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ChaCO-Ban: The Revolutionary of Eco-Charcoal Utilising Kitchen Food Waste

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ABSTRACT

The heavy reliance of traditional charcoal is worrying as this will continuously cut down the mangrove trees for its production. Major mangrove deforestation had affected not only the environment but also the socio-economic of the local community. To date, there have been several attempts to produce eco-friendlier charcoal (biochar). These studies had amplified from producing biochar for combustion into many other functions such as soil nutrients, carbon dioxide removal, catalysts and others. The aims of this study are to produce a biochar from the biomass domestic kitchen food waste (banana peel and orange peel) with minimal cost. Previous biochar production needed to use pyrolysis but this study used a domestic oven in order for the public to replicate this at home. This will not only be reducing the food waste in the landfill but also minimise the cost for charcoal production. To sum up, this study gave an early conclusion that biochar can substitute traditional charcoal for combustion and more studies needed to verify the usage of biochar for other purposes.

Keywords: Biochar; food waste; orange peel; banana peel

INTRODUCTION

Traditional charcoals are widely used global wide. They are traditionally made of mangrove trees. There are many advantages of using mangrove trees as the sources of charcoal such as long burn times, less smoke and low spark [5]. Most importantly, they are odourless. These made mangrove trees as the most suitable source for traditional charcoal [6]. However, there are many bad effects from using the traditional charcoal. One of them is degradation of mangrove areas [6]. Other than holding many important species, mangroves act as important wave breaker to protect the shoreline from soil erosion & maintaining water quality [7]. Continuing using mangrove trees as charcoal sources seemed to be disadvantageous as this is not sustainable. Prolong use of mangrove as charcoal had led to mangrove clearing in certain areas such as in Indonesia [10], Sri Lanka [9] and Malaysia [11]. This had caused soil erosion which will lead bigger cause. Biodiversity disruption is not the only effect caused by the deforestation, but also the gas emission will cause an adverse effect on air pollution. Commercial charcoal had proven to emit harmful substance such carbon dioxide, carbon monoxide, formaldehyde and acetyldehyde. Some emissions are mutagens such as formaldehyde (associated with nasopharyngeal tumours) and acetaldehyde.

Charcoal is not restricted for combustion only. There are many other functions of charcoal such as, act as catalyst, removal agent of phenol compound in water bodies, supplemented into domesticated animal’s feed, whitening agents and bacteriological adherent for biomethanation of organic waste [13]. Apart from that, biochar (charcoal which is made from plant biomass) is widely used in agricultural industries such as for fertility of lands and able to act as precursor for adsorbents in treating the water [2]. Hence it is very important to study more about the usage of biochar in daily life. The escalating demand in biomass energy had urge for more research on charcoal, preferably in producing eco-friendlier biochar. Thermogravimetric analysis (TGA) can be analysed in order to study this.

There are several points of view that needs to be look closer in substituting traditional charcoal into biochar. Some of them are the emission of carbon monoxide (CO), nitric oxide (NO) and hydrogen sulphide (H_2S). Other than that, the amount of heat energy released is important especial if the biochar is designed to be used as combustion fuel. Charcoal in general is produced by pyrolysis which requires expensive equipment. Furthermore, this cannot be done at home. This is not parallel to the concept of self-sufficient.

Second issue is the food waste generated all around the world. Food waste generated in Malaysia alone comprised of 44.5% out of 38, 142 tonnes of total waste per day in 2018 [8]. Rice contributes the most in the food waste. Many ways to avoid the food waste, either by prolonging the food shelf life by fermentation [14] or processing the food waste into something new to avoid getting the food waste at the landfill. This food waste biomass still contains a lot of energy left which and therefore should not be neglected carelessly [3]. Food waste should be converted into other energy-rich product such as energy pellet biochar, fuel and other products owing to their unique properties [1].

To date, there are several attempts of research in substituting traditional charcoal into eco-friendlier ones such as cellulose extraction from banana peel, faecal-sawdust char and bamboo. All of these, either utilising waste or using more sustainable resources such as bamboo. These made better alternatives than the traditional charcoal. Hence, this study aims to produce biochar utilising the kitchen food waste with low cost of production (oven) rather than pyrolysis. This is the novelty of this study. Later, the decomposition of the biochar is tested using TGA.

