Overview on Sustainability Criteria for Food Waste Bioproducts Management

Mohd Ikhmal Haqem Hassan¹, Aeslina Abdul Kadir¹,², Lidya Najiha Nasarullah¹, Noor Amira Sarani³, Nur Jannah Abdul Hamid¹, Nurul Nabila Huda Hashar¹, Azini Amiza Hashim¹ and Nur Fatin Nabila Hissham¹

¹Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, 86400, Batu Pahat, Johor, Malaysia
²Center of Excellence Geopolymer & Green Technology (CEGeoTech), Universiti Malaysia Perlis, 02600, Arau, Perlis, Malaysia

E-mail: aeslina@uthm.edu.my

Abstract. Ever since the pandemic of Covid-19 crisis hit all over the world, many aspects of the economy have changed especially on the healthcare issues, solid and medical waste management, as well as our food system. For a developing country like Malaysia, even though during movement control order, food wastage is not yet to be neglected. Some factors in households can influence food waste such as over shopping behaviour, panic buying that led to uneaten foods (leftovers) and household management practices such as poor planning and food storage problems. The increase in food wastage and collection generated every year will also lead to environmental pollution issues and natural resources. To overcome this issue, some researchers has been working to finding a sustainable approach to replace common practices for food waste management. Food waste will be used as industry substrates for production of valuable bioproducts and has achieved results in diversification applications and increased market demand for bioproducts. Therefore, this study discusses on current and available practices on food waste by converting it to bioproducts that enhance sustainable development. These productions is a new concept that is implemented to raise more attention to the efficient and sustainable use of resources, energy, and infrastructure to guarantee the life quality for human beings.

1. Introduction
For a country that is developing rapidly, the increase in population will also occur sharply. It will indirectly increase the food consumption rate and will result in wastage. The increase in food wastage and collection generated every year will also lead to environmental pollution issues and natural resources. According to a household or family survey, it is the biggest contributor to the overall 16,650 tons of food waste in Malaysia every day. A household or family resulted in a higher food waste of 38% as compared to wet market (24%) restaurant (23%) or hotel (7%). On average a family consisting of four people wasting almost a kilogram of food every day [1]. Global rankings are estimated at 1.3 billion in the rest of the global food to be disposed of at annual disposal sites each year [2]. Worldwide, over 30% of food is wasted, which coincides with 1.32 billion tons of food produced for individual uses and the global economic cost is more than USD 900 billion [3].
To address this issue, the science community has been working towards finding a sustainable approach to replace common practices for food waste management. Nutrient-rich food waste is often as an attractive substrate for conversion to precious bioproducts such as industrial enzyme, fuel, and active compounds. The aim of increasing the bioeconomic distribution can be implemented by performing a sustainable approach in food waste reuse. Food waste will be used as industry substrates for production of valuable bioproducts and has achieved results in diversification applications and increased market demand for bioproducts [4,5]. This study discusses current practices and latest advancements on food waste use for valuable bioconversion to bioproducts and sourced from food and it will follow the sustainable development. In Malaysia, sustainable use and production is a new concept that is implemented to achieve sustainable development, raise more attention to the efficient and sustainable use of resources, energy, and infrastructure to guarantee the life quality for human beings. It can also be done to the waste of food that we own produce. With this sustainable development, it can formulate an overall development plan with reduced costs to the economy, the environment, and the community. It will also enhance the competitiveness of the economy; the country thus helps in reducing poverty.

2. Methodology
There are often many methods to manage the waste of food such as being disposed of in landfills, doing combustion, composting and applications as animal feed [6]. For food waste burning methods that have high water content need to be through the process of energy loss due to evaporation of water and will result in an unfailing discharge that can cause severe environmental impacts. In addition, when substrates baked the feasibility of precious compounds and recycled nutrients will diminish and it will change the chemical composition and thus produce relatively low commercial value [7]. To date, a majority of agricultural and food wastes are still inevitable from being placed on landfills and this causes serious environmental problems and contributes to severe and infectious bacterial contamination. The composting process are the spreading/ground injections that are the most prevalent approaches. It is a very nature-friendly practice and very easy to implement. It can also be accepted as it diverts food waste from the disposal site and therefore, the necessity of planters for steel and water from the use of industrial effluents and the rest of the solid. However, this type of practice is still experiencing a lack of high cost and implementation of facility. Dumping of large amounts of food waste at the disposal site are costly and have high potential in harming the environment. It is also apparent, either with direct and indirect greenhouse gas emissions, namely methane and CO2. Food waste management work as a improve enhancer in the land that is expected to be evaluated in the coming year [8].

3. Results and Discussion

3.1. Life cycle assessment
The Life Cycle Assessment (LCA) is a system used for managing solid waste (MSW) and serves to optimize the infrastructure system to manage the amount and composition of wastes produced by an organization or individual [9]. This system is often used to assess the amount of hierarchy wastes in identifying the waste management technique is effective and appropriate for production and only provides very small impact on the environment. Waste prevention and product use are two main components of the first waste hierarchy, both aspects are usually not considered of this assessment [10]. Solid waste managers for the municipality often only focus solely on the 'end of life' of the waste management level when the waste is generated.

