

Food Waste Conversion to Halal Organic Fertilizers

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Abstract

Up to one-third of the food produced for human consumption is wasted, with negative effects on the environment, society, and the economy. The value contained in kitchen food waste is being recognized more and more, and Brunei Darussalam is among the highest in the region with a solid waste output of 1.4 kg per capita per day. However, it is estimated that only 11.3% of the food waste was recycled, with the remaining portion ending up in landfills. In this context, this paper aims to offer recommendations for the most environmentally beneficial methods of using kitchen food waste, with composting kitchen food waste producing natural, halal, eco-friendly fertilizer. Thus, a two-month experiment was conducted to produce compost-based fertilizer from kitchen food waste. The nutritional value of the plant was then ascertained by fertilizing one plant of bird's eye chillies with compost-based fertilizer (CBF) and another plant with clay-based soil (CBS). Results of this study showed that the nutrients in CBF plants consist % of Total Nitrogen, % Total Phosphorus which are all in the accepted range. Thus, it demonstrates how composting food waste from households can aid in the management of waste reduction for sustainable and a healthy environment, and circular economy.

Keywords: *Brunei, compost, kitchen food waste, halal organic fertilizers, green*



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INTRODUCTION

Every year, one-third of the food produced for human consumption worldwide is either lost or wasted (Ilakovac, et al., 2020; Shahrajabian, et al., 2019; Jeevahan, et al., 2021; Gustavsson, et al., 2011). Similarly, millions of tonnes of halal food waste are dumped into the environment every year (Sulaiman, et al., 2014). Food waste is a serious problem in Brunei and is a problem that affects many other countries as well. Brunei Darussalam ranks among the highest in the region for garbage creation per capita while having a relatively small population of only 400,000 people. According to Shams, et al. (2014), Brunei produces 1.4 kg of solid trash per capita per day, which is second only to Singapore among the ASEAN nations. 70% of Brunei's total trash is directly disposed of in its six landfills, 2% of it is utilised to make compost, and the remaining 40% is disposed of in other customary methods (Shams, et al., 2014). In 2019, According to estimates from Brunei, just 11.3% of food waste was recycled, with the balance ending up in landfills (Borneo Bulletin, 2021).

Thus, food wastes could be considered to be pure waste streams, and they pose a serious environmental burden by attracting vermin, emitting poisonous gases, and contaminating groundwater (Okareh, et al., 2014). To maintain a clean and healthy environment, food waste must be eliminated from homes and institutions such as boarding schools, schools, jails, sports

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complexes, industries, etc (Okareh, et al., 2014). These can be accomplished by using composition, a key element in the treatment of food waste (Sun-Kee & Hang-Sik, 2004) to create compost for use in agricultural cultivation (Okareh, et al., 2014). A moderate, consistent pace of plant development, which is extremely desirable for urban farming, is made possible by the delayed release of nitrogen provided by food waste composts (Sullivan, et al., 2002). Because they have fewer phytotoxic chemicals and more stable organic matter than fresh residues, composts are safer from an agricultural standpoint than fresh wastes (Ayuso, et al., 1996) indicates a viable strategy for sustainable farming (Milinković, et al., 2019).

As a result, the nation needs to take urgent action to manage waste effectively, especially given the high value of organic fractions. So, by evaluating the analysis of plants used composted fertiliser, the study aims to show the goodness of compost fertilizers which eventually will reduce the quantity of food waste that ends up in landfills and the amount of methane gas created as a by-product of food waste in the home. However, the only workable solution to this issue is the prescription of composting to turn household food waste into organic fertiliser. Additionally, organic fertilisers are essential in the agriculture industry since they improve the soil without harming plants or groundwater (Min, 2015).

