogbonna Sylvanus Orji
sylvanogbonnao@gmail.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Okuneye Josephine Olayinka
okuneyeolayinka19@gmail.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Anozia Euphemia Chibuzor
anoziachibuzo@gmail.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Obuene Udoka Shedrack
obueneud@gmail.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

ABSTRACT

Expanded Polystyrene (EPS) also referred to as Styrofoam, is a form of plastic frequently use for food packaging. This research focuses on the generation, disposal and the negative effects of waste EPS in Lagos Municipal Solid Waste (MSW). Studies from some specific locations in five Local Government Areas (LGAs) of Lagos showed daily usage of EPS (as food package) by street food vendors and its negative impact on the environment and human life. Qualitative analysis of these locations of Lagos state has shown how several factors including the properties of EPS such as low cost, light weight, versatility, low recycle value and non-biodegradability has contributed to the surge of EPS waste in Lagos state. This paper shows how street food vendors and consumers' attitudes have contributed to defacing the aesthetic quality of Lagos state.

Keywords: *Expanded Polystyrene (EPS), Lagos state, Municipal Solid Waste (MSW), Street Food Vendors.*

1. INTRODUCTION

Waste is any substance that is discarded or required to be discarded after it becomes worthless. Waste can appear in the form of solid, liquid or gaseous substances. These wastes are usually generated due to human or animal activities. Solid wastes are solid or semi-solid substances that became worthless, valueless and useless due to use and are needed to be disposed or recycled (Anifowose et al., 2011, Leton et.al.2004). Solid waste from residents, commercial areas, industrial and agricultural processes are referred to as Municipal Solid Waste (MSW) (Singh et al., 2011). With increasing rate of urbanization comes population growth and with increase population comes increase in consumption which often results in the rise of Municipal Solid waste (MSW).

MSW generation rates are usually determined by level of industrialization, climatic condition, civic behaviors and economic growth. Usually, the quantities of municipal solid waste generated are based on the economic growth and rate of urbanization (Hoornberg and Bhada-Tata, 2012). The MSW generated within the Lagos metropolis is usually high due the high level of urbanization and it is composed of high percentage of plastics. The high composition of plastic noticed in Lagos MSW is to a certain level, because of affordability, lightweight, versatility and its single use purposes. Some of these plastics are used as packaging materials for food and other products. Most of the plastics used as packaging materials by the food vendors in Lagos is the Expanded Polystyrene (EPS)often referred to by its trademark 'Styrofoam' (invented by Dow Chemical in 1941) or take-away pack as commonly referred to by consumers. EPS is a plastic product made from the polymerization of styrene (vinyl benzene) monomers to form polystyrene (an aromatic polymer which is a petroleum-based plastic), it is made of pre-expanded closed-cell

foam beads. The production process involves carrying out the polymerization of styrene in droplets suspended in water. From this process PS beads are formed (Farelly et.al.,(2017); Nukmal et.al.,(2018);Yanto et.al.,(2018)).

In 2013 alone, about 21 million tons of Polystyrene was produced globally and this is because of its wide range applications (B T. Ho et.al., 2017) This type of plastics (EPS) is usually lightweight, inexpensive and design for single use purposes. Nowadays, food vendors in lagos and most cities in Nigeria has embrace the use of EPS as take-away packs due to the impact of Covid-19 restrictions on social gathering in the country. The use of EPS has been on the increase as more street food vendors commonly called "mama put" keep on emerging with little or no government restrictions. These vendors are scattered everywhere; bus stops, streets, under bridges, motor parks, office areas, commercial areas, etc Most of these street food vendors do not have space for sitting customers, some resolve to hawking the food due to unavailability of space or insufficient funds to rent a space and in this case the consumers have to collect the food in the available EPS disposable pack. Many other consumer goods come in EPS and because they are single use form of plastics they all end up as MSW. Regrettably these EPS are non-biodegradable and resistant to photolysis, they have low or no recycling value. EPS finds application also in other areas apart from packaging, areas such as construction, electronics, agriculture etc.

