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Treatment of smuggled cigarette tobacco by composting process in facultative reactors

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A B S T R A C T

This paper presents a study on the degradation of smuggled cigarette tobacco combined with domestic organic waste and sawdust or wood chips, using facultative reactor. Four reactors with different amounts of residue were assembled. For the study of the quality of the compost obtained, physicochemical, phytotoxicity and microbiological analyses were carried out. The mixture with wood chips presented the best temperature conditions and pH variation optimizing the degradation. The final germination index (GI) values of all treatments were above the recommended GI value (50%) and the final C/N ratio between 8 and 13 indicated a mature compost. The concentration of metals under study was below the limit allowed for the commercialization. The composting carried out in all facultative reactors provided ideal conditions for the total sterilization of the final compost. Therefore, the treatment of smuggled cigarettes through facultative reactors was efficient to produce stable and mature compost.

1. Introduction

Considering the increasing generation of organic waste, a great volume of tobacco residue is produced during and after the tobacco plant harvest up to its processing in the cigarette industry (Ćosić et al., 2012; Liu et al., 2015; Silva et al., 2016a,b). In addition, significant quantities of smuggled cigarettes are seized annually all over the world generating tons of waste.

The seizure of smuggled cigarettes is estimated to have reached 600 billion units in 2015 (BAT, 2015). In Brazil, the volume of smuggled cigarettes sized has increased lately reaching over 14 billion cigarettes in 2015 and 18 billion units in 2016 (BFR, 2016). Such a high number of seizures turns this material into an environmental liability, which requires proper treatment. Up to now, the most used treatment is incineration (Portal Planalto, 2015; Silva et al., 2016a,b). The process of incinerating cigarettes is not the best alternative, since it results in emissions of CO_2 and other toxic substances such as: ammonia, phenol acetate, aromatic polyhydrocarbons, among others (Eldridge et al., 2015; Novotny and Slaughter, 2014).

Tobacco is an organic residue, which can be treated and transformed into a compost of commercial and agricultural interest (Szwed and Bohacz, 2014; Wu et al., 2015). Moreover, the mature compost can promote nitrogen immobilization in the soil, reducing NH_4^+ and increasing NO_3^- (Cayuela et al., 2009). The composting of organic waste through piles is considerably developed and studied, being widely reported in the literature (Bernal et al., 2009; Fialho et al., 2010). However, studies on composting in reactors from the technical and scientific viewpoint are scarce (Hu et al., 2009; Iyengar and Bhave, 2006; Kopčić et al., 2014).

The composting in reactors is a promising technology, when compared to conventional technologies of open systems such as windrows and presents advantages, since it does not require revolving the composting mass and provides sufficient aeration to the mixture (with or without mechanical injection of air) to produce mature final compost (Campos et al., 2014). Also, it provides the control of physical and chemical parameters such as temperature and moisture, and can be used in different climatic seasons (Campos et al., 2014; US.EPA, 2016).

Composting in reactors is an efficiency technology when compared to the anaerobic digestion or incineration, for resulting in

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compost able to improve the physical and chemical conditions of the soil, preventing the emission of greenhouse effect gases (CO_2, NO, CH_4) and provides the control of leachate and of odor (Campos et al., 2014; US.EPA, 2016; Gutiérrez et al., 2017). Some research has demonstrated that tobacco waste originated in cigarette factories (powder, leaves, stems, residue, etc.) can be composted through reactors (Briski et al., 2012; Kopčić et al., 2014, 2013).

However, no research presents data on the treatment of tobacco used to produce smuggled cigarettes. Due to the lack of quality in irregular factories, smuggled cigarettes are highly harmful to the human health and the environment, with excess of toxic substances such as: cyanide, ammonia, arsenic and heavy metals (Shen et al., 2010; Silva et al., 2016a,b, 2014). Therefore, this study main aim was to verify the viability of treating smuggled cigarette tobacco through facultative reactors by adding four different combinations of waste materials (smuggled cigarette tobacco, domestic organic waste, sawdust and wood chips) and to evaluate chemical and biological parameters in the maturity of the composts.

