



Prioritizing Food Waste Management for a Greener Tomorrow Beyond Landfills: Strategies to Shrink our Carbon Footprint through Food Waste Reduction

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: <https://doi.org/10.9734/ajee/2024/v23i7562>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/117080>

Original Research Article

Received: 15/03/2024

Accepted: 17/05/2024

Published: 22/05/2024

ABSTRACT

The Sustainable Development Goals (SDGs) are attracting global attention amid concerns over food security and environmental pollution resulting from the expanding global economy and population growth. Food waste that occurs at all stages of processing is thrown into landfills. This food waste is sent to landfills where it decomposes to produce greenhouse gas emissions. A significant portion of waste thrown into landfills is organic kitchen waste that decomposes to produce greenhouse gases responsible for climate change and environmental risks. This observation is that of our results, which point out that poor management of food waste, the landfills which receive it are uncontrolled and thus leaving access to human persons due to the

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proximity to the residential houses, as well as to insects and animals. Incineration is the main method used to dispose of waste, with very few initiatives for recycling or composting of waste, thus leaving their degradation or incineration in the open air with all the consequences on the carbon footprint and the climate.

Initiatives for the good use of waste, in particular: recycling, composting, etc., must be encouraged for the good management of waste and landfill sites in order to preserve our environment from greenhouse gases. For this reason, regulations on waste management and landfills must be considered to prevent the future.

Keywords: Food waste; waste discharge; carbon footprint; recycling.

1. INTRODUCTION

“Food is a precious commodity that not only quickly turns into waste, but also negatively influences the environment” [1]. “Food waste generated from homes and restaurants is becoming a significant part of municipal waste” [2]. Food waste also comes from hotels, food markets, cafeterias and bakeries.

“The high rate of food consumption and the very low rate of recycling of food waste lead to the formation of mountains of food thrown into landfills. In these landfills, dumped food is burned, thereby producing harmful gases” [3].

Thus, waste management is one of the crucial practices essential for maintaining a sustainable environment [4]. This management refers to the process of collection, transport, treatment and disposal of waste. And encompasses various activities aimed at reducing, reusing and recycling waste [5]. This involves the proper management of waste from its generation to its final disposal.

“Because inappropriate waste disposal practices can have serious environmental consequences” [6]. “When waste is not treated properly, it can contaminate air, water and soil, posing significant risks to ecosystems and human health” [7,63,64,65]. “Poorly managed landfills can release harmful gases, such as methane, a powerful greenhouse gas that contributes to climate change. These emissions can worsen air pollution and contribute to global warming” [8].

“Careless waste management can also lead to pollution of water sources” [9]. “Improperly disposed hazardous materials, such as chemicals and pollutants, can leach into

groundwater, rivers, and oceans, affecting aquatic life and compromising water quality” [10,11]. “Contaminated water not only harms marine ecosystems, but also poses risks to human consumption and agricultural activities that depend on clean water sources” [12].

From this observation, it is urgent, before developing strategies to reduce food waste in order to support the economy and fight against climate change, to understand through an inventory, the process of managing food waste, to their packaging and especially the state of the landfills which receive them as final disposal sites.

The objective of this study was therefore to understand the process of managing food waste and its packaging from its collection to its elimination at landfills in order to determine the overall impact of food waste on the environment through production. possible greenhouse gases.

2. METHODS

The present study involved direct observational research on the management of food waste and its public landfill in the city of Lubumbashi. Using Google Form, third-year Bachelor of Biomedical Sciences students questioned and observed food store managers regarding the management of food waste within the food store and during the disposal process at the food site. dump.

For a reasonable assessment of the disposal quality of the landfill site, we have defined landfill site evaluation parameters in order to understand the risk presented by each site. photographs of certain sites were taken to illustrate their condition.

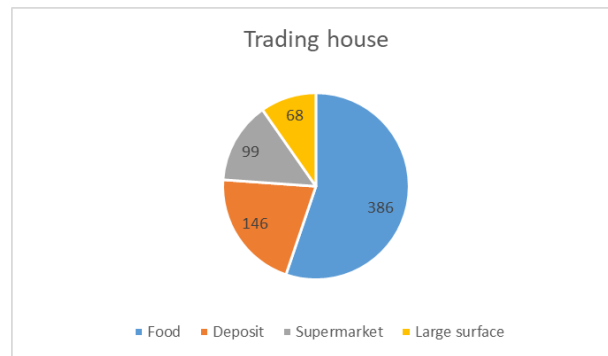


Fig.1. Distribution of business houses visited

3. RESULTS AND DISCUSSION

From this Fig. 1, it appears that the power supplies in the community are the first producers of waste followed by depots and supermarkets and the supermarkets come in last position.