EPS has become an environmental challenge due to its wide usage which resulted in indiscriminate disposal of the waste EPS. Its non-biodegradable nature and its low interest to waste pickers have made EPS a nuisance causing serious threat to the environment, wildlife and human health. EPS debris are sometimes mistaken for food by animals and marine life thereby ingesting it and this can cause other harmful effect or dead of such animals. Tons of EPS are littering the aquatic and terrestrial environments with damaging effects to the ecosystems due to the toxicity of its component (B T Ho et.al., 2018; ATSDR, 1992; CIWMB, 2004; Lacounty Gove,2008). In this research we focused on the EPS waste generated from street food vendors in lagos state and its impact on the environment and living organism.

2. MUNICIPAL SOLID WASTE (MSW)

Municipal solid waste (MSW) is produced as a result of use of resources and energy by living things (Sharma and Jain, 2020). Every living thing produces waste and because majority of these waste produced has little or no recycle potentials, it tends to accumulates with time becoming a huge problem. Municipal Solid waste problems are huge challenges faced by city government in several municipalities of Africa and other developing countries (Noufal et.al., 2020). In Africa, sudden and unplanned urbanization has led to increased waste production which has negative impact on public health and the environmental standard. (Aliyu &Amadu, 2017; Saghir & Santoro, 2018, Mazhindu et al., 2012). MSW generation globally has also been on the increase as most people and companies shift to keep up with the high rate of urbanization. According to Hoornberg and Bhada-Tata 2012, about 0.68 billion tonnes of MSW was produced by 2.9 billion urban dwellers in 2002 and 1.3 billion tonnes of MSW was produced by 3billion urban dwellers in 2012, this MSW generation is projected to rise to 2.2 billion tonnes by 2025generated by an estimated 4.3 billion urban dwellers. The predicament pose by MSW has continued to be one of the most serious environmental problems facing many cities in Nigeria. Table 1. Shows the human population and the waste generated by several cities in Nigeria, Lagos having the highest waste generation capacity. Lagos, being among the fastest growing cities in Africa is not left out when it comes to massive waste generation and this is due to the significant increase in population caused by its rapid urbanization and Industrialization. MSW generated in most Developing countries are composed of organic matters, plastics , papers etc. Table 2.shows percentage waste composition of some developing countries. It can be observed from the table that in most of the countries presented, plastics are estimated to be the second most generated waste after organic waste.

3. PLASTIC WASTE

Plastics are made from polymeric materials and they are broadly used for several purposes. Since the commercial production of plastics began in the 1950s, more production and research on different forms of plastics and their uses has been on the increase. From 1950 to 2018, the global production of plastics was estimated to be about 6.3 billion tonnes (UNEP, 2018). This high rate of production was as a result of their physical and mechanical properties which makes them versatile and suitable for different purposes. The growth in global population has amplify the demand for plastics and plastic goods and this also account for the increase in plastic waste generation. The rapid growth in plastic production has been accompanied by a resultant increase in the concentration of plastics in the environment and dumpsites. This sudden surge of plastics in the environment and dumpsite has become a critical challenge. Plastics are non-biodegradable, only a little percentage o of the plastic waste generated are recycled (Alabi et.al.,2019, Wilcox et.al., 2015). Waste plastic pollution occurs due its recalcitrant nature, its prolong biophysical breakdown and its toxicity when in contact with other waste substance, all these have negative impacts on wildlife, aquatic and human health. Plastics are used for various applications ranging from food packaging, electronic gadgets, automobiles, construction equipment, etc. (Alabi et.al., 2019). Table 4 shows different types of plastics, their properties and their uses.