LITERATURE REVIEW

Brunei has the greatest carbon dioxide emissions per capita in the world despite having an abundance of forests, with 55% of those emissions coming from gaseous fuel, 28% from liquid fuel, and 13% from gas flaring (Dariah, et al., 2022). Additionally, the Sungai Paku Landfill, which is frequently used and is anticipated to be full by 2025 if effective recycling procedures are not done, received rotten goods and vegetables from stores in Brunei, according to an article in the Brunei Times. Additionally, retailers in Brunei produced up to BND 1000 worth of spoiled goods, including fruits, every month, including imports from other nations. One of Brunei's largest supermarkets, Hua Ho, discards 2 to 3 kg of spoiled produce every two days, totalling 45 kg of waste every month. (Dariah, et al., 2022).

Food that is suitable or edible for human consumption but has been thrown, whether after being held past its expiration date or allowed to decay, lost quality, or eaten by pests (Sun, et al., 2021). A sizeable part of food waste is improperly treated and sent to landfills or incinerators, or it is illegally diverted into the unofficial system to feed cattle or make cooking oil, leading to substantial issues with food safety (Sun, et al., 2021).

More and more people are considering using technologies that reduce environmental effects for food waste prevention and treatment to create more sustainable global food and waste systems (Thyberg & Tonjes, 2017). Sustainable food waste management policies are being suggested and implemented, particularly in the U.S. and Europe (Thyberg & Tonjes, 2017), China (Sun, et al., 2021), and Saudi Arabia (Waqas, et al., 2018), and the United Kingdom (Slorach, et al., 2020). Concerns about the social, environmental, and financial impacts of food waste have brought attention to this issue. So one method of reducing food waste is to compost food waste.

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RESEARCH METHOD

Material Selection

The material used includes organic food waste that was collected from the author's homes. It's important to remember that not all food has the same caloric and nutritional worth (Aldaco, et al., 2020). Therefore, when making decisions, it is important to consider the nutritional value of food waste (Bradshaw, 2018). Thus, the remaining food waste that was chosen for composting included green vegetables, eggshells, and banana peel. In addition, garden soil and dry leaves are added to the compost to lessen the surplus moisture (Hamid, et al., 2019) also expedite the composting process and keep the unpleasant odour at bay.

Carbon and Nitrogen Sources

In composting, greens and browns are needed as the basic source of the composting materials, which are used to be called Carbon and Nitrogen source. By greens, wAs the primary sources of composting materials, often referred to as the carbon and nitrogen sources, greens and browns are required in the composting process. Kitchen waste is referred to as "greens," whereas "browns" refers to things like dried leaves, sawdust, shredded paper, and soil. e mean kitchen waste, while browns mean dry leaves, sawdust, shredded paper and soil (Hamid, et al., 2019). The source of the carbon and nitrogen that will be added to the composting process is shown in Table 1.

Table 1. List of Carbon and Nitrogen source

Greens (High in Nitrogen -N)	Browns (High in Carbon - C)
<ul style="list-style-type: none">• Leftover green vegetables• Banana peels	<ul style="list-style-type: none">• Dry leaves• Garden soil

Composting Process

The composting container of choice has been a plastic container. There are a few holes drilled into the container's lid to let air into the compost since bacteria need oxygen to continue respiring in aerobic systems. Additionally, it is advisable to put the compost in a closed container. The bin will protect the compost from the elements and keep the temperature stable within. Additionally, the container's closure keeps out unpleasant odours and keeps other animals from interrupting the process.

To adapt and maximise the input substrate, the compost mixtures were blended (Aldaco, et al., 2020) in the composting container. The input mixtures were then allowed to decay and were only opened once every two weeks to stir and let the gas out to avoid the container from blowing up (Abdullah, et al., 2021) and ventilation to enhance the composting process' aeration (Hamid, et al., 2019). This enables aerobic biological breakdown and modification as a result of the rotting

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(Aldaco, et al., 2020). The container was put in a warm location because warm temperatures will enable the compost's microbes to function more effectively.

Finally, every two weeks, the liquid was drained from the container and poured back into it (Abdullah, et al., 2021), to ensure that the composted food waste undergoes the aerobic breakdown process (Waqas, et al., 2018). Last but not least, compost can be produced through a post-treatment-based sifting process. Figure 1 illustrates the characteristics of mature compost, which has a pleasant soil-like aroma and dark brown colour.