Locally, food businesses always organize a catering area with significant activity and which unfortunately is accompanied by the production of enormous quantities of food waste, the result of leftovers not consumed by buyers. This situation is known worldwide, because the global catering sector generates significant quantities of food waste [13]. UNEP (2021) estimates this waste at 244 Mt. per year, or 19% of the global total of avoidable food waste [14].

Plastics and papers are the waste most produced in our commercial structures, followed by organic waste consisting of food waste.

“When food is thrown away, so are the packaging materials it was contained in. Large quantities of different materials, such as paper, glass and

plastic, are used worldwide to make packaging materials and more than two thirds are used in the food sector alone” [15].

“The packaging industry consumes the largest volumes of plastics produced in the world and is the leading source of plastic waste into the environment at an alarming rate” [16]. “Plastics, materials obtained by polymerization of compounds (ethylene, propylene, styrene, etc.) resulting mainly from the steam cracking of hydrocarbons themselves resulting from the distillation of petroleum” [17]. “Plastic pollution has various negative health impacts in Africa, affecting both human populations and ecosystems” [18]. “Plastic waste, especially single-use plastics and microplastics, can contaminate freshwater sources such as rivers, lakes and groundwater” [19]. “This pollution can lead to the consumption of microplastics via contaminated drinking water, potentially posing risks to human health” [20]. “Likewise, plastic can end up in the food chain” [21]. “Plastics can also contain toxic chemicals, which can leach into the environment and potentially enter the food chain” [22]. “Prolonged exposure to these chemicals,

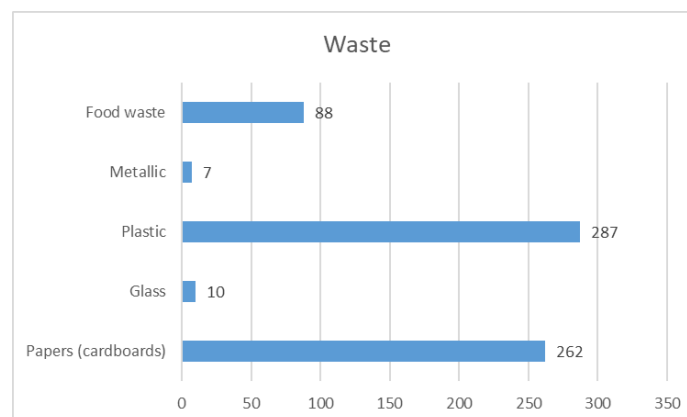


Fig. 2. Types of waste produced

including through consumption of contaminated food or water, can cause adverse health effects, including endocrine disruption, developmental problems, and increased risks of cancer” [23].

“Paper and board account for 31% of the global packaging market segment and are most widely used in food packaging for containment and protection of food products, convenience during storage or consumption and communication of information relevant to consumers, including their marketing aspects” [24]. The paper carries an environmentally friendly label, making it the first choice for food industries and is mainly used at the primary level (i.e. in direct contact with food products) and secondary level (i.e. i.e. for the transport and storage of primary packaging) [25]. Plain paper is insufficient for food products due to its poor barrier properties, poor heat sealing and low strength. Thus, it is impregnated with an additive or laminated with aluminum or plastic to improve its functional properties [26]. Various components and additives from paper can migrate into food products and cause serious risks to human health depending on the level of migration and consumption (exposure is expressed as a product of migration and food consumption) [27,28].

“Food waste is the main contributor to greenhouse gases and climate change” [29]. “When food is thrown away, it goes into landfills, where it rots to produce methane, a greenhouse gas 28 times more potent than carbon dioxide” [30]. “If we divert food waste from landfills to an innovative food waste treatment system, we can stop almost 11% of greenhouse gas emissions” [31]. “The methane released from food waste stays in our environment for 12 years and traps most of the sun's heat. Although methane is

short-lived, it contributes 20% of greenhouse gas emissions” [32]. “So, to fight against food waste, The food waste hierarchy best describes food waste management priorities. The most favorable option is prevention, followed by reuse, recycling, recovery and disposal as the least favorable option” [33]. “It is the responsibility of households and individual consumers to contribute to the reduction of food waste using the 3R principle of reduce, reuse and recycle” [34]. “Using this 3R principle can also reduce resource usage. Reducing means reducing the amount of food and managing the amount of food, that is, not accumulating too much food. Repurposing involves using leftover ingredients to prepare a new menu and saving leftover food that can still be consumed for the next meal, which will help minimize the amount of food wasted. Recycling is the use of food waste to make compost or animal feed. By following the 3R principles, consumers can help reduce economic losses, reduce the use of natural resources, reduce global warming and protect the environment” [35].

