

The Potency of Microorganisms on Environmental Waste Management: A Review

Nworu S. JEROME^{1,*}, Ayuba KALURI², Orjime M. TERHILE²

¹Department of Chemistry, School of Basic Science, Nigeria Maritime University, Okerenkoko, Delta State

²Department of Biology, School of Basic Science, Nigeria Maritime University, Okerenkoko, Delta State

*Corresponding author: jerome.nworu.nmu.edu.ng

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Abstract: Problems with waste are as old as human race. In a very less time humans realized that waste is a hazardous source of diseases. The product which is unavoidable product of all human activities is Municipal Wastes. Monetary social advances and rising living standards of the human being in the society lead to increases in the waste generation. A major challenge to all the countries world-wide is effective management of the waste generated. Waste can be categorized by many methods but by the classic classification is degradable waste, recyclable materials, inert waste, electrical and electronic, composite wastes, harmful waste and Toxic waste. Microbes can continue to exist in the extreme environmental conditions so there are lots of possibilities to identification and classification of microbe's which can solve various types of problems of mankind. Large amount of microbial produced products are not identified yet. That's why there is a great need to identify useful microbial strain from various sources like municipal waste.

Key Words- Environment, Pollution, Enzyme, Protease, Amylase, Cellulase, Bacteria, Waste, Bioconversion, Municipality.

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1. INTRODUCTION

Problems with waste are as old as human race. In a very less time humans realized that waste is a hazardous source of diseases. The first well managed treatment of waste report dated 500 BC Athens in Greece, where regulations has directed that waste should be dumped at least a mile far from the city boundary and must be covered by soil.

Municipal solid waste refers to any non fluid waste that are created by human activities like households, small business institutions such as schools collages and hospitals, hotels etc. these variety of waste material are known as "trash" or "garbage" and include everyday items for example. Things that are broken, food that has spoiled, kitchen waste, papers, iron rods, plastics, rubber bands etc.

The product which is unavoidable product of all human activities is Municipal Wastes. Monetary social advances and rising living standards of the human being in the society lead to increases in the waste generation. In recent years the huge quantity of electronic waste created which is named as e-waste has been increased drastically as peoples become more dependent on electronics goods such as computers, cell phones etc. A major challenge to all the countries world-wide is effective management of the waste generated.

In present days it is very compulsory for every country to search the beneficial methods to overcome the problem of waste and issues related with it. Each and every product that are used and thrown away at open places contains very dangerous chemicals which can affect human health than ever before as more than 60,000 chemicals found entry in daily use consumer products (Yu H. Et al, 2019).

2.1. CLASSIFICATION OF MUNICIPALITY ASSOCIATED SOLID WASTE

The constituents of solid waste vary according to inhabitants of the country and alter significantly with time. In the countries which have a proper waste recycle system, the waste material contains mostly of obstinate wastes such as single use plastic and unrecyclable materials. With the initiation of the twenty century the bigger part of household waste consisted of coal ash from unwrapped fires. In urbanized nations without significant recycling practices it mostly consists of food wastes, plastic containers, marketplace wastes and manufactured goods wrapping materials, and other assorted solid wastes of housing, commercial, organizational and industrial sources.

Most municipal solid waste classifications do not include manufacturing wastes, farming wastes, medical waste, radioactive waste or sewage sludge. Waste gathering is performed by the municipality within a defined area. The term residual waste relates to substances that neither divided nor

reprocessed (Kishneth Palaniveloo et al, 2020). Waste can be categorized by many methods but by the classic classification is

- Degradable waste: food and kitchen waste, green waste
- Recyclable materials: paper, cardboard, glass, bottles, jars, tin cans
Aluminum cans, aluminum foil, metals, certain plastics, fabrics, clothes, tires, batteries, etc.
- Inert waste: construction and demolition waste, dirt, rocks, debris
- Electrical and electronic waste (WEEE): electrical appliances, light bulbs, washing machines, TVs, computers, screens, mobile phones, alarm clocks, watches, etc.
- Composite wastes: waste clothing, plastics such as plastic carry bags
- Harmful waste: including most paints, chemicals, tires, batteries, light bulbs, electrical appliances, fluorescent lamps, aerosol spray cans, and fertilizers
- Toxic waste: including pesticides, herbicides, and fungicides Bio-medical waste, expired pharmaceutical drugs, etc (Fig. No.1.1).