4. EXPANDED POLYSTYRENE (EPS)

The Expanded Polystyrene (EPS) type of plastics will be considered for the purpose of this study. EPS as the name implies is a type of plastic made from polystyrene foam. Polystyrene is a petroleum based plastic produced from the polymerization of styrene monomers. Expanded Polystyrene is commonly known by its trademark "Styrofoam", it is composed of about 5% polystyrene (PS) and 95% air (Ali et.al., 2012). It is a petroleum based polymer, thermoplastic, light weight, low density and large volume, suitable for various applications. One of its common application in Lagos is in the area of food packaging. It is widely acceptable in Lagos and other cities in Nigeria due to some of its properties which include low cost, light weight and low density. In Lagos, retaurants and street food vendors are found almost every with less or no government regulation. This street food vendors make use of EPS as their packaging materials for consumers. With the high human population in Lagos and also the high number of food vendors scattered across the municipality, many people prefer to eat from the food vendors either due to nature of their engagements that does not give them sufficient time or due to insufficient fund to prepare food at home. Some of these reasons

have contributed to the high patronage of food from street food vendors. Majority of the consumers are served in EPS packs and since these EPS are made for single use purpose, they end up in landfills as waste. Some of these EPS waste are found littering roads, streets, major highways and some even find their way into canals, drainages, rivers, gutters and sea thereby causing various forms of hazards. This hazards occurs as a result of high usage of EPS, poor attitude of people towards waste disposal, non-biodegradable nature of EPS, light weight(easily carried by wind) and low recycling rate etc. Numerous investigators have attempted to manage or recycle waste EPS through degrading these polymers under bioactive conditions, degrading by ligninolytic enzymes, use as an alternative construction materials, etc (Otake et.al.,(1995); Yanto et.al.,(2018); Ngugi et.al.,(2017). But most efforts seem uneconomical or unsustainable.

EPS is part of the plastics that are found as debris in water bodies and it becomes toxic to marine life over a period of time due to its components (Alayande et.al., 2012). EPS waste is virtually found almost everywhere in Lagos most especially in commercial areas. Although efforts are being made by LAWMA through the engagement of street sweepers but most of their efforts are jeopardize by wind carrying the EPS waste to already swept areas or by people disposing the EPS waste indiscriminately along the swept streets. EPS waste have now become a monster in Lagos which attacks humans, wildlife and aquatic lives directly or indirectly and sometimes resulting in death due to its health hazards in humans or due to ingestion by aquatics.

5. MAETRIALS AND METHOD

5.1 Area of Study

The study was carried out in Lagos the former capital of Nigeria. As earlier stated, Lagos was the former capital of Nigeria from independence up until1991 when it was moved to Abuja by the then Head of State. Lagos is a southwestern state in Nigeria, situated between Longitudes $2^{O}42'E$ and $3^{O}42'E$; Latitudes$6^{O}22'N$ and 6^{O} 52'N. It is surrounded by Ogun state on the North, Republic of Benin on the west and by the Bight of Benin and the Atlantic Ocean on the South. Lagos State is home to several financial institutions and other major foreign organizations and businesses. Figure 1. Shows the map of Lagos and its Local Government Areas. For effective Governance as all other states of Nigeria, Lagos state is divided into twenty Local Government Areas (LGAs) and Thirty-Seven Local Council Development Areas (LCDAs), with Ikeja LGA being the State Capital (Oresanya, O.O and Olukanni, D.O, 2018).

Figure 1. Map of Lagos State showing all the 20 Local Government Areas (Source:https://www.mapsof.net/nigeria/lga-lagos)

Five Local Government areas in Lagos state were surveyed. Two areas were selected from each Local Government Areas and are labeled as location A and B for each LGA. The LGAs studied are Mushin, Oshodi - Isolo, Alimosho, Amuwo-Odofin and Ikeja.

The research design applied for this study made use of both primary and secondary data. Interviews and observations were used as source of primary data while Newspapers, textbooks, literatures concerning plastics in the Municipal Solid Waste of Lagos, Nigeria, Africa and the world were studied to obtain secondary data. Interviews of street food vendors and some consumers were carried out. The interview was aimed at collecting information on daily and weekly usage of EPS Packs. Observation was made to ascertain the effects of EPS on the environment. The information obtained were analyzed and presented (Onuminya et.al.,2017).