And observing Fig. 3, these principles are less applicable in the city of Lubumbashi, the food stores and supermarkets visited ignore in most cases the practice of 3R. which has the result , production of large quantities of methane. Methane has a greater global warming potential than carbon dioxide at the landfill [36].

From Fig. 3, we see that most food sales structures collect waste and few sort and separate waste and almost all of these structures do not process waste for transformation. waste treatment and disposal in Lubumbashi is still suboptimal.

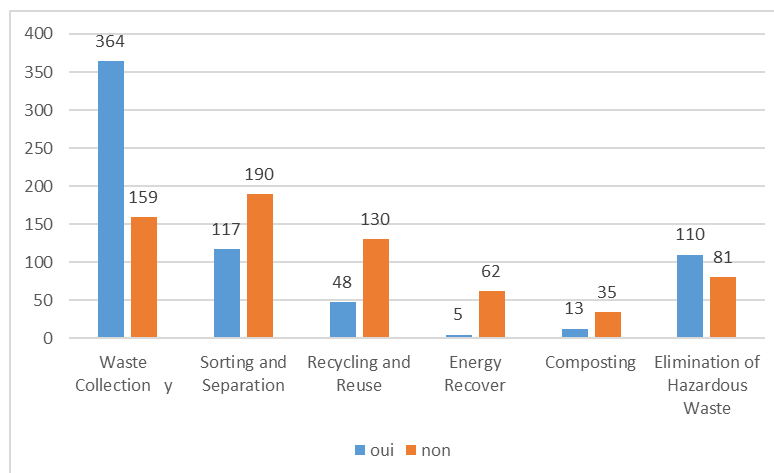


Fig. 3. Waste sorting activities waste treatment

Table 1. Sorting and Separation: Centenary color code and lid color code

	Gray Cover	Black cover	Green lid	Blue lid	Yellow lid	Red cover	Chocolate lid
Centenary gray	339	198	38	28	8	25	21
Black centenarian	93	430	55	27	15	23	14
Centennial green	107	178	285	25	14	23	25
	539	806	378	80	37	71	60



Picture 1. Waste collection

The sorting and separation of waste is done without respecting the color code as also shown in the Picture 1, in which we note poor maintenance of the bins: too full, without lids, containing the same types of waste whatever the size. color of the trash can.

“Waste collection and first sorting of waste is done using bins and waste sorting behavior is strongly linked to the perception of trash cans. Waste sorting can be improved through better bin design and/or more appropriate location, this will result in better segregation of waste at source and thus reduce costs and time spent on recycling processes” [37]. “A low recycling rate is strongly linked to poor waste sorting. Waste sorting is correlated with the economic status of countries – the sorting rate is generally higher in higher income countries” [38].

The design of the bins also helps to encourage waste sorting. For example, specially designed opening slots for recyclable waste increased separation performance [39] and prevented recycling contamination [40]. The color classification of trash cans can also guide consumers when sorting waste for disposal [41].

“Additionally, color perception impacts human memory and decision-making” [42]. “Color can be associated with different types of waste. Choosing optimal colors can therefore improve the efficiency of waste sorting. The influence of colors in visual communication has been used to reveal the meaning of colors in recycling

behavior” [43]. “Bright yellow trash cans can improve the capture rate of food waste” [44].

“The location and location of trash cans also impact waste disposal behavior” [45]. “Easy access to trash cans can improve the efficiency of sorting compostable and recyclable waste in high-density residential buildings” [46,47].



Picture 2. Appearance of public trash cans

From this Fig. 4, we see that trash cans with capacities between 120 and 240 liters are the most used. and the trend is much more for that of 120 liters.

In addition to public bin-shaped trash cans as shown in Picture 2, commercial food establishments use plastic trash bins of different sizes and these trash bins are designed to accommodate the increasing volume of household waste generated in modern life, offering solutions efficient and hygienic waste management [48].