2.2. Effective management of municipal waste: A global issue for environmental Pollution

The relation between human and environment cannot be viewed as new. The ancient Vedas pointed out the importance of nature and the necessity of existence with it. The concept of 'Panch tatva' (Earth, water, fire, space and air) as indispensable constituents of life have evolved according to the man's experience of the relationship between the biotic and nonbiotic factors in nature (Gopalan, 1982). A similar ideology was expressed by Gurunanak dev. When he told "Air is like God, Water is Father and Earth is Mother", it is because the harmonious interaction of all these vital ingredients by that the whole universe is being persistent (Wasir, 1997). In his research Lahiri (1997) realized that manufacturing uprising that had introduced in the end of the 18th century and progress at an ever greater than ever pace through the time proved as important factor in the slog of consumerism and related degradation of environment.

Leach (1998) suggested three alternatives to conserve natural environment. Viz, reduce the resource utilisation, reuse of resource and recycle the waste materials. G B Maraghi (1998) refer the concept of research and recovery to the three 'R' approach of municipality related waste management which were Reduce, Reuse and Recycle. He further suggested that waste can be used for energy by which waste could be reduced by ninety percent in volume and fifty percent in mass. Research provided key developments related with the municipal waste management techniques.

Maraghi, (1998) and Vyas and Reddy (1998) had given opinion that metropolitan areas face environmental degradation problems at two steps, the first one is the impact of high growth oriented development and another is the strait impact of the improved life style. According to him the waste problem comes under the second category. It is known fact that industrialization and urbanization resulted to steady degradation of nature. Urbanization and industrial development had polluted ambient air and water. Industries create a lot of unsafe wastes and urban life produces a lot of. Some researchers traced out the impact of development on planet, as changes in four important areas that were population, energy, industrialization and urbanization (Foster, 1999).

The most of researchers advocated for a sustained education and awareness programme to ensure active citizen participation (Shekdar, 1999). The Down to Earth reported that the shortcomings of waste clearance system in India were due to institutional deficiencies, low productivity management staff and low economic state of local authorities.

According to Vishvanathan (2000) our country reuses about 60 percent of its waste although it is not supported by either study as ratio of non recycled plastic is the highest in the globe. According to him European countries recycle only seven percent where Japan recycles 12 percent and China recycle only 10 percent of its plastic waste.

The comparative figure of plastic recycling indicated our cultural attitude towards plastics. Gawaikar and Deshpande (2006) examined about the waste managing agencies of municipality related wastes from metropolitan areas with aim of providing good environmental conditions which also protected public health and found that evaluation of source requirement for collection, transportation processing and disposal requires correct assessment of quantity of waste generated every day from various sources and their distinctiveness. Source related quantification and categorization has great significance for proper management and planning of hard waste management which will be able to precise evaluation of waste mass.

Arvind K.Jha et al (2011) reported that clearance of solid waste is a budding environmental problem. like wood, sludge and non-degradable materials like metals, glass, plastic etc. Gentil et al (2011) reported from his study that Waste prevention, also known as waste reduction, applies to both.

2.3. Soil Microbes Associated with Municipal Solid Waste

A large community of microbes resides in the soil and related with the bioconversion of waste material. Microorganisms offer a wide array of precious molecule in the form of enzyme, antibiotics and single cell proteins. Municipality waste is consists of diverse substances as substrate suited for many different microorganisms to grow. It is also documented that municipal solid waste comprising biological substances is an ideal environment for various species of microorganisms.

Cellulolytic fungal strains obtained from this source have been used to change cellulosic materials into important manufacturers and waste generators. At the manufacturers' end, such a policy can be termed 'primary-source prevention', and in relation to waste generators 'secondary-source prevention'. The use of this strategy at the manufacturers' end helps minimize the production of heavy packaging materials, while for waste generators it can promote the purchasing of reusable products. Prevention must be the uppermost priority in every waste policy in various regions (K.Hayden et al, 2012; Abila and Jussi, 2013).

Waste and its environmental effects are the inevitable consequences of inappropriate waste treatment and management approaches. The environmental sustainability of waste treatment approaches, systems and processes is critical, given the growing global importance of environmental concerns. Waste managing can be characterized on the facts ranging from practices, strategies, goals, control, monitoring and regulation of the production, financial and marketing aspects, to environmental assessments of various treatments, evaluation and policy. These aspects should be used for a holistic approach to mitigating challenges emanating from waste, its management and various treatments (Rada et al, 2014).