2. Materials and methods

2.1. Assembling facultative reactors

Four facultative reactors were prepared (R1, R2, R3 and R4) (Fig. 1), made of bronze metallic alloy (Cu/Zn) with a cylindrical vertical shape, 570 mm diameter, 870 mm height, volume around 240 L and 120 mm from the lid height. In the system, the oxygen flow occurred through 120 holes of 1.0 mm each distributed symmetrically on the lid (Campos et al., 2014). The four facultative reactors have the same structure and dimensions.

2.2. Experiment

The reactors were filled with smuggled cigarette tobacco residue smuggled cigarette tobacco (SCT), domestic organic waste (DOW), sawdust (Sa) and wood chips (WC). The waste of DOW and SCT was shredded to achieve between 1 and 30 mm particles size for better aeration and moisture control. The residue was homogenized and distributed in layers in the reactor. The filling was carried out daily and homogeneously for 4 weeks and the mixture was matured. The material was analyzed in different phases through physicochemical parameters (temperature, pH, C/N ratio), heavy metal concentration, germination index and pathogenic microorganisms. The idea was to have an aerobic type reactor initially, which would eventually become anaerobic at the bottom layers when the depth of load increased. If the top layers were aerobic, they would contribute to capture odorous compounds and also to accelerate the compost stability via nitrification of the system (Campos et al., 2014).

The facultative reactors provide controlled conditions of temperature, moisture, homogenized mixture and aeration during the process, without requiring air injection or shaking the mixture (Campos et al., 2014). The waste material initial characterization is given in Table 1.

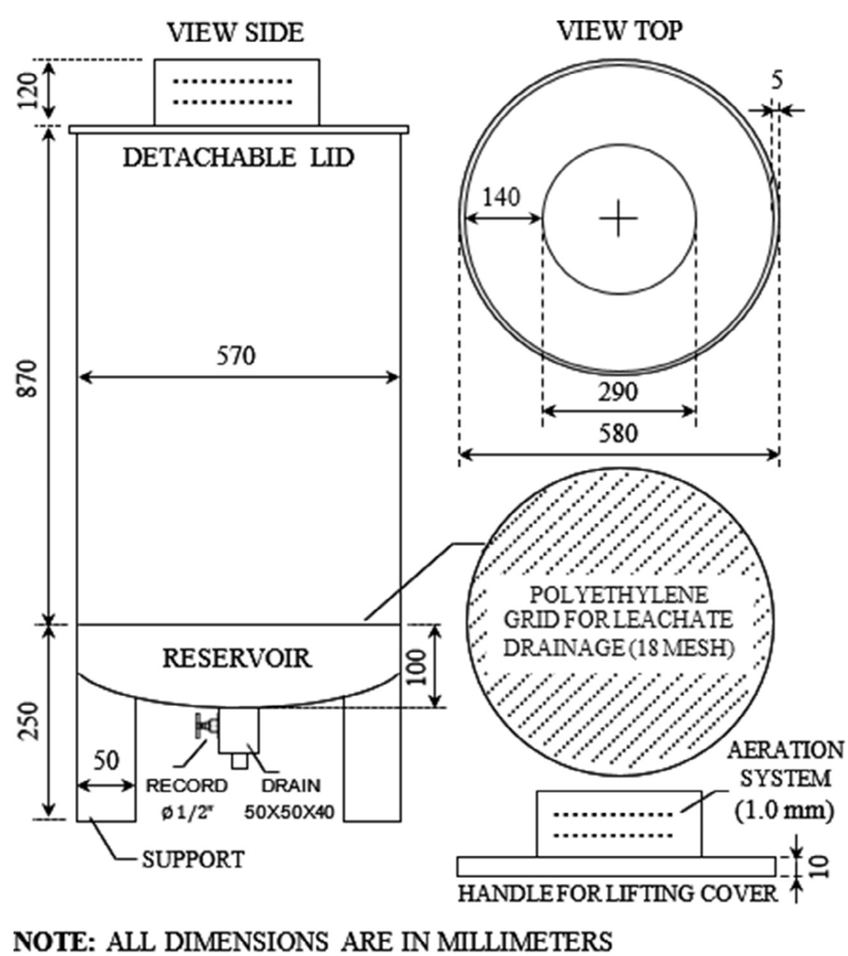

Fig. 1. Facultative reactor.