The LCA of the current and prospect future food waste treatment scenarios has been done in accordance with the ISO 14040/14044 methodology [11,12,13]. Figure 1 shows the following life cycle stages that have been considered which are the collection of food waste from households, treatment, and the recovery of valuable resources, and associated environmental credits and revenue. The
construction of waste treatment facilities is included but their decommissioning is excluded due to a lack of data. Food waste is assumed to be burden-free. Salomone et al. (2016) [14] has conducted LCA study on food waste by comparing the conventional production of protein and lipids with alternative origins of raw materials. Results showed that the benefit of the production was the reduction on land use but resulting in poor in energy consumption.

![System boundaries for the food waste treatment scenarios Life Cycle Assessment (LCA)](Figure 1)  
(Source: ISO 14040, 2006).

3.2. Food waste in sustainable ways to produce the high value bioproducts
From the life cycle assessment (LCA), food waste can be defined as the remaining residual biodegradation kitchen or pre-cooked agricultural waste that is disposed of from households and other industries especially the food processing industry [15]. As such, some researchers has put numerous attempts to enhance waste management system in a better way to reduce the accumulation of food wasted that being generated gradually by reutilizing the food waste as the feedstock to produce high value products. Other than that, each food waste comes from a variety of sources and consists of different chemical compositions, however these sustainable raw materials are very good for different production to produce bioenergy and other more commercial bioproducts and stakeholders. Various studies have been conducted in seeking innovative and sustainable bioprocess to convert food waste to valuable and quality bioproducts suitable to economic potential from a transformation and based product from processing food and agriculture waste. This happens when compared to food issues that result in disposal problems. In fact, food waste is a sustainable and capable raw material for microbial fermentation process to produce a range of active products as it contains a composition that is rich in fatty acids, proteins, minerals, and phenolic compounds. The biotransformation of food waste to bioproducts can improve the function and it can reduce production costs, maintenance costs and reduce environmental pollution. This was drafted by his ability to eliminate the need for food wastage treatment [16]. Besides that, several bioproducts such as enzymes, antioxidants, pigments can be generated by using microbial fermentation using food waste as crude feedstock [17].

3.3. Food waste bioconversion by sewage system
The implementation of the food scraps industry into high value products will depend entirely on the cost of investment for each equipment and infrastructure as well as the commercial value of the final
product. Each bench-scale experiment and a sustainable approach are often required before implementation of a more large-scale bioconversion process industry. Thus, the enzyme system has been established and introduced in the process of the food leftovers to replace the existing chemical herding system. It is more stable and larger reuse can be run along the processing of leftover food. Food waste flow is not an appropriate entity for enzyme response and at the same time affects the overall productivity of bioprocess due to complex chemical compositions [18]. The method of mobilization of enzymes has been a good engineering tool in facilitating biocatalysts to scavenge the Bioconversion process. Although the use of enzymes can provide a variety of more beneficial features compared with traditional chemical divisions in the flow of residual assess as it is less maintaining the catalyst for activity and their stability under the typical circumstances residual flow of food processing such as non-neutral pH and higher temperatures is the main barrier to existence. Thus, the construction of biocatalytic stable system is essential for industrial application strengthening. The remaining flow of food is not genuine and does not have a good environment to the enzyme, with circumstances beyond the optimum working point. In recent years, many researchers have pursued mobilization as a tool of engineering that needs to be given attention to adjust and improve the various features of enzyme scaving, such as activities, where, specificity, opposition to inhibitors [19,20].

4. Conclusion
The abundance of food wastage that resulted from the increasing of human populations around the world has forced a sustainable completion of road search to take care of leftover food and can also overcome the problem of environment caused by the gathering of leftovers. Biotransformation of food scraps into high value bioproducts has emerged to be implemented for industrial practice due to the potential economic value and ability demonstrated by bioprocesses at optimum and maximum. However, the cost of investment for food scraps quotations and categorization based on chemical composition should be considered towards enforcement purposes. Moreover, the initial investment cost for the intensive inaugral test for the experiment for optimum operation efficiency and infrastructure is mainly a barrier to the implementation of food waste industry to valuable bioproducts. The increase in the number of food waste generated annually is caused by the growth of human population drastic has established a tremendous need in the reuse of food scraps for better purposes. However, economic barriers have resulted in new developments and benefits emerging on the search for alternative approaches to food waste management are often restricted. It is also mobilized by complicated infrastructure demands when practical implementation. Therefore, be cautious and detail the biotechnology investigation with a bold assumption is needed to maximize economic gains with a minimum input of the use of energy and investment costs and to be widely achieved by circulars economic goals.

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