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STUDY ON THE GREENHOUSE GAS EMISSIONS OF ALGAL BIOMASS AS GREEN WASTE LANDFILL

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Introduction

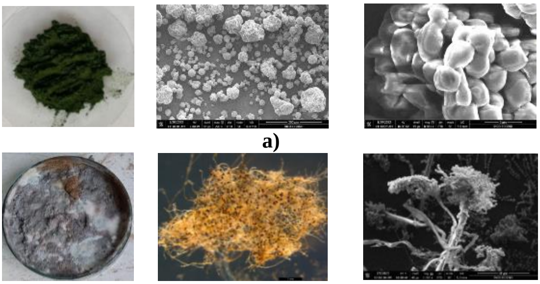
Landfill gas (LFG) is a natural by-product of the organic materials decomposition in landfills. LFG is generally composed of methane, carbon dioxide (CO_2) and small amounts of non-methane organic compounds with methane being a greenhouse gas, more efficient than CO_2 in trapping heat in the atmosphere over long periods, according to the latest studies. Recent evaluations show that methane emissions from municipal waste deposits represent approximately 2% of the total greenhouse gas emissions in the atmosphere. At the same time, methane emissions from municipal landfills represent a lost opportunity to capture and use a significant energy resource.

Microalgae are microscopic organisms found in both seawater and freshwater. They can provide a cost-effective approach to remove inorganic nutrients and contaminants from wastewater while producing valuable biomass (carbohydrates, proteins, lipids and pigments). At the same time, at their end of life, microalgae become waste that, stored in open spaces, can produce gases with greenhouse effect. Assessment of landfill gas emissions from organic substrates is essential for performing a life cycle analysis and greenhouse gas (GHG) emissions. In a desirable configuration of landfill management system, GHG emissions may be reduced compared to conventional waste disposal, when both active GHG collection and energy production are considered. The proposed study aims to evaluate the gases emitted by *Chlorella vulgaris* algal biomass with 50% humidity during a 45 days timespan. The samples were placed at room temperature in a closed 125 L bioreactor with IoT system to monitor various physical-chemical parameters. Thus, relative humidity, temperature and concentrations of CO_2, O_2, methane, tVOC (total volatile organic compounds), and ozone were monitored continuously. The aim is to evaluate the gases and the behavior of algal biomass as a greenhouse gas emitter under conditions of storage in spaces whose temperature is between 17-21 °C and the relative humidity of the air is between 20-60% RH. The gas sources of algal landfilling are the degradation processes of the organic substrate and the development of microorganisms on the biomass. The process of algal biomass decomposing leads to release of GHGs in different ratios depending on the temperature and the storage conditions.

Materials and methods

Chlorella (*Chlorella vulgaris*) powders were purchased from local suppliers (Rawboost Smart Food SRL Romania). Deionized water (< 0.1 μS·cm^{-1} @ 25°C) was used for all the experiments. Chlorella biomass samples with 50% humidity were introduced into a closed poly(methyl methacrylate) bioreactor with a capacity of 125 L. The non-sterilized storage space had transparent walls and was illuminated according to the night-day cycle, the temperature maintained in the range of 17 – 21 °C (room temperature). The sensor platform was made of humidity, temperature detectors, and gas sensors for the qualitative / quantitative detection of the following gases: CO_2, O_2, O_3, total volatile organic compounds (tVOC), and CH_4.

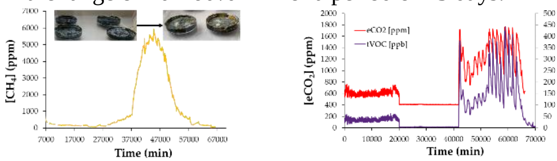
Results and conclusions



a) b)

Fig. 1. *Chlorella vulgaris* biomass from the storage space: a) the initial stage of the powder introduced into the bioreactor (SEM images), b) *Chlorella vulgaris* biomass at the end of the 45 days of storage (confocal microscopy and SEM image)

In the transparent box the algal biomass benefits from the light according to the night-day cycle, while the temperature was maintained in the range of 17 -21 °C and the relative humidity was in the range of 20 - 60% RH for a period of 45 days.



a) b)

Fig. 2. *Chlorella* biomass landfill gases: a) methane, b) CO_2 *vs.* total volatile organic compounds

From the response of gas sensors we can distinguish two stages of algal biomass transformation: the first stage, which coincides with the first two weeks of storage in the box with sensors, and the second stage, starting with the third week of storage, large variations in gas concentrations are recorded, these values being correlated with the development of fungi on the algal biomass.

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