Table 1: Major Cities in Nigeria and their Waste generation capacity

City	Population	Tonnage/ month	Density (Kg/m^3)	Kg/Capita /Day
Lagos	8,029,200	255,556	294	0.63
Kano	3,248,700	156,676	200	0.56
Ibadan	307,840	135,391	330	0.51
Kaduna	1,458,900	114,433	320	0.58
Port Harcourt	1,053,900	117,825	300	0.6
Makurdi	249,000	24,242	340	0.48
Onitsha	509,500	84,137	310	0.53
Nsukka	100,700	12,000	370	0.44
Abuja	159,900	14,785	280	0.66

Source: *Ifeanyi. O et.al, 2012*

6. DISCUSSIONS

The high level of EPS waste seen on the streets, roads, rivers, canals, drainages, etc. in the Lagos metropolis is scary and this occur as a result of indiscriminate disposal and the non-biodegradable nature of the EPS waste. This has contributed immensely to health hazards, underground water pollution and environmental pollution (Mazhindu et al). These wastes are not properly managed and this creates great concern.

Table 4. shows an estimated quantity of EPS generated daily (Monday to Friday) from the different locations situated in the five Local Government Areas under investigation. Two locations were randomly selected from each of the five LGAs. From the result presented, it can be observed that there is high usage of EPS packs in Oshodi – Isolo axis and low in Amuwo-Odofin axis. This is because of the high commercial activities going on in that area. Although not less than fifty (50) street food vendors were seen scattered around the area (Oshodi-Isolo Market), yet the rate of EPS pack generated was high at the locations studied. Fig 2. Shows Oshodi having the highest daily usage of EPS Packs recorded on friday. According to some of the food street vendors in Oshodi-Isolo and Mushin axis, EPS packs are used more on Saturdays and Sundays.

6.1 Interviews of Street Food Vendors and Consumers

The interview of food vendors, hawkers and consumers were carried out in the five LGAs under study. Some of the street food Vendors when asked their reasons for using EPS commonly known among them as take away pack; Mrs. A, a food vendor in Oshodi said most of the customers prefer the take away pack (EPS) because they are mostly business men and women, so they don't have the time to eat at that spot. Mrs. B also in Oshodi said there is no space to set up a batcher or any convenient building and so they resolve to use the take away pack (EPS) and majority of her customers likes her service. Mrs. C in Alimosho said the use of EPS becomes mandatory as no permission is given to her to sell food and as such she is afraid that the taskforce may cease her food. Mrs. D in Mushin said she uses EPS because it is very easy to use and light to carry around. She also said most of her customers are people she meets on the way along streets and roads. Mrs. E in Amuwo-Odofin said due to covid-19 most of her customers that use to sit and eat at the spot now prefer to collect the food in a take away pack (EPS) to go and eat at home or at their working areas. Mrs F in Alimosho said she prefer serving her customers in take away packs (EPS) because it saves her from the stress of washing plates and also buying water and detergent.

Two consumers were interviewed in oshodi and mushin. A customer in Oshodi said he prefer to collect the food in take away pack so that he can comfortably eat it in his shop and at the same time keeping a watch over his shop. The other customer in mushin said since the restriction on social gathering due to Covid – 19, he prefers to collect food in a take away pack (EPS) to avoid eating in crowd.

6.2 Indiscriminate Disposal of Waste EPS

Waste EPS are found littering surroundings due to indiscriminate disposal. Waste EPS are light weight and are easily carried away by wind to other destinations further than where they originated from. Waste EPS affects the aesthetic quality of the environment. This light weight property of waste EPS has also contributed immensely in defacing the surrounding when indiscriminately disposed. This has made it possible to find waste EPS even in inhabitable areas. Fig. 2 shows littered major roads in Oshodi and Mushin axis.

(a) (b)

Figure 2:(a) Indiscriminate disposal of Waste EPS in Oshodi axis (b) Indiscriminate disposal of Waste EPS in Mushin axis

6.3 Blocked Drainages

Waste EPS are disposed into drainages by some end users due to their poor attitude to waste disposal while other EPS waste gets into drainages from dumpsites due to the non-biodegradable and light weight properties. This Waste EPS mixed with other plastics in the drainages tends to block drainages. Blocked drainages has led to various hazards ranging from water borne diseases, air pollution, underground water contamination to flooding, displacing and also causing deaths of flora and fauna. Fig 3 showed blocked drainages caused by waste EPS and other waste.