INNOVATION DEVELOPMENT

Preparation of raw materials

This study replicated methods listed by [12]. Orange and banana peel were collected from the local restaurants and stalls nearby Kuala Nerus, Terengganu. In the previous study, there was only one alternative biochar tested with a mix of both banana peel and orange peel. No biochar produced testing using a single material (either banana peel or orange peel alone). This study produces three biochar with 1) orange peel alone, 2) banana peel alone and 3) both orange and banana peel at specific ratio. The ratios are as shown as in Table 1.

A few other trials utilizing other kitchen food waste had been tested, however we found them as not suitable candidates for biochar. It is the coconut dregs. Coconut is one of the main food items use in common kitchen in Malaysia, mainly for the coconut cream. The coconut dregs (the leftover after straining the cream) are considered as waste. Other than that, this study also had tried using the sugar cane fibre collected from the street stall hawkers selling sugarcane juice. However, we noticed that the biochar produced did not produce flame like the successful samples did (orange peel and/or banana peel). Hence, we excluded coconut dregs and sugarcane fibres from the studies.

Table 1: Composition of substance within tested biochar [12].

Sample	Percentage of the substance (%)					
	Orange peel	Banana peel	Paddy husk	Sand	Tapioca flour	Commercial charcoal
1 (orange and banana peel)	24	24	50	0.4	1.6	-
2 (banana peel alone)	-	48	50	0.4	1.6	-
3 (orange peel only)	48	-	50	0.4	1.6	-
4 (traditional charcoal)	-	-	-	-	-	100

Banana and orange peels were cleaned under tap water before kept dried in a 140 °C oven for 24 hours [3]. The samples are mixed according to Table 1 and shaped using mould. The samples are tested for TGA first. Later, they are burnt in a 200 °C oven for 2 hours to produce the biochar. Traditional method is using pyrolysis which needs expensive equipment. Other analysis such as EDS, SEM image, are not included here as it will produce the same results as [12]. This is the continuity of the experiment from [12].

Proximate analysis by using Thermogravimetric Analysis (TGA)

Proximate analysis was carried out by a thermogravimetric analyser-before turn it into biochar [3,4]. TGA is important to study the biochar's thermal stability by measuring the weight loss of the sample over increasing heat at a constant rate. The weight loss is determined by fractions from the moisture content, into volatile matter, carbon and ash content. Around 20 mg of sample were heated at 30 °C to 100 °C to remove the moisture out of the samples. Later, the decomposition at 600 °C were carried out for 7 minutes. The heating rate is 10 °C/min from 25 °C to 700 °C under an N2 atmosphere (100 ml/min). This slow heating rate is to ensure the evenness in terms of heating distribution between particles. This is to identify the content of volatile matters such as silica etc. From 600 °C, the samples are later heated gradually until 800 °C until its weight remained. This remaining was the ash residue.

COMMERCIAL POTENTIAL

This product is suitable for domestic level in practicing zero waste lifestyle. Previously, zero waste practitioner had implemented composting to reuse the kitchen food waste or fermenting the fruits to lengthen the shelf life of the fruits. Today, everybody can convert their food waste into biochar as we propose a method of producing biochar using a domestic oven. We can reduce the reliance of landfill as this waste can be reuse. Apart from that, biomass food waste, it dumped in the landfill can release the greenhouse gases which later contributes to the global warming. If they were reused properly, we can mitigate the adverse effect from the global warming. Certain industries as well can produce money from this effort and request the public to donate the food waste for further processes. The total cost for a 27 cm^3 of ChaCO-Ban can cost about RM 1.05. With a selling price of RM1.50, we can have a 43% profit. Furthermore, our product had obtained an IP number (LY2020003882).

CONCLUSION

This study lacks many analyses for other usage of biochar. Future studies should study the physical properties of the biochar such as porosity, water retention capability, electrical conductivity, size and shape of the particles. Electrical conductivity is determined by the salt content of the biochar and to extrapolate, plants' ability to absorb water is related to the salinity. Apart from that, chemical properties such as pH value, buffer capacity. Lastly, properties related to environmental protection is also important as this will involve the permitted and prohibited heavy metal content within the biochar. It is very important as this may affect the performance in agriculture. A good biochar will encourage the earthworms to reside and the germination of the crop such as lettuce.

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