2.4. Global Municipal waste management strategies

The management of waste systems in Poland based on the foundation of the collective hygiene and Order Maintenance Act of 13 September 1996 (Bai and Sutanto, 2002). Municipality related solid waste in Mexico, is treated and recycled by mostly non organized groups known as scavengers, while collection and transportation is the sole responsibility of the municipality; waste disposal strategy is based upon the burying of 98% of municipal waste (Berneche, 2003, Liamsanguan, 2008, Manga et al, 2008).

Greece is in contrast to the European Union's policy on waste: in a case where a great amount of unwrap dump sites, however reduced from over 5500 during 1990 to 1260 in 2004 constitute the most harmful element and the percentage of useful components recovered is low" (Erkut et al., 2008). In our country metropolitan city like Kolkata which is head quarter of West Bengal in eastern India, the treatment of municipality related solid waste is the responsibility of the their municipal corporation.

Method involved in the treatment of municipality related solid waste included waste collection from household's activities and from streets, collection at specific points, transportation to dumping points and clearance (Hazra and Goel, 2009.) In China, incineration is limited as compared to dumping at landfill, which is the principal technique for the treatment of municipality related solid waste (Zhang, 2010). However, two ministries are concerned in municipality related solid waste management, as fixed in the law. The primary is the Governments Construction Ministry, which manage and monitor the compilation, cleaning, storage, translocation and final elimination of municipal solid waste.

The secondary is the Environmental Protection Ministry, which administers and supervises the gathering, handling and final disposal of harmful waste, waste operate and secondary pollution created by the building and discarding of solid waste treatment (Chen et al., 2010). According Bovea et al (2010) the towns of Spain bases household collection on the selective selection of glass, paper, cardboard and packaging material of banks and road-side collection of all other waste.

Developed countries such as Finland, the sorting, storage and deposition of municipal waste at central waste bins are the primary duties of consumers, while collection, transportation and treatment are the responsibility of municipal authorities (European Environment Agency, 2013). Currently, in incorporated solid waste management, an effective and comprehensive programme is applied. In France incineration method still used as the foremost waste treatment option for metropolitan solid waste (Beylot and Villeneuve, 2013) By the amendment act of 1 July 2011 the organization related to waste has the responsibility of the municipalities, which deal with all activities affecting local communities (Lech, 2014).

Similarly, In United Kingdom, landfill is the most common practice of municipal waste management, which cover the about 49% of municipality solid waste clearance (Al-Salem et al., 2014). In Vietnam capital Hanoi, which is the second largest city of the country, municipality solid waste is collected without any sorting process and directly dumped in landfills (Thanh et al, 2015). Component such as alcohol and organic acid. Some of these fungal strains are mesophiles whereas others are thermophiles. Usually the thermophiles produced enzymes are more dynamic at high temperature and more thermo stable than enzymes formed by their mesophile counterpart.

The biological conversion of cellulosic material has a great significance in the properties of living organism. Many cellulosic waste materials which are inedible and not useful for our consumption are biologically converted into valuable products by the activity of microorganisms (S. P. Gautam et al, 2011). A.Rasheedha Banu et al (2010) concluded that moulds are well known for pectinases production can be isolated from municipal waste. The fungal strains extracted from waste site soil sample were tested for pectinase enzyme making when cultured on pectin containing medium. *Penicillium chrysogenum* was chosen based on clear zone formation and potential of pectinase enzyme production, the whole process performed in sunken fermentation procedure. Enzyme excreted by *Penicillium chrysogenum* observed higher at pH near 6.5, temperature at of 35°C with sucrose as sole carbon source, ammonium per sulphate used as C and N sources.

In the biological breakdown of materials like the decomposition of synthetic polymers at natural environments, microorganism plays a chief role which is known as biodegradation (Mansi Rastogi, 2020). Polythene and plastic are recalcitrant and hence remain unaffected to biodegradation which leads to their environmental accumulation, and therefore creating grave environmental troubles (Priyanka N and Archana T, 2011).