(a) (b) (c)

Figure 3:(a) Blocked drainage in Oshodi axis (b) Blocked drainage in Mushin axis (c) Blocked drainage in Amuwo – Odofin axis.

7. CONCLUSION

The properties of plastics most especially the EPS form of plastics has made it acceptable among food vendors and their consumers. Properties such as light weight, versatility, high volume, moisture resistance, low density, thermal efficiency and low cost has greatly contributed to the emergence of waste EPS littering surroundings and water bodies in Lagos state.

The research carried out so far has shown that most commercial areas generate more waste EPS due to the high population and the commercial activities going on. In a quest to make profit and render acceptable service to customers, EPS are introduced food vendors. Some factors such as Covid-19, too many street food vendors scattered everywhere, lack of sufficient time for most business and working class to cook at home, low or no recycling value and the non-biodegradable nature of EPS has contributed to the enormous quantity of EPS Waste in Lagos state. Although in a search to get rid of waste EPS or to recycle it, several research works were carried out but most of these works appears to be inefficient, unsustainable and a threat to the environment and Human existence. As a result of that, more research is required on the recycling and proper management of waste EPS.

8. RECOMMENDATION

- More research on waste EPS recycling and management
- Training of public on recycling of EPS wastes into useable products.
- Policies regulating the production and use of EPS should be enacted and monitored
- More Public – Private synergy towards Waste EPS management should be encouraged.
- Public enlightenment against indiscriminate dumping of plastic waste should be embark upon by government and private organisations

REFERENCES

[1] Ali N. Siyal, Saima Q. Memon, M.Y. Khuhawar(2012). Recycling of styrofoam waste: synthesis, characterization and application of novel phenyl thiosemicarbazone surface. Polish Journal of Chemical Technology, 14, 4, 11 —P 1o8l., J1. 0C.2h4e7m8/.v 1T0ec0h2.6, -V01o2l.- 01049, 5N-0o. 4, 2012 11

[2] Aliyu A.A. and .Amadu L., (2017). Urbanization Cities and health : The Challenges of Nigeria – A review. Ann Afr. Med. 2017; 16:149-58.

[3] Anifowose, Y. B., Omole, K. E., & Akingbade, O. (2011). Waste Disposal Site Selection using Remote Sensing and GIS: A Study of Akure and its Environs, Southwest-Nigeria. Proceedings of the Environmental Management Conference, Federal University of Agriculture, Abeokuta, Nigeria (pp. 2-9).

[4] ATSDR, 1992. Agency For Toxic Substances and Disease Registry (ATSDR). Toxicological Profile For Styrene,U.S. Public Health Service, U.S. Department of HealthAnd Human Services, Atlanta, GA.

[5] Ba Thanh Ho, Timothy K. Roberts & Steven Lucas (2018) An overview on biodegradation of polystyrene and modified polystyrene: the microbial approach, Critical Reviews in Biotechnology, 38:2, 308-320, DOI: 10.1080/07388551.2017.1355293

[6] CIWMB, 2004. California Integrated Waste Management Board (CIWMB). Use and Disposal of Polystyrene in California.

[7] D H Y Yanto, N P R A Krishanti, F C Ardiati, S H Anita, I K Nugraha, F P Sari, R P B Laksana, S Sapardi, and T Watanabe(2019). Biodegradation of styrofoam waste by ligninolytic fungi and bacteria. IOP Conf. Series: Earth and Environmental Science308 (2019) 012001 doi:10.1088/1755-1315/308/1/0120012

[8] Daniel Hoornweg and Perinaz Bhada-Tata (2012). WHAT A WASTE A Global Review of Solid Waste Management. Urban Development & Local Government Unit World Bank1818 H Street, NW Washington, DC 20433 USA www.worldbank.org/urbanpp1 - 101

[9] Elias Mazhindu, Trynos Gumbo and Tendari Gondo (2012). Waste Management threats to human health and urban Aquatic habitat – A case study of Addis Ababa, Ethiopia. Open access peer – reviewed chapter. DOI: 10.5772/48077.

