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Determination of Exhaust Gases during Composting of Agro-Industrial Waste in a Closed Reactor

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Extended Abstract

Industrial solid or liquid wastes contain considerable amounts of organic matter. Tobacco and winery waste are generated during different processes of the tobacco and cigarette production cycle and production of wine, respectively. Tobacco solid waste mostly contains tobacco particles and flavouring agents while winery waste contains mostly stalks, skins and seeds. The main characteristics of tobacco waste are lower C/N ratio and high content of toxic nicotine. To the contrary of the tobacco waste, grape waste have higher C/N ratio, lower pH value and often shows a strong phytotoxicity, which can be attributed to the presence of significant concentration of organic acids and ethanol. Tobacco and winery waste are classified as agro-industrial waste and as such can be decomposed by composting.

Composting is an environmentally friendly and effective process to treat or manage organic wastes. It is a self-heating aerobic process and under optimal conditions biodegradation of organic waste material proceeds through three phases: an initial activation phase, followed by a thermophilic phase characterized by a rapid temperature increase, and a final mesophilic phase where the organic mixture cools down to ambient temperature.

Composting releases to the atmosphere heat, CO_2 and water vapour while converting organic matter into a soil amendment. However, composting can also generate volatile organic compounds, ammonia (NH_3), carbon monoxide (CO), nitric oxide (NO), N_2O and CH_4 which have negative impact on the atmosphere. Carbon dioxide (CO_2) is a greenhouse gas with the largest impact on climate changes, while ammonia is one of the main compounds responsible for generation of offensive odour and atmospheric pollution when composting organic waste with high nitrogen content. Several factors such as C/N ratio, temperature, mixing and turning, and aeration rate can influence the volatilization of ammonia during composting.

The objective of this work was to determine amount of carbon dioxide and ammonia in the exhaust gases during composting of tobacco and mixture of tobacco and winery waste. The composting experiments were conducted in a closed thermally insulated column reactor with effective volume of 10 L. The reactor was operated at an airflow rate of 0.66 L/min $kg_{volatile\ solids\ (VT)}$ and the temperature was monitored by thermocouples connected to the data logger during the 21 days. Condensate and exhaust gases were collected in volumetric flasks, ammonia was trapped in boric acid solution and carbon dioxide in sodium hydroxide solution. In samples of composting material taken periodically from reactor were determined moisture content, volatile solids, pH value, total Kjehldal nitrogen and number of mesophilic and thermophilic bacteria and fungi.

The growth of both the mesophilic (20-45^oC) and thermophilic (45-70^oC) bacteria and fungi, at various stages of the composting process of tobacco waste and tobacco and grape waste, was determined. The microbial species involved in the degradation of the substrate and their number has been changing with the change of the temperature in reactor. Bacteria are mostly responsible for the initial phase of the composting process because they consume the available soluble nutrients and produces metabolic heat. From obtained results the number of mesophilic and thermophilic fungi in composting mass of tobacco

and grape waste was higher than in composting mass of tobacco waste because grape waste initially contained a high concentration of simple organic compounds such as fruit sugar. Further, the initial pH value of tobacco waste and of tobacco and grape waste was 6.5 and 5.3, respectively, which was adequate for fungal growth. Fungi are generally more tolerant to acidic environment and less tolerant to temperatures above 35-40^{o}C than bacteria, and therefore they are an important group in the early phase of composting.

It was found that the highest emission of carbon dioxide was at thermophilic phase while emission of ammonia mainly depended on pH value of composting mass and at pH 9 it was detected in exhaust gas. The cumulative evolved CO_2 during 21 days of composting of tobacco waste and mixture of tobacco and grape waste was 94.01 g CO_2 kg_{VS}^{-1} and 208.18 g CO_2 kg_{VS}^{-1}, respectively, and evolved NH_3 of tobacco waste and mixture of tobacco and grape waste was 504.81 mg NH_3 kg_{VS}^{-1} and 122.45 mg NH_3 kg_{VS}^{-1}, respectively.