Study was conducted by some investigators for the microorganism led degradation of Low density polyethylene in natural environment using mixture microorganism. They concluded that environmental factors like light of sun and their temperature with rain may increase the rate of biodegradation in nature (Harshita Negi et al, 2011). Smriti Mainali et al (2011) reported from their study that waste has a sizeable proportion of the decomposable organic matter. They have studied the activity of microbial protease enzyme extracted from soil of the solid waste and collected 20 different samples from Kathmandu valley. They concluded that among 113 isolates they isolated the 3 bacteria were observed to have Proteolytic capability. Protease enzyme isolated from the most potent species was mainly active at 40°C and at pH 8, while the Protease enzyme from another isolated strain, which remained unknown, was mainly active at 37°C at pH 9. It was suggested that these enzymes should be used for the solid waste management (R. Usha et al, 2011).

Bacteria can use wastes material for their own need of carbon source and by that they produce some simple and useful components which are vital for soil health, growth of plants and to keep well balance of natural ecosystem (D. Barman et al, 2011) Bacteria and some fungi is an important biological factor for the good agricultural practices and bioconversion of the kitchen related wastes. W.M.F. Wan Ishak et al (2011) concluded from their study that Municipal solid waste should be sanitized before the discharge in environment to reduce the activity of microbes by that we can prevent or slowdown the release of unsafe chemicals into the environment and shrink odor production.

The plastic is a great challenge in front of scientific community. Identification of competent plastic degrading microorganism at molecular level is not identified yet which indicate the use of microorganism at large scale (Manisha K Sangale et al 2012). E.Venkata Nagaraju and Goli Divakar (2012) reported that Because of the unfavorable effects of pollution on living beings the pollution created by polythene is gaining attention globally. The biodiversity of microorganism is realized very significant on various grounds. As in the view of biotechnologist microorganism are considered very useful to fulfill the need of safe environment for human race. It is observed that *Bacillus* species were dominantly observed in every waste material (E.Venkata Nagaraju and Goli Divakar, 2012). Cellulose is a main component found in municipal wastes, agricultural waste and industrial material. The most effective thermophilic cellulolytic microbes were recognized as *Bacillus subtilis*. The microbe based degradation of biological waste has been recommended as a reasonable choice for the microbe assisted bioconversion of lignocelluloses waste material into fermentable component and production for biofuels (A. Acharya et al, 2012).

Due to plastic's resistance to decomposition and its propagation in industry, the concern of plastic related pollution has evolved as a threat for global ecology. Although flow of harmful plastic material is maintained by two reasons: tenaciously by inappropriate removal of domestic and industrial reject; and inadvertently, by using poor method of waste disposal. The Hayden K. et al (2013) and Amalesh Samantha et al (2014) reported from their study that although municipality related waste poses the great threat for all the countries in the world but the microbe originated enzymes can deter this type of hazards for their final execution. As it is sure that nature has the perfect remedy for every problem.

Some researchers isolated an amylase making bacteria that is able to grow in the municipality solid waste and is also has the capability of bio conversion of municipality solid waste into use full components. The bacterium identified in their study was *Cronobacter sakazakii* (Amalesh Samantha et al, 2013). The ever increasing human population which escort to growth of cities and over misuse of natural resources badly affected the environment has led to posed risk to human life in There are various methods for waste management from very old times. But older methods are not sufficient to full fill present needs. Therefore in current situation there are necessity to invent and develop newer tools and method such as Mechanical Biological treatment.

In Mechanical Biological treatment method, mega-bacillus is play as main agent for deprivation of household biological waste. By using this method about 20 Kilogram organic waste can be converted into 4.074 Kilogram of compost in just 15 days which has the proper carbon, nitrogen ratio for using as fertilizer into farming practices (Anuradha.S.Tanksali et al ,2014).

Fungi and bacteria commonly found around us and have the property to decompose household and municipal wastes as they produces some important enzyme for which organic waste used as substrate and converted them into some very useful byproducts. These byproducts are very useful to sustain soil health and make natural ecosystem balanced. By metabolic processes, microorganisms convert solid waste completely into Carbon, Hydrogen components and salts. Amid microbes, fungal varieties are of high potential for enzyme creation since they secrete their enzymes extracellularly. Fungi have the great capability of bioconversion of biological waste and can be used to optimize municipal and agricultural waste bioconversion.

The *Trichoderma reesei* which can convert simple as well as derivative cellulose into glucose is most frequently studied organism which has the ability to lyses the cellulosic compounds include: Fungal species *Trichoderma*, *Humicola*, *Aspergillus*, *Penicillium* (L.Shilpa and M.Musaddiq, 2014). since all the surfaces under natural or artificial conditions are covered with the microorganisms so initially when the waste is discarded it has to go through multi step procedure of physical and chemical alteration in the nature of waste by the activity of microbes.

