Available online at www.sciencedirect.com

ScienceDirect

Procedia Food Science 6 (2016) 97 – 102

Procedia Food Science

International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015)

Ascertaining of optimum pyrolysis conditions in producing refuse tea biochar as a soil amendment

H.A.H.I. Amarasinghe[a]*, S.K. Gunathilake[a] and A.K. Karunarathna[b]

[a]*Department of Natural Resources, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, P.O.Box 02, Belihuloya.*
b Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Peradeniya.

Abstract

Refused tea is a waste product of tea processing. Manufacturing of biochar from organic waste is an emerging technology where biochar can be used as a soil amendment for environmental remediation and carbon sequestration. As such the aim of this study was to determine the optimum pyrolysis conditions in producing refuse tea biochar for the said uses. Three refused tea samples were collected randomly from the bulk from tea processing factory in Gampola area of Sri Lanka and basic physical and proximate analysis were done. Initially, refused tea was packed tightly in the pyrolytic reactor which was designed to pyrolysis refused tea and pyrolysis was carried out by using five combinations of temperature (300, 350, 400, 450, 500 ^{o}C) and four retention times (15 min, 30 min, 45 min and 1 hour). The physical and chemical characteristics of biochar were analysed in line with the biochar quality standards proposed by International Biochar Initiatives (IBI). Results showed that the yield of biochar varied with the residence time for a given temperature treatment. The chemical, physical and morphological properties of biochar are largely influenced by the residence time for a given temperature treatment. Temperatures between 450^{o}C and 500^{o}C, and residence time between 45 and 60 minutes showed the highest biochar mass recovery. This research revealed that refuse tea can be effectively converted to biochar between 450 to 500 oC temperatures subjected to a residence time of 45 to 60 minutes. It also showed that higher volatilization rates at optimum temperature and residence time combination can be positively used for up scaling the pyrolysis reactor.

Peer-review under responsibility of International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015).

* Corresponding author. Tel.: +9 477 974 4574.
E-mail address: hemaliamarasinghe@gmail.com

Peer-review under responsibility of International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015).
doi:10.1016/j.profoo.2016.02.021

Keywords: Biochar; Pyrolysis; Refuse tea

1. Introduction

In agricultural eco systems, intensive farming has been focused mainly on monocultures required of considerable amounts of inorganic fertilizers. Nutrient cycles often go into imbalanced situations when high amounts of inorganic fertilizers are used. To counter-balance such it would be an appropriate the practice of blending with organic fertilizers or/and innovative raw materials such as refused tea bearing organic nature.

Handling and disposal of absolute refuse tea (ART) are worldwide constraints in the tea industry. Therefore a significant number of research studies have been conducted to examine the potential of absolute refuse tea for soil fertility improvements as well. Pyrolizing of refused tea for energy recovery and biochar producton are emerging technologies. Development of high quality biochar using tea refuse has been proposed as one of the alternative way of resource recovery and safe disposal. Biochar is a carbon rich product obtained from thermal decomposition of organic materials in absence of oxygen[1].

Researchers have shown that addition of biochar to soil reverses soil fertility decline, improve crop yields, and improve plant response to fertilizer[2]. It has also been suggested that biochar may have the potential to reduce leaching of pollutants from agricultural soils. This property of biochar is explained by the strong adsorption affinity of biochar for soluble nutrients such as ammonium[1], nitrate[3], phosphate and other ionic solutes.

The aims of this study are to (i) determine the optimum material handling and material mass balance for slow pyrolysis of refuse tea (ii) determine the optimum thermal conditions for slow pyrolysis of refuse tea (iii) characterize biochar produced according to the guidelines/test categories of International Biochar Initiatives (IBI).

2. Methodology

Quality of the produced biochar and the performances of the reactor were analyzed at Soil and Water Engineering Laboratory, Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Sri Lanka.

Three Absolute Refuse Tea (ART) samples were collected randomly from the bulk from a black tea post-processing factory in Gampola area. The heating energy required to achieve higher temperature to produce biochar from refused tea were given by placing the pyrolytic reactor in a Muffle furnace, type 6000 - model F 6018. The reactor was consisted of following components as shown in figure 1.

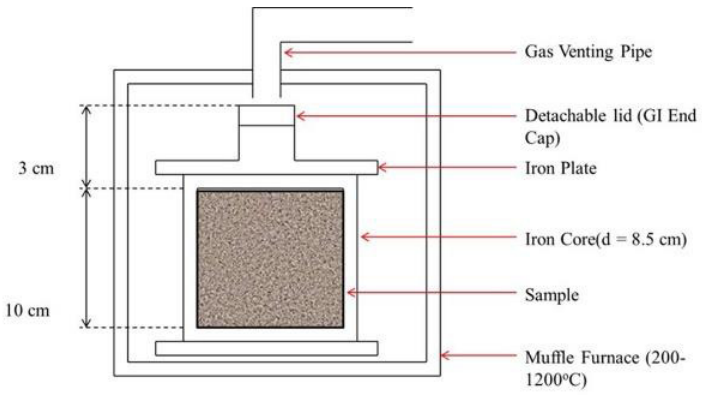

Figure 1: A schematic diagram of the reactor

Refuse tea was packed tightly in the pyrolytic reactor by compressing, minimizing amount of air entrapped in the reactor. Then, the lid was placed on the top and tightened to avoid air exchange between in and out. Once the