[10] Hannah Nyambara Ngugi, James Wambua Kaluli, Zachary Abiero-Gariy. Use of Expanded Polystyrene Technology and Materials Recycling for Building Construction in Kenya. American Journal of Engineering and Technology Management. Vol. 2, No. 5, 2017, pp. 6471. doi: 10. 1 16 48/j .ajetm. 20170205.12

[11] https://www.aaapolymer.com/recyclable-plastic-materials/

[12] Ifeanyi Okocha, Ebenezer Okonkwo, Ogbonna Friday Joel, 2018.Completing the Value Chain for Plastic Recyclers in Nigeria: An Integration of Renewable (Solar) and Conventional (Gas) Energy Sources for Fuel ProductionConference: SPE Nigeria Annual International Conference and Exhibition, August2018, DOI:10.2118/193436-MS

[13] Jambeck J. R, Geyer R, Wilcox C, Siegler T. R, Perryman M, Andrady A, Narayan R, & Law K. L. 2015. Plastic waste inputs from land into the ocean. Science, 347(6223), 768-771. Available at: http://science.sciencemag.org/content/347/6223/768. Accessed on 20/04/2019.

[14] Kapil Dev Sharma and Siddharth Jain (2020)Municipal solid waste generation, composition, and management:the global scenario. VOL.16 NO. 6 2020, pp. 917-948 DOI 10.1108/SRJ-06-2019-0210

[15] Lacounty Gove, 2008. An overview of expandedpolystyrene food containers in los angeles county.County of Los Angeles.

[16] Leton, T., & Omotosho, O. (2004). Landfill operations in the Niger delta region of Nigeria. Engineering Geology,73(1), 171-177. https://doi.org/10.1016/j.enggeo.2003.12.006

[17] Map of Lagos State showing all 20 Local Government Areas https://www.mapsof.net/nigeria/lga-lagosMay 22 2012 Issue.

[18] Mohamad Noufal, Liu Yuanyuan, Zena Maalla, and Sylvia Adipah (2020). Determinants of Household Solid Waste Generation and Composition in Homs City, Syria. Journal of Environmental and Public Health Volume 2020, Article ID 7460356, pp917 - 948 https://doi.org/10.1155/2020/7460356

[19] Nismah Nukmal, Suratman Umar, Sheila Puspita Amanda and Mohammad Kanedi (2018)Effect of Styrofoam Waste Feeds on the Growth, Development and Fecundity of Mealworms (Tenebrio molitor). OnLine Journal of Biological Sciences 2018, 18 (1): 24.28 DOI: 10.3844/ojbsci.2018.24.28

[20] Okunola A. Alabi, Kehinde Ologbonjaye, Oluwaseun Awosolu and Olufiro E.Alalade (2019). Public and Enviromental Health Effects of Plastic Waste Disposal: A Review. Journal of Toxicology and Risk Assessment. 2019, 5,021.pp1-13. DOI: 1023937/2572-4061.1510021 ISSN 2572-4061.

[21] Olukanni, D.O. and Oresanya, O.O. 2018.Progression in waste management in Lagos Sate, Nigeria.International Journal of Engineering Research in Africa. ISSN:1663-4144, Vol 35, pp 11-23. Doi:10.4028/www.scientific.net/JERA3511

[22] Oluwagbemiga Alayande, Samuel Olatubosun, Oluwaseun Adedoyin, Olalekan Deborah, ,Olayinka Sanda, Adeniyi Fasasi, Olugbenga Dare, Gabriel Osinkolu, John Ajao and David Pelemo (2012). Porous and non-porous electrospun fibres from discarded expanded polystyrene. Int. J. Phys. Sci. pp1833 – 1836

[23] Singh, R. P., Singh, P., Arouja, A. S. F., Ibrahim, M. H., & Sulaiman, O. (2011). Management of Urban SolidWaste: Vermin composting a sustainable option. Resource. Conserv. Recycl. 55, 719–729.

