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A Look at Plastic Bags and Alternatives

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Abstract

Bags are essential items in the day to day activities of man, therefore, their continued use seem undeniably essential and unstoppable for many consumers. At present plastic bags have dominated the bag market against other alternatives. However, the dominant use of plastic bags have been queried as a result of its non-biodegradable nature and its environmental impact. This paper takes a cursory look at plastic bags and some available alternatives in order to highlight their impact on the environment throughout their life cycle. Plastic bags have alternatives in form of paper bags, tote bags, hemp bags, woollen bags, and degradable plastic bags. This paper is based on the concept of best practicable environmental option(s) (BPEO) and waste management hierarchy (WMH). BPEO advocates adopting the option that provides the most benefits and the least damage to the environment, as a whole, at acceptable cost, in the long term as well as the short term. While WMH promotes waste avoidance and reduction principle ahead of recycling and disposal principles. The review discovered that despite the myriad of proffered alternatives, none exist with zero impact on the environment. This paper recommends that all options be extensively juxtaposed from the process of resource extraction to the final waste disposal stage to determine best practicable environmental options. Waste management hierarchy which advocates reduction, reuse and recycling will be pivotal in reducing observed impacts from recommended bag type when employed in waste management planning.

Keywords: Plastic bags; paper bags, degradable bags, alternatives, waste management

1 Introduction

Bags are convenient food, grocery, holding item which have become part of our everyday life. Bags are made of several materials such as plastic, paper, wool, and silk, to mention a few. Modern technology have expanded the materials with which bags are made, following the environmentally unfriendly nature of some bags in existence especially plastic bags. Plastic bags accounts for nearly half of all plastic waste generated globally (Clapp and Swanston, 2009; Parker, 2019), and much of it is thrown away within just a few minutes of its first use. When discarded in landfills or in the environment, plastic can take up to a thousand years to fully decompose (UNEP, 2005; Clapp and Swanston, 2009; Camann et al, 2010; Wong, 2011).The environmental impacts of the widely used plastic bags have prompted environmental managers, researchers to clamour for use of alternative bags instead, but this seems to be contrary to the wish of plastic bag consumers. The displeasure of plastic bag consumers over alternative bags prompted this review of plastic bags and its alternatives. Many environment friendly alternatives to plastic bags exist, such as, paper bags, jute bags, bio-plastic bags which are reusable and biodegradable bags. Paper bags are environment friendly alternative to plastic bags. It has been suggested that the natural fibres of paper and its recyclability creates a positive image of the paper bags (Though, 2007; Jalil and Mian, 2011). Jute bags are recommended environment friendly alternative to plastic bags because the bags are made from biodegradable fibre derived from a plant called jute. The fibre which mostly consist of cellulose is eco-friendly and has no harmful effects on the environment

Another alternative to the traditional plastic bags are the biodegradable or bio-plastic bags which have the same positive image of natural fibres and degradability as paper. Examples of biodegradable plastics are aliphatic polyesters, poly lactic acid (PLA), polyvinyl alcohol, and Cellulose esters. While some bio-plastic bags have been successfully tested, research on other biodegradable plastics are ongoing to determine its end of life impact on the environment and for improvement in its biodegradability. Though (2007) highlighted that many alternatives to plastic bags suggested have equal if not more damaging environmental impacts than plastic bags. Therefore, the alternatives to plastic bags have to be assessed for environmental and social impacts across their potential life cycles, or a life cycle analysis before they can be recommended.

2 Conceptual Framework

2.1 Best Practicable Environmental Option(s) (BPEO): The Royal Commission on Environmental Pollution (RCEP) Twelfth Report defines BPEO as "the outcome of a systematic consultative and decision making procedure which emphasizes the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefits and the least damage to the environment, as a whole, at acceptable cost, in the long term as well as the short term" (Department of Environment (United Kingdom),2002).

The concept involves a balancing of criteria, including technology, financial costs and environmental impacts. Therefore, BPEO is a key principle in pursuing greater sustainability in waste management. In this context of waste management planning, the "options" considered are specific combinations of methods for the collection, transport, treatment and disposal of waste, including recycling and recovery. The process of decision making for the BPEO for most appropriate bag type to utilize should as a matter of fact consider the raw materials involved, the technology for extraction, means and methods of processing/manufacturing, and its impacts, in addition to methods for waste collection, transportation, treatment and safe disposal of waste, including recycling and recovery.

2.2 Waste Management Hierarchy (WMH): The waste management hierarchy is a concept that promotes waste avoidance and reduction principle ahead of recycling and disposal principles. The principles advocated by the waste management hierarchy are depicted in Fig. 1.