In occurrence of oxygen aerobically decomposition takes place but in the lack of oxygen into the landfill the decomposition continues by the activity of anaerobic microorganism. Heat is also produced in the process; temperature is increases in the process of bioconversion. Temperature affect the solid waste bioconversion by two methods: First are short-time effects on rates of reaction and second is a long time effect on microbial numbers (Rimzhim Gupta et al, 2014).

Amrita S. and S.C. Santra (2014) reported from their study that waste management become necessary factor for safer environment. By the dynamic lifestyle and higher speed of population growth the production rate of waste is increasing in an alarming rate. The main challenge to the human society is the environmental friendly clearance of the waste that's why the use of microorganism considered as better tool in comparison to other methods.

Organic waste is used as their food source by the bacteria, and is no harmful effect on the environment as consumption of waste by bacteria converts the waste into safer substance for the natural environment. In the process of bioconversion bacteria produces some highly important material for the humans. During the bioconversion process actually several important metabolites are produced by break down of the complex compounds into simple elements.

The microbial world is very diverse and the great number of microbes is not identified yet. In a study in two cities of Bangladesh (Dhapa and Barrackpore) reported that the 09 isolates of bacteria showed tolerance against As, Zn, Pb, Hg, and Cd at optimum culture conditions. The isolates showed sensitivity to gentamycin, penicillin, streptomycin and oxytetracycline, beside that production of useful enzymes also observed in Nutrient Agar medium. Among the 09 isolated strains 06 showed protease production capability in which 01 isolate showed very high level of protease production ability. This type of findings point out at the extent of the detection of new strains of bacteria which could be important for the industrial purposes.

Study indicates the presence of usefull microbes in the municipality related waste. (Amrita S. and S.C.Santra, 2014). The two bacterial strains were incubated with the Low-density polyethylene and after 60 days of incubation they were observed by various highly sensitive methods like scanning electron microscopy reported that two strains which were *Bacillus amyloliquefaciens* was able to grow on the Low-density polyethylene by using the Low-density polyethylene as sole carbon source.

It is also observed that these strains were capable to change the surface structure of the Low density polyethylene. Bacterial isolates showed the depolymerisation capability in very short time span (Merina paul das and Santosh kumar, 2015). As waste volume growing continues the loss of natural resources greater than before, environmental risks due to municipality related solid waste is now a critical problem in all of the dynamic megacities of the world.

Composting is very old practice for the microbe assisted conversion of biological waste to natural soil like substance and it can be enhanced by using latest technologies that are more efficient and has low cost and more environmental friendly. This can enhance soil into nutrient rich properties. Municipal Solid Waste comprises of about forty percent of biological material that why the composting is a better method to convert biological waste material into important soil for agriculture needs (K.R. Atalia et al, 2015).

Ethylene monomers has low density and the polymers of ethylene can be converted into many type of goods which are use full for everyday life of human, beside that the cost of it also suited for everyday need of human being now main sources of environmental pollution. The use of polyethylene rising at a speed of 15% per year worldwide and about 1.50 billion tons of man-made polymers are created worldwide each year. Such a huge total of polyethylene poses a great threat for ecological balance and sustainability of environment. Some microorganisms are capable to degrade polythene into their monomers such as *B. megaterium*, *Pseudomonas* species, *Azotobacter*, *Ralstonia eutropha*, *Halomonas* sp. The some enzymes produced by the Microbes are responsible for the deprivation of polythene material into their monomers.

In a study 160 bacterial strains were fetched out from 64 soils by plastic waste based samples from various areas in Baghdad city. Forty two isolated bacteria showed higher activity to degrade Low density polyethylene in which three strains identified to have greater potential in secondary screening in dynamic environmental condition. The three isolated strain have been characterized were *Pseudomonas aeruginosa*, *Pseudomonas fluorescens* and *Acinetobacter ursingii* (Amal A. Hussein et al, 2015).

R.Vignesh et al (2016) concluded in their study that till the date Low density polyethylene is the most used polymer that are up nearly impossible to be converted in a safe material. However, some bacterial species has been identified to degrade Low density polyethylene which was *Bacillus* species, *Pseudomonas* species, *Streptococcus* species and the fungal species were characterized as *Aspergillus* species and two *Fusarium* species.