[24] Temitope Olabisi Onuminya and Evelyn C. Nze (2017). An Appraisal of waste management in the Lagos Metropolis: A case study of Lagos State Waste Management Agency. Nig. J. Pure & Appl. Sci. Vol.30 (Issue 3, 2017): 3104-3108.

[25] Trisia A. Farrelly and Ian C. Shaw (2017).Polystyrene as Hazardous Household Waste. (Household Hazardous Waste Management -Chapter4) pp45-60 http://dx.doi.org/10.5772/65865

[26] UNEP 2018. Single-Use Plastics: A Roadmap for Sustainability. ISBN: 978-92-807-3705-9. DTI/2179/JP

[27] Yoshito Otake, Tomoko Kobayashi, Hltoshl Asabe Nobunao Murakam, and Katsumch, (1995). Biodegradation of Low-Density Polyethylene, Polystyrene,Polyvinyl Chloride, and Urea Formaldehyde ResinBuried Under Soil for Over 32 Years. Journal of Applied Polymer Science, Vol. 56, 1789-1796 (1995)

APPENDIX

Table 2: Waste composition (%) in some Developing countries

Area	Organic	Paper	Plastic	Glass	Metal	Others
Phnom Penh/Cambodia	63.3	6.4	15.5	1.2	0.6	13.0
Mekong Delta/Vietnam	80.0	.7	6.3-7.1	0.7-1.0	0.5-0.7	0.9-1.4
Bangkok/Thailand	43.0	12.1	10.9	6.6	3.5	23.9
Bahrain/Bahrain Kingdom	59.6	9.9	134	5.5	3.4	9.2
Baghdad/Iraq	70.0	5.0	5.3	2.2	2.2	15.3
Amman/Jordan	54.4	14	13.2	2.8	2.4	13.2
Abadan/Iran	66.9	112	14.3	2.8	1.35	3.45
Chittagong/Bangladesh	62.0	3.0	2.0	5.0	9.0	3.0
Kathmandu/Nepal	71.0	7.5	12.0	1.3	0.5	7.9
Lagos/Nigeria	68.0	10.0	7.0	4.0	3.0	8
Cape Haitian/Haiti	65.5	9.0	9.2	5.8	2.6	7.9
Bhutan	62.2	15.2	13.1	2.7	0.7	6.1
Chihuahua/Mexico	48.0	16.1	11.9	5.9	2.4	16.0
Ghana	61.0	5.0	14.0	3.0	3.0	14.0
Nablus/Palestine	65.1	9.1	7.6	2.9	2.8	5.4

Source: Extract from Noufal et.al., 2020

Table 3: Types of plastics, their properties and common uses

SYMBOLS	TYPES OF PLASTICS	COMMON USES	PROPERTIES	
1 	Polyethylene terephthalates	Soft drinks, water bottles, containers, salad dressing, biscuit trays and salad domes.	Clear, tough, solvent resistant, barrier to gas and moisture, softens at 80 °C.	Pillow and sleeping bag filling, clothing, soft drink bottles, carpeting, building insulation
2 	High density polyethylene (HDPE)	Shopping bags, freezer bags, buckets, shampoo, milk bottles, ice cream containers, juice bottles, chemical and detergent bottles, rigid agricultural pipe, crates.	Hard to semi-lexible, resistant to chemicals and moisture, waxy surface, opaque, oftens at 75 °C, easily coloured, processed and formed	Recycling bins, compost bins,
3 	Polyvinyl Chloride (PVC) Plasticized Polyvinyl chloride PVC-P.	Cosmetic container, plumbing pipes and fittings, electrical conduct, blister packs, wall cladding, roof sheeting, bottles, garden hose, Shoe soles, cable sheathing, blood bags and tubing.	Strong, tough, softens at 80 °C, can be clear, can be solvent welded. Flexible, clear, elastic, can be solvent welded	Compost bin