Fig. 1.Waste Management Hierarchy

2.2.1 Waste Avoidance and Reduction

The first principle of waste management hierarchy which is waste avoidance and reduction lays a clear emphasis on abandoning activities and processes that generate harmful and enormous waste through substitution process. By clearly focusing on waste avoidance and reduction as opposed to treatment and disposal of waste, the generated waste stream is reduced accordingly, as well as the associated costs of treatment, disposal and environmental impact. The principle of avoidance and reduction will imply more use of substitute bags that are environment friendly. As reported by BBC News (2009, May 9); Germain (2005); Clapp (2008); Rayne (2008); Chitombe (2014); UNEP (2018) and Iheukwumere et al (2020) a number of regulatory instruments have been used worldwide to reduce the plastic bag problem, ranging from traditional command and control approaches such as total and partial bans, imposition of taxes or levies and marketing of alternative bags. Iheukwumere et al (2020) using their theorized IPPAT concept are of the opinion that environmental impact of plastic bag waste could be mitigated with reduced production of plastic bags and increased production of alternatives.

2.2.2 Reuse

The principle of reuse is one that is consciously or subconsciously applied by individual consumers. It entails re-utilising items or materials which would have been trashed as waste. Reuse may involve some sort of repair to revitalize the item or to make it suitable for intended use. The

reuse principle encourages the utilization of items including bags several times over before discarding it. The reuse principle is a waste stream reduction measure if well practised especially in countries and cities as obtained in most Nigerian cities where poor attitude to plastic bag reuse and disposal exist as well as inadequate technological structures for collection, recycling, and other forms of managing plastic waste.

2.2.3 Recycling

Recycling is a process that requires mechanical or electrical means to convert waste materials into useful items once again. Recycling is an environment friendly measure but is capital and labour intensive, this accounts for the reason why avoidance and reuse are advocated before recycling. According to Tripathi (2014) paper can only be recycled four to six times, and recycled paper is usually mixed with virgin tree pulp for strength, so recycled paper bags are rarely made from 100 percent recycled materials. On the other hand, a major problem with plastic bags recycling is that many cities refuse to recycle them due to high cost and little economic benefit. This is because "recyclable" plastic bags are never truly recyclable. They can only be "down-cycled" meaning that recycled plastic bags can only be used to make more plastic bags which can then no longer be recycled (Kruptnik, 2003; Wong, 2011).

2.2.4 Treatment and Disposal

Waste treatment and disposal is a vital and final stage of waste management. The essence of treatment before disposal is to render the waste stream harmless to humans, plants, animals, ecology and the environment in general. Irrespective of the method used, waste disposal has its environmental consequences. The term “safe disposal” denotes the best available option with least environmental impact. This segment of waste management hierarchy is one of the expensive segments of waste management hierarchy. This implies that the disposal of plastic bags as well as available alternatives also has its impact on the environment, however, at varying degrees. Iheukwumere et al (2020) in their IPPAT concept where I = Impact; is a function of: P = Production rate of plastic bags and production of alternatives; P = Population of consumers and rate of consumption; A = Attitude (in terms of reuse, recycling and disposal); T = Technology (in terms of adequate structures for efficient waste collection, safe disposal and recycling technology), believe that the impact of haphazard disposal can be reduced with the help of attitudinal change and technology. A positive change in attitude of consumers geared towards reusing and properly disposing bags at the appropriate channels, where waste managers with a positive attitude to

environmental management will treatment and dispose generated waste. Tripathi (2014) explained that in many parts of the United States, there are recycling centres where people can throw their single-use paper bags for recycling. This greatly saves the environment and can even reduce fires especially in the summer. By using authorized recycling centre for paper bags rather than attempting to dispose of the bags themselves which is a common cause of many summer fires, the environment is preserved. Technology on the other hand will provide an efficient platform for timely collection, safe disposal and recycling of waste.

3.0 Plastic Bags and Alternatives

3.1 Plastic Bags

Plastic shopping bags are made from polyethylene, a thermoplastic made from petroleum which is a non-renewable resource. Paper bags, jute bags, hemp bags amongst others are made from plants. The energy needed to manufacture and transport plastic bags eats up more resources and creates global warming emissions. According to SPREP (2005) the amount of petroleum used to make a plastic bag would drive a car about 115 metres. It would take only 14 plastic bags to drive one mile. The production of plastic is largely reliant on fossil hydrocarbons, which are non-renewable resource. If the growth in plastic production continues at the current rate, by 2050 the plastic industry may account for 20% of the world's total oil consumption (UN Environment, 2018; Chow, 2020). The production of plastic bags requires petroleum and often natural gas, both non-renewable resources. Additionally, prospecting and drilling for these resources contributes to the destruction of fragile habitats and ecosystems around the world. The toxic chemical ingredients needed to make plastic produces pollution during the manufacturing process.