Figure 1 Mature Composted Fertilizer

Experimental design on Bird's Eye Chilli

After two months of fermentation, the compost was prepared to be applied to one bird's eye chilli plant with compost-based fertiliser (CBF) and the other plant with clay-based soil (CBS). Compost must include the nutrients that plants need because it is the organic fertiliser for plants (Chew, et al., 2018).

Nutrient analysis

Since compost is the type of organic fertiliser used for plants, it must be nutrient-rich. Macronutrients, which include nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur, are those that plants need in huge quantities. The plant of Bird's Eye Chilli from both CBF and CBS were sent for analysis to Soil Science and Plant Nutrient Unit, Department of Agriculture and Agrifood, Ministry of Primary Resources and Tourism, Brunei Darussalam to determine the content of the organic fertilizer. The content of Nitrogen (N), Potassium (K), Magnesium (Mg), Calcium (Ca), Phosphorus (P) and Iron (Fe) were measured for the nutrient analysis.

FINDINGS AND DISCUSSION

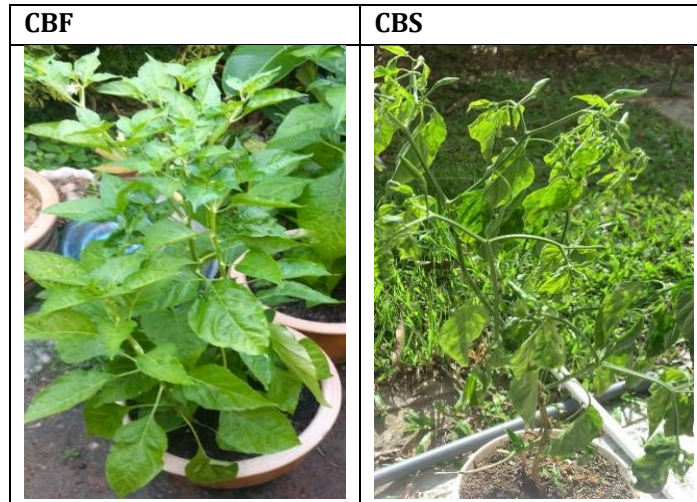
Observation analysis

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The growth of the bird's eye chilli was observed, and it was discovered that the plant grown with CBF performed better and contained more nutrients than the chilli cultivated with CBS, as shown in Figure 2.

Figure 2. Comparison of visual observation of Bird's Eye Chilli Plants



Source: (Rahim, et al., 2022)

Visually, the plant with CBS in Figure 2 exhibits the telltale signs of nutrient insufficiency, including twisting, cupping, and crinkling (Uchida, 2000) distorted (McCauley, et al., 2009) or misshaped leaves. This occurs as a result of calcium insufficiency, which may result from either an excessively high or low pH in the root zone. The organic fertiliser made from a leftover bone meal could be utilised as fertiliser in the soil as a calcium supply as a remedy. As demonstrated in Figure 2, organic fertiliser made from food waste demonstrates that it can provide plants with extra nutrients.

Nutrient Analysis

According to the findings shown in Table 2, CBF receives the most crucial macronutrients required by a plant, including nitrogen, magnesium, calcium, phosphorus, and iron. The halal organic fertilisers produced from halal food waste are then sufficient to swap out nutrients for plants to grow on their own. It can also be used as an additional fertiliser to improve the health of plants naturally. Food waste was composted by microorganisms, which resulted in the creation of microbial fertilisers with a wide range of nutrients that can enhance soil quality and production (Sun, et al., 2021).

Table 2. Nutrient analysis of Bird's Eye Chilli Plants

Identification	CBF	CBS	Acceptable Range
Total Nitrogen - N %	4.27	1.19	3.5-5.0
Total Potassium - K %	1.96	2.16	3.0-5.5

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Total Magnesium - Mg %	1.00	0.182	0.25-1.2
Total Calcium - Ca %	13.70	0.206	1.0-3.5
Total Phosphorus - P %	0.318	0.204	0.3-0.6
Total Iron - Fe ppm	177	181	60-300

Therefore, it is reasonable to introduce or advocate turning kitchen waste into halal organic fertiliser based on observation and nutrient analysis. All halal food, including leftover vegetables, fruits (including banana peels), bread, processed foods, dairy products, eggshells, tea bags, coffee grounds, and animal-based products in small amounts, such as meat, sausages, cheese, small chicken bones, small nutshells, and single-use items marked as "biodegradable" or "compostable," can be composted to cut down on waste. Organic waste that has been composted is a beneficial amendment for soil sustainability and crop productivity (Galsim, et al., 2021).