4 	Low density polyethylene (LDPE)	Refuse bags, Irrigation tubing, mulch film, cling wrap, garbage bags, squeeze bottles.	Soft flexible, waxy surface, translucent, softens at 70 °C, scratches easily.	Bin liners, pallet sheets
5 	Polypropylene (PP)	Microwave dishes, lunch boxes, packaging tape, garden furniture, kettles, bottles and ice cream tubs, potato chip bags, straws	Hard and translucent, soften at 140 °C, translucent, withstands solvents, versatile.	Pegs, bins, pipes, pallet sheets.
6 	Polystyrene (PS) Expanded polystyrene (PS-E)	CD cases, plastic cutlery, imitation glassware, low cost brittle toys, video cases/foamed polystyrene cups, protective packaging, building and food insulation	Clear, glassy rigid, opaque, semitough, soften at 95 °C, Affected by fat, acids and solvents, but esistant to alkalis, salt solutions, Low water absorption, when not pigmented is clear, is odour and taste free. Special types of Polystyrene (PS) are available for special applications.	Recycle bin
7 	Other	Automotive and appliance components, computers, electronics, cooler bottles, packaging	Includes all resins and multi-materials (e.g. laminates) properties dependent on plastic or combination of plastics	Recycle bins

Source: https://www.aaapolymer.com/recyclable-plastic-materials/

Table 4: Random Survey on the daily use of EPS pack by food Vendors in some selected locations

LGA	Monday	Tuesday	Wednesday	Thursday	Friday	Total
Ikeja (computer village)						
Location A	30	15	20	20	30	115
Location B	40	30	15	25	45	155
Oshodi-Isolo (Market axis)						
Location A	70	70	80	60	120	390
Location B	50	90	70	80	100	265
Alimosho (Ikotun axis)						
Location A	40	60	45	50	70	265
Location B	20	40	20	30	40	150
Mushin (Market axis)						
Location A	50	40	25	35	50	200
Location B	50	60	40	30	70	250
Amowo-Odofin (Apple junction axis						
Location A	30	25	15	20	10	100
Location B	50	20	25	25	30	150
Total	430	450	355	375	565	2175

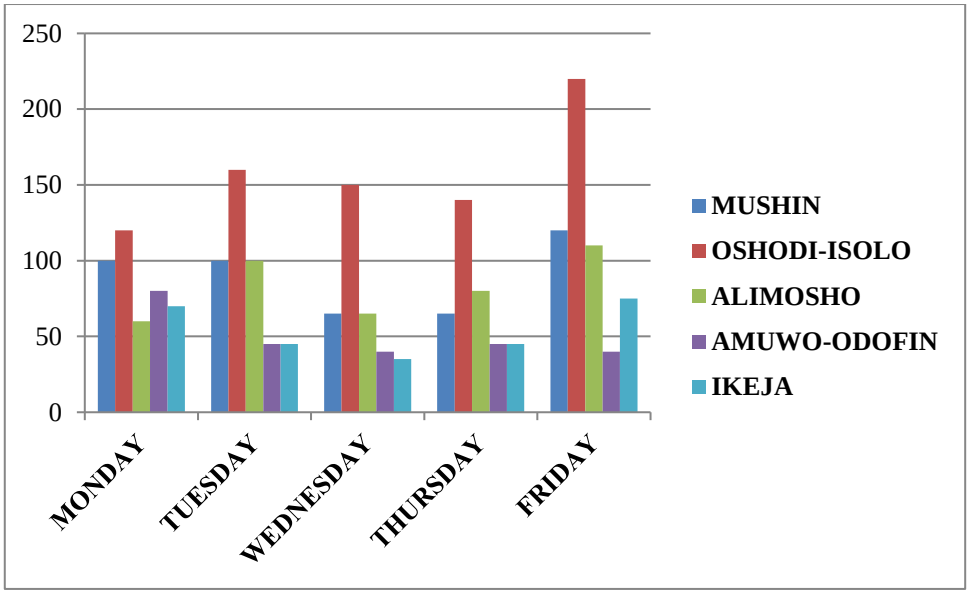

Figure: Chart representation on the daily usage of EPS pack by food Vendors in some selected locations