The benefits of plastic are undeniable. For the producer, the material is cheap, lightweight and easy to make. These qualities have led to a boom in the production of plastic over the past century. For the consumer, the benefits include ease of use, lightweight, waterproof, and cheapness (plastic bags are sometimes issued for free). Despite these advantages, plastic bags are not environment friendly as plastic bags photo-degrade. Over time they break down into smaller, becoming more toxic petro-polymers.

Much of the plastic bags produced are designed to be thrown away after being used only once. As a result, plastic bag packaging accounts for about half of the plastic waste in the world (UNEP, 2018). Plastic waste causes a plethora of environmental problems when they are not properly

disposed. From physical observation and from the works of Hasson et al (2007); Rayne (2008); Ayalona et al (2009); Xing (2009); Clapp and Swanston (2009); Moharam and Maqtari (2014), plastic bags can block drainages and intensify natural disasters by clogging sewers and providing breeding grounds for mosquitoes and pests. High concentrations of plastic materials, particularly plastic bags, have been found blocking the airways and stomachs of several terrestrial and aquatic animals (Moharam and Maqtari, 2014). According to Aldred (2007) and UNEP (2018) Plastic bags are often ingested by turtles and dolphins who mistake them for food. There is evidence that the toxic chemicals added during the manufacture of plastic transfer to animal tissue, eventually entering the human food chain. Aldred (2007) and Moharam and Maqtari (2014) stated that when plastic bags photo-degrade, it makes an easy entry into the food chain, contamination of soil and water takes place with the toxic chemicals from which they are made. Ritch et al (2009) and Moharam and Maqtari (2014) further stated that toxic chemicals emanating from plastic bags are attributed to disrupting hormone levels of animals within the food chain, ranging from abnormalities to the eradication of populations. The hormones are passed from the mother to the child via the womb and breast milk in both humans and animals, and are stored in body fat causing damage to the nervous system and immune system.

One strategy to fight plastic pollution is to convert oceans of plastic trash into something valuable. To curb plastic pollution and its perceived effects, Researchers in India developed a relatively low-temperature process to convert certain kinds of plastic waste into liquid fuel as a way to reuse discarded plastic bags and other plastic products (Inderscience, 2014). Another of this approach comes from a team at Purdue University led by Linda Wang, which has devised a method to convert used plastic into liquid fuel (Patel, 2019). The process, as reported by Patel (2019), is more energy-efficient than recycling or burning waste plastic. Tapkire (2014); Shiri et al (2015); Sojobi et al (2016); and Jassim (2017) have also reported the recycling of plastics including plastic bags into building materials such as building blocks, interlocking stones and roofing tiles.

3.2 Paper Bags

Paper bags which are made from wood or recycled wood, are becoming a fast rising option for plastic bags. Wood which is a forest resource is environmentally friendly and renewable through afforestation and regeneration programmes. The production of paper bag is not dependent on a lone source. According to Two Sides (a non-profit organisation) (2019), paper bags are

manufactured from a wide variety of fibre types dependent on what they are being designed to carry. Paper bags made of recycled or, a hybrid of new and recycled fibre are a cost efficient option for non-food packaging applications required to carry less weight e.g. shoe or textiles/clothing. The raw material used in the production is nontoxic, therefore, can be used for food packaging. Entrepreneur India (nd) argued that contrary to popular belief, paper bags can be very robust. Bags that are made of paper material called sarc-kraft can withstand such weight. Kraft paper is essentially developed for demanding packaging. Due to its long and strong fibres, it has a high level of mechanical strength. However, the durability of paper bags during wet season has limited its wide acceptance amongst majority of residents in Nigeria.

The recycling rate for paper and cardboard packaging stands at 58% globally (Two Sides, 2019). An improperly discarded paper bag poses less threat to the environment than plastic bag due to its natural compostable characteristics. In terms of production energy requirement, Tripathi (2014), posited that it takes more than four times as much energy to manufacture a paper bag as it does to manufacture a plastic bag.

Tripathi (2014) revealed that the impact of paper bag production on forests is enormous. According to Tripathi in 1999, 14 million trees were cut to produce the 10 billion paper grocery bags used by Americans that year alone. Paper bag production delivers a global warming double-whammy, this is because forests (major absorbers of greenhouse gases) have to be cut down, and then the subsequent manufacturing of bags produces stench which pollutes the air and greenhouse gases which cause acid rain.