Incineration is the most used means of eliminating waste and plastics, in certain proportions, we resort to the reuse of metal and aluminum waste and composting for organic waste.

Incineration has the advantage of being able to considerably reduce the volume of waste and generate energy. However, cremation also has several disadvantages.

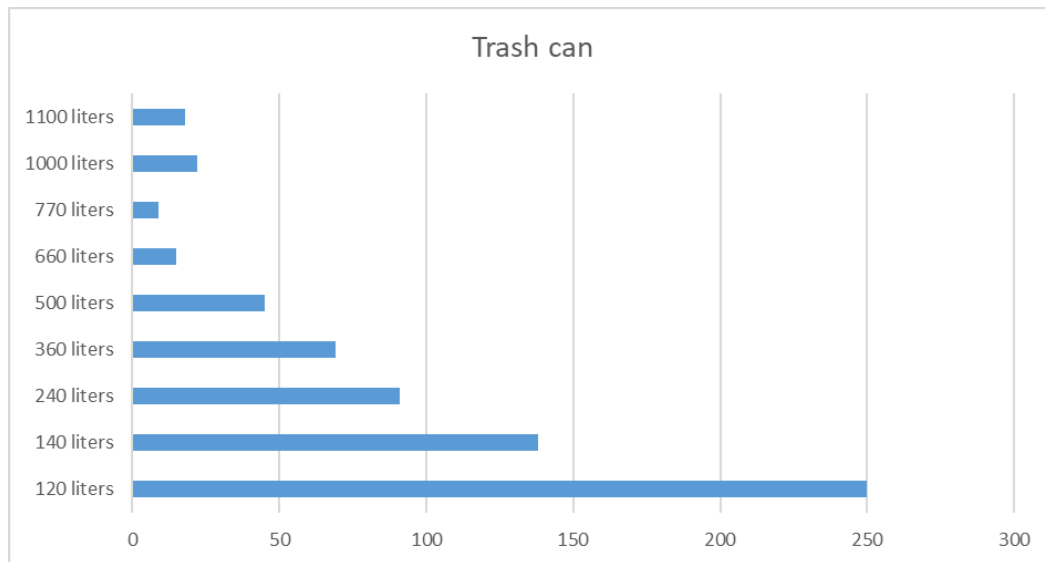


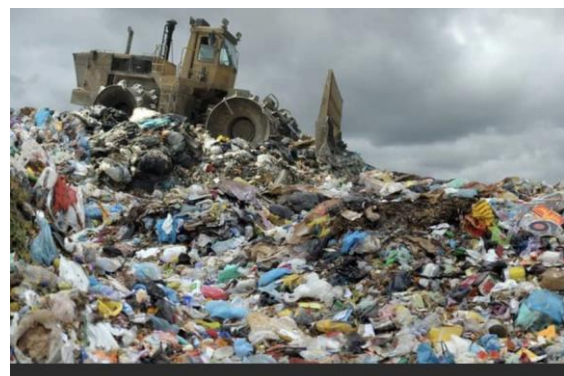
Fig. 4. Trash can capacity

It can release harmful pollutants into the air, such as dioxins and heavy metals [49]. Recycling, in turn, has several benefits, including reducing the amount of waste in landfills, conserving resources natural resources and the reduction of pollution [50]. Finally, Composting is the process of breaking down organic waste into nutrient-rich soil. Composting has several benefits, including reducing the amount of waste in landfills and providing a natural fertilizer for plants [51].

The landfills are characterized by strong odors, presence of smoke, accessible to the population, they are nearby, these landfills present liquid flows and are visited by insects and animals. There we find more plastic waste, then paper (cardboard) and then food waste and finally metal waste and glass.

The high proportion of odor at landfill sites is synonymous with a composting process, the major disadvantages of which are the long duration of the process and the emission of odors [52]. The landfill areas are uncontrolled and give access to animals and insects in

proximity to residential houses (see Picture 4) and this uncontrolled elimination generates serious pollution by heavy metals in the water, soil and plants [53], open air combustion is the origin of CO, CO₂, SO, NO, PM₁₀ and other pollutant emissions that affect the atmosphere [54], waste collection in Open dumps pose serious health risks to people working in these areas [55].