Plants will eventually require more nutrients, such as NPK, to meet demand (Fernández-Delgado, et al., 2022). However, excessive or inappropriate chemical fertilisation of crops results in the negative environmental effects of inorganic fertilisers. Some negative effects include greenhouse gas emissions, eutrophication of surface waters, and excessively quick plant nourishment (Coskun, et al., 2017; Liang, et al., 2013; Walling & Vaneckhaute, 2020). Contrarily, some benefits of organic fertilisers include the increase in organic carbon in the soils and the gradual release of nutrients that are safe for plants (Sharma, et al., 2019). Consequently, there is a growing urgency to switch from inorganic to organic fertilisers.

Furthermore, according to Dariah et al. (2022), there is currently no explicit legislation in Brunei to regulate air emissions from industries, and enforcement efforts are primarily dependent on administrative orders, a code of conduct, and the management's good faith. The government should therefore emphasise the significance of waste and pollution control, particularly regarding water and air pollution in all sectors. Nevertheless, it makes sense to include composting of food waste as part of waste management in policy since doing so might minimise waste sent to landfills and reduce harmful carbon emissions.

Additionally, the COVID-19 pandemic event in 2020 demonstrated that this nation's key resource sectors can expand in the future (Dariah, et al., 2022). Foreign direct investment in the sectors of primary resources and production for food security is encouraged by current government policies. According to Brunei Darussalam's Vision 2035, this will help the country attain economic sustainability (Dariah, et al., 2022). As a result, composting household trash encourages individuals to engage in home gardening or urban farming, as His Majesty suggested in a speech at the inauguration of Majlis Ilmu in honour of His Majesty's 72nd birthday; *"Agriculture, it needs to be explored by anyone. It is not limited to those who own hundreds of hectares of newly planted land, but people can also plant in the courtyards of their homes or in pots to produce, such as vegetable trees and peppers likewise. ... We must also contribute to greening the earth. The green earth is a symbol of sustenance"* (Pelita Brunei, 2018).

CONCLUSION AND FURTHER RESEARCH

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In this study, organic fertilisers made from waste materials such as food scraps from households are evaluated for sustainability. The scenarios are based on the composting process of aerobic degradation and the transformation of food waste into organic fertilisers. The study thus serves as a foundation for recycling organic waste and shows the practicality of making fertilisers from organic food waste.

To meet the aim, set by Sustainable Development Goal (SDG) Goal 13 of the United Nations, it is envisaged that waste management will be able to reduce per capita food waste at the retail and consumer level by half by 2030. In light of Islam's emphasis on maintaining personal cleanliness at all times, composting can help reduce food waste at home, keep the environment clean, and promote self-discipline and awareness of the harm that food waste causes to the environment. Islam forbids wasting any resources, including money, time, energy, food, and wealth, in all facets of life. Furthermore, reducing food waste is crucial to attaining sustainability.

Composting also prevents us from paying for a private garbage truck and saves governments money by preventing the importation of pricey chemical fertilisers, which saves us money, time, energy, and food. This is so that plants can benefit from the compost's high-nutrient fertilisers, which give fruits and vegetables a nutritional boost. Hence, controlling food raw materials such as vegetables and plants might guarantee that the food we produce is halal and thayyiban as we handle and manage the process of ingredients from 'farm to fork'. As a result, eating Halal and Thayyiban cuisine can help us stay healthier because it is good for both our bodies and minds and spirits.

Future research might evaluate the nutrient analyses of various compost fertilisers using selected food wastes from university cafeterias or restaurants. Future research should also examine how well-informed stakeholders are about food waste.

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