Assessing the Potential to Produce Shoe wax using Agricultural Waste Bio char as an Additive

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Abstract
Huge amounts of agricultural waste are being generated daily in Sub Saharan Africa and are being left to rot resulting in the emission of greenhouse gases such as carbon dioxide and methane into the environment and eventually climate change effects. In this study, agricultural waste was converted to bio char and its potential to be used as an additive in shoe wax production evaluated. Slow pyrolysis of the agricultural waste was done at 400 °C for 3 hours resulting in a bio char yield of 65%. This bio char was added with beeswax in the ratio 1:1 to result in a shoe wax. The produced shoe wax physiochemical properties compared very well to the standard shoe waxes available on the market. This study revealed that agro waste bio char can be utilized as a raw material in organic shoe wax production.

Keywords: Agricultural waste, bio char, pyrolysis, shoe wax

1. Introduction

Sub Saharan Africa as an agro-based region generates huge amounts of agricultural waste, which if not managed properly have the potential to generate carbon dioxide and methane emissions resulting in climate change effects (Visvanathan, 2010). This agricultural waste has the potential to be converted to bio char through pyrolysis. Several studies have been done on bio char and concluded that bio char has several applications including briquettes production, soil conditioning, application in water treatment as well as biogas production (Schmidy, 2012). Bio char is produced by several methods including fast pyrolysis, slow pyrolysis and hydrothermal carbonization as indicated in Table 1.

Table 1. Bio char production processes (Mayhead *et al*., 2011)

Pyrolysis type	Terms used	Temperature (°C)	Residence time	Products
Slow	Charcoal making, Carbonization	300-400	Hours-days	Bio char
Mild	Torrefaction, Torification	200-315	5-30 minutes	Bio coal
Fast	Fast pyrolysis Flashy pyrolysis	400-600	1 second	Bio oil Bio char Gases

However slow pyrolysis is recommended due to the high yield of bio char obtained.

The schematic diagram for bio char production from agro waste is indicated in Figure 1.

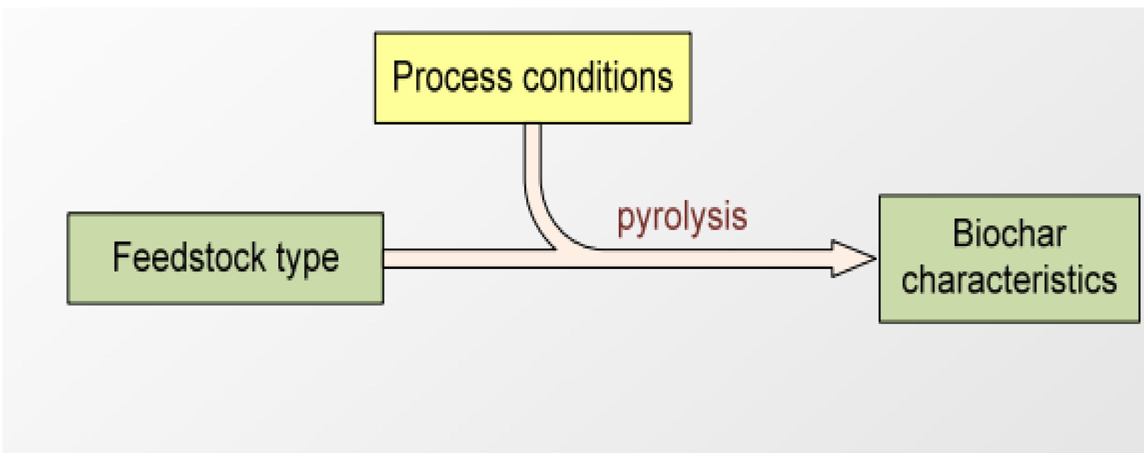

Figure 1**.** Bio char production pathway from agro waste (Ronsse *et al*., 2013)

Despite the several applications bio char has, there is still a need to investigate its potential to be used in organic shoe wax production, a product which is required on a daily basis. Shoe wax refers to various formulations containing components of waxes, solvents and dyes (Cifuentes and Greenleaf, 1991). This study focused on the production of an organic shoe wax that utilizes agricultural waste bio char as a major source of raw material using Beeswax as an additive in a bid to promote sustainable development and mitigate climate change.

2. Experimental

2.1 Materials

A blend of shredded agricultural waste which included corn silage, wheat straw and sawdust was used to make bio char. Beeswax was obtained from a local supermarket. Pyrolysis was conducted in a 1L lab-scale reactor.

2.2 Methods

Bio char production

The bio char was prepared in accordance with a method described by Jindo *et al*. (2014). Bio char was produced through pyrolysis at 400 °C for 3 hours under atmospheric pressure. The bio char was ground to a fine powder of particle size of <0.4 mm measured through sieve analysis. The bio char had a yield of 65% and was calculated according to Sadaka et al. (2014). The bio char density was measured by standard methods.

Figure 2. Bio char used as an additive in shoe wax preparation

Shoe wax preparation

A sample of 200g of beeswax was heated slowly to melt it. Bio char of equal amounts was slowly added. After that, a wax was formed and allowed to cool at room temperature. The melting point, pour point, viscosity, density and relative density were measured using standard methods as described by Ameh (2011).

3. Results and Discussion

3.1 Bio char characteristics

A bio char yield of 65% was achieved after slow pyrolysis. The bio char was ground to particle size of <0.4 mm and had a density of 0.8 g/cm^3.

3.2 Shoe wax characteristics

The shoe wax had an average viscosity of 2.2 centipoise measured at 45 °C. The characteristics of the shoe wax are given in Table 2. The organic shoe wax characteristics compared very well to the conventional shoe wax. The melting point of the organic shoe wax had a difference of <12 °C in comparison to the standard shoe wax on the market. The pour point of the organic shoe wax also compared very well to the conventional shoe was as reported by Ameh (2011). The organic shoe wax and the conventional shoe wax had the same densities (Table 2).

Table 2. Shoe wax characteristics

Parameter	Organic shoe wax	Conventional shoe wax (Ameh, 2011)
Melting point (°C)	27	32-39
Pour point (°C)	-9	-7 to -5
Density (g/mL)	0.62	0.62
Relative density	0.62	0.62

4. Conclusion

The production of bio char from agro waste can be used as a waste management strategy. Agricultural waste bio char poses as a raw material for natural shoe wax production. In addition to having the same characteristics as shoe polish already on the market, bio char shoe polish stands out as an attractive product due to the natural ingredients utilized.

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