Picture 3. Appearance of a waste dump

Table 2. Waste disposal

	Reuse	Composting	Energy recovery	Landfill	Incineration
Waste Paper	132	85	12	19	409
Plastic	140	124	20	40	333
Metallic	230	123	56	157	89
Aluminum	166	130	86	145	127
Organic waste	99	181	30	201	145
Glass	155	146	35	204	117



Picture 4. Discharge of waste in smoke and near residential houses: makeshift incinerations

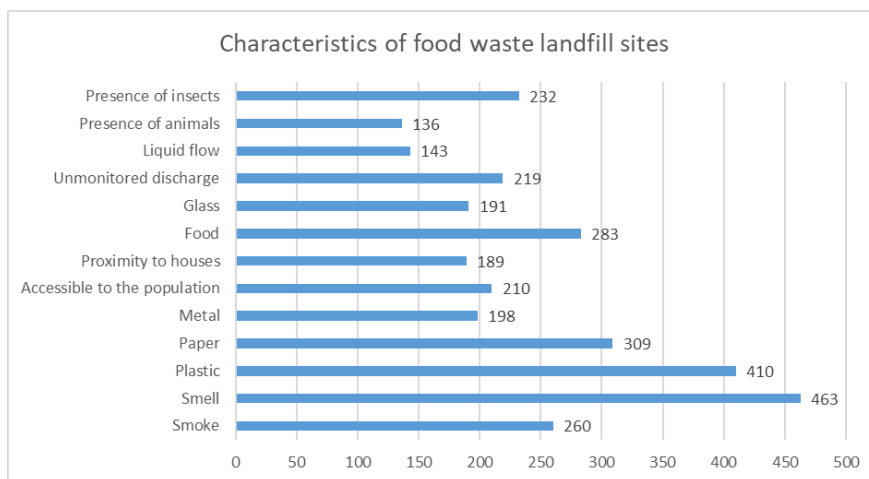


Fig. 5. Discharge characteristics

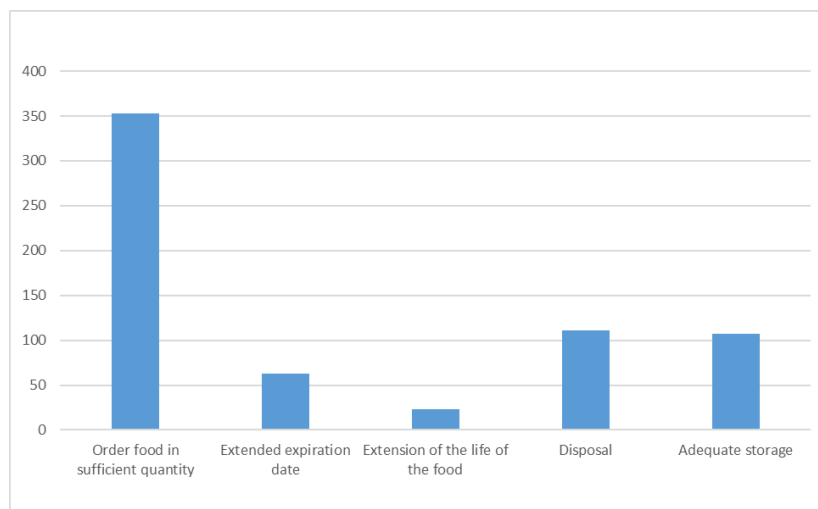


Fig. 6. How to avoid waste

This Fig. 6 reveals that traders, in order to reduce food waste and also reduce the quantity of packaging waste, consider ordering sufficient quantities of goods and adequate conservation to be completely purchased, some consider eliminating expired items during that others think

about continuing to sell them by extending the expiration date.

The other authors believe that to improve waste management in developing countries, solutions such as organic waste buy-back programs, with

compost or biogas production [56], the implementation of waste management plans and technologies energy recovery [57], energy recovery from waste in parallel with recycling of glass, metals and other inerts [58], production of energy from biomass waste by manufacturing briquettes [59], implication of the integration of waste pickers with legal incentives [60-63], between others.

4. CONCLUSION

Effective waste management enables environmental sustainability by reducing pollution, conserving resources and minimizing the ecological footprint. Additionally, stores that prioritize good waste management demonstrate their commitment to social responsibility, which improves their reputation and strengthens their relationships with customers, suppliers and stakeholders. Additionally, effective waste management can result in savings through reduced waste disposal costs, optimized use of resources, and potential revenue generation through recycling or waste-to-energy initiatives. By implementing effective waste management practices, businesses contribute to a cleaner, healthier environment while reaping economic and social benefits.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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