3.3 Tote Bags, hemp bags, Jute Bags and woollen bags

These bags are made from plants which make them environmentally friendly. Tote bags are mainly made of cotton or hemp, Hemp bags are made from hemp plant, Jute bags are produced from jute plant popularly called “ewedu” (a common vegetable for local soup preparation in Yoruba land) in Western Nigeria and Woollen bags are made from wool. These bags can be reused several times before final disposal. The bags biodegrade within a short time when disposed into the environment. Wong (2011) in lending credence stated that the bags are so desirable in that they eliminate waste, are cheap to produce and are easily recyclable. While these bags have been confirmed to be environmentally friendly, researchers have revealed that the bags has a tenfold chance of carrying harmful coliform bacteria. The researchers also tested bags that were hand washed after use and

found that washing was 99% effective in removing all types of bacteria from reusable shopping bags (Wong, 2011).

3.4 Degradable Plastic bags

Biodegradable bags are bags that are capable of being decomposed by bacteria or other living organisms. Degradable plastic bags though not popular in Nigeria is not a new concept in the pursuit for alternatives to plastic bags. Camann, et al (2010) citing Shogren, Fanta, and Doane (1993) stated that research on biodegradable plastics based on starch began in the 1970s and continues in various labs. Technologies have been developed for continuous production of extrusion blown films to containing 50% or more of starch mixed with polymers and water sensitivity of such films have been reduced by lamination with polyvinyl chloride.

Biodegradable plastic bags are theorised to be a better replacement for the conventional polyethylene plastic bags due to its perceived ability to degrade over time. However, Nativejar (2017), Katz (2019), and Schlanger (2019) have pointed out that biodegradable plastics cannot biodegrade if they are buried in the landfill or left in the sea. Katz (2019) explained that degradable plastic bags that claim to be biodegradable were still intact and able to carry shopped items three years after being exposed to the natural environment.

Biodegradable plastic bags can become a better replacement for polyethylene plastic bags if the biodegradation capability and rate is improved on, to degrade in 6month or less with no visible trace and production of any secondary reaction or pollution. In the context of degradable plastic bags a lot of other terminologies are used, such as bioplastic bags, compostable plastics bags, and biodegradable plastic bags. These terms have been used interchangeably albeit with a slight difference in meaning. Compostable plastics and biodegradable plastics are materials that break down into their organic constituents. Biodegradable plastics are produced solely or in combination with renewable raw materials. Petrochemical plastics are considered bio-plastics if produced partly or wholly with biologically sourced polymers. Bio-plastics are made from natural materials such as starch. Not all bio-plastics are biodegradable. An example of a biodegradable film is when starch, which is hydrophilic is mixed with the hydrophobic plastic. Addition of natural polymers like starch into polyethylene creates starch-LDPE films containing up to 30% starch. These films have been shown to be biodegradable upon composting. These starch-LDPE films fit perfectly into the ecosystem because of their total biodegradability.

In terms of energy required for production, literature has shown that several researchers have carried out extensive assessments on biodegradable plastics to determine whether these materials are more energy efficient than conventional plastic bags. Result showed that 50-60MJ/Kg of fossil fuel energy is required to produce a kilogram of biodegradable plastic. However, further drop in the energy requirement is anticipated with advancement in commercial production of biodegradable plastic bags. This is in contrast to 70-80MJ/Kg of fossil fuel energy required for the production of a kilogram of plastic bag.

Conclusion

With the case of plastic bag pollution becoming an unarguable discourse, environmentalist and concerned stakeholders have put forward a host of alternatives for consideration and possible use. The plastic bag which seems like an indispensable tool has been a top choice for many retailers for some time owing to the fact that it is strong and durable. From the Camann et al (2010) and Iheukwumere et al (2020), it is apparent that most of the public are aware of the potential problems behind plastic bags. Environmentalists also contend that the use of paper bags as an alternative contributes to the destruction of the world's forests and by extension the environment. The review discovered that despite the myriad of proffered alternatives, none exist with zero impact on the environment. The cited alternatives potential to biodegrade gives them an advantage over plastic bags.

Recommendation

Hinged on the concept of BPEO and WMH, this paper recommends that all options be juxtaposed from the process of resource extraction to the final waste disposal stage to determine best practicable environmental options and resilience. The BPEO implies that the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long-term as well as in the short-term. Waste management hierarchy which advocates reduction, reuse and recycling will be pivotal in reducing observed impacts from recommended bag type when employed in waste management planning.

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