It was found that *Bacillus* species has degrades the plastic up to 23 percent and the *Fusarium* species degrades the plastic up to 44 percent. An introspection of the relative quantity of plastic bioconversion by using bacteria and fungus species sampled from Chennai. It is observed that three bacterial and three fungal species which formed most opaque were used for further studies. (R.Vignesh et al, 2016).

Polyethylene is a commonly used raw material in manufacturing of plastics, which are non-biodegradable substances that stay in the environment for an unknown time length. As documented by the Central Pollution Control Board our country produce almost 56 lakh tones of plastic related waste every year in which only 60 percent is recycled and reused. The remaining 40 percent left to dangerous affect on all type of environmental component, such as marine and terrestrial ecosystem.

Bacillus subtilis is the most efficient soil microbes which degrade polyethylene without the need of applying any external treatments and may provide an ecofriendly solution for management of plastic waste. Plastic degradation by microbes is by the activity of enzymes that convert the mono polymer entity into related oligomers and monomers.

The degradation of plastic by *Bacillus subtilis* is analyzed using liquid culture method and observed that *Bacillus subtilis* degrade plastic in about thirty day or more time period (T. Karthick et al, 2016). The different microbes have capability to degrade types of plastic material in a different time span and in different environment. The microbial associated biodegradation has been accepted as a safe clearance of plastic waste but investigation is still ongoing for its enhanced efficiency. Microorganisms have the natural capability to degrade plastic in natural condition. But microbes able to decompose polythene are limited to 17 and 09 genera of bacterium and fungi.

Microbial conversion of plastic waste material is led by oxidation or hydrolysis activity by microbial enzyme which resulted into sequence cleavage of the complex polymer into monomer by the enzyme catalyzed process. The species of microbes are associated with the potential to degrading plastic waste material characterized as fungal community, bacteria and actinomycetes species and *saccharomonospora* genus. The microorganism's growth is affected by many factors which include the redox potential, water, temperature, and energy source.

Microorganisms produce exo-enzymes and endo-enzymes both can affix to the substrate and slice them in minor segments (M. Raziya fathima et al, 2016). Different polymers having high molecular weight named plastic that can be decomposed by different microbe assisted processes. It is documented that chemical and physical method of plastic degradation leads to incalculable environmental hazards. Beside that the microbial assisted conversion of plastic is very effective, has low cost and safer to environment as microbes can be easily isolated from the different environmental components

3. CONCLUSION

Microbes can continue to exist in the extreme environmental conditions so there are lots of possibilities to identification and classification of microbe's which can solve various types of problems of mankind. Large amount of microbial produced products are not identified yet. That's why there is a great need to identify useful microbial strain from various sources like municipal waste. It is universally known that soil and waste materials contain a large number of antibiotic, enzyme producing microorganisms which could make the human life healthier and easier.

FIGURE

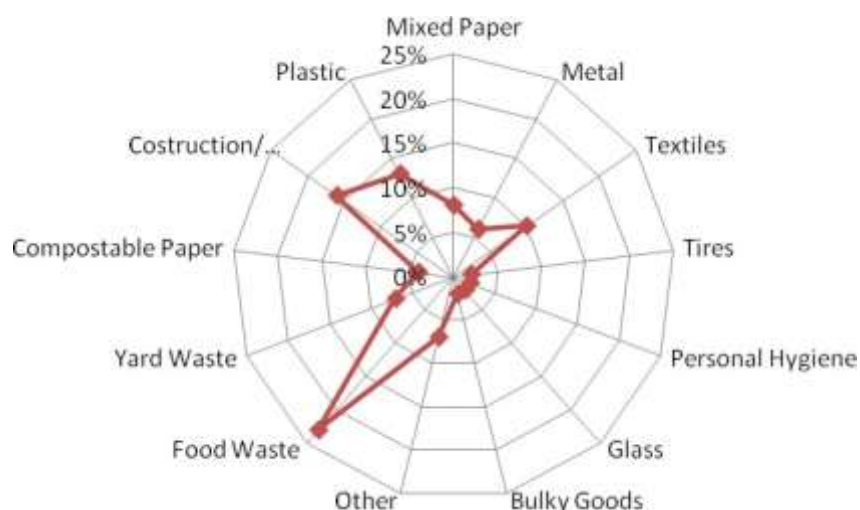


Fig. No. 1.1. Composition of municipal solid waste

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