INTRODUCTION

Today, the most urgent environmental problem is global warming, the main challenge in the waste management sector being waste avoidance. Solid waste management, especially the organic fraction, has become one of the major challenges of the 21st century from an economic, social and environmental protection point of view (Fernandez et al. 2016). Organic waste, such as agricultural and forestry residues and municipal solid waste, has become a major issue in both developed and developing countries (Rashad et al. 2010). Waste treatment involves all the chemical, physical and biological processes which have the role to modify certain features of the wastes in order to reduce their volume and hazardous character, thus facilitating their recovery (Căpățână & Simonescu 2006). According to Eurostat statistics, at the level of EU member states, 15% of the municipal wastes generated by one person in 2013 were treated by composting (http://ec.europa.eu/eurostat).

Among the methods of biological waste treatment, composting is the simplest and most efficient technology for treating the organic fraction. Composting can be defined as an aerobic process of biochemical decomposition of organic matter resulting in a stable product without pathogenic germs that can be used in agriculture (Haug 1993; Zhang & Sun 2014). The substrate used in the composting process consists of different sources of organic waste, such as: biodegradable waste collected from dwellings and households (kitchen waste, garden waste - cut grass, leaves, tree bark, debris from trimming trees and hedges, animal manure), residues from the processing of vegetables and fruits, residues from meat and fish processing, biodegradable municipal waste (sludge from wastewater treatment plants, newspapers, cardboard), waste from wood processing (sawdust, wood chips) and residues from agricultural crops (Francoü et al. 2005).

Transformation of organic matter during the composting process consists of two complex processes, namely: degradation and humification. Over time, special attention has been given to the humification process, especially the formation of humic substances (humic and fulvic acids), due to their efficiency in improving soil fertility and stimulating plant growth (Forbes et al. 2012; Zhao et al. 2016). During the first phase of the process, the simple organic carbon compounds are easily mineralised and metabolised by the microorganisms, producing CO₂, NH₃, H₂O, organic acids and heat. The optimum temperature range for composting is 40–65°C but temperatures above 55°C are required to kill pathogenic microorganisms. The temperature variation during composting plays an important role in the development of microbial communities. During the various stages of the biodegradation phase, the organic compounds are decomposed into CO₂ and NH₃ with O₂ consumption (Bernal et al. 2009). In Figure 1, it can be seen the temperature curve during the composting process.

Figure 1 – The temperature curve during the composting process (Bachert et al. 2008)

A – degradation; B – transformation; C – maturation

The pH level of the raw materials used in composting pile is also very important. The optimum pH range for microbial activity is between 6.5 and 8.0 (Graves et al. 2010). Water is another important parameter for the survival of composting micro-organisms. The moisture content of the compost pile fluctuates during the composting as water is lost in evaporation process. If the substrate subject to composting is too dry, sprinkling with water must also be ensured during the decomposition process (Paraschiv et al. 2017, Graves et al. 2010).

Aeration is another key factor in the composting technology. A correct aeration controls the temperature, eliminates excess humidity and CO₂ and provides the O₂ required for biological processes. Optimal O₂ concentration is between 15 – 20% (Bernal et al. 2009).
Maturation phase of substrate is the most important operation in the composting technique. The process is taking place in several phases and is decisively influenced by the composition, homogeneity and humidity of the organic substrate used and by the amount of air used in the decomposition process. The start-up phase of the maturing phase is the production of raw compost, the purpose of the operation being on the one hand ventilation and on the other hand the mixing of the raw materials at different stages of decomposition. In this phase, fresh compost is in a state of advanced decomposition, being semi mature. The mature compost is obtained after all organic components have been transformed into soil and humus aggregates, appearing in the form of black, loose and fine soil.

Properly storing the finished compost product is the final step of the composting process. The finished compost should be stored in a manner that prevents dust or odours from developing and prevents contamination of the product from weeds, leachate or other contaminants.

This paper was aimed to present the main composting methods used for organic waste treatment, namely: passive composting in piles, turned windrow composting, passive aerated windrows, aerated static pile and in-vessel composting.

MATERIAL AND METHOD
Composting methods differ in duration of decomposition, the potential for stability and maturity, depending on the type of substrate used (Mengistu et al. 2017). The main five methods of composting developed for use in large-scale are passive composting piles, turned windrow composting, passive aerated windrows, aerated static pile and in-vessel systems.

RESULTS
Passive composting pile is the simplest form of composting and does not require special equipment, being used in principle for composting the leaves. The compost pile should be periodically turned for determining the porosity of the substrate. Aeration is done by passive air movement through the perforated pipes placed in the porous layer (peat moss, straw or matured compost) at the base of the pile (Figure 4). The porous layer can have a height of 15-20 cm and a width of 3 m. The main feature of this porous layer is to allow a uniform distribution of air in the pipes, but also to insulate the pile, which will ensure the optimum temperature during substrate degradation. The top layer (aprox. 15 cm) consists of peat moss or matured compost, which has the role of retaining moisture and unpleasant odors released during the decomposition process (Graves et al. 2010; http://esrd.alberta.ca/waste/composting-at-home).

Aerated static pile is one of the most used methods for composting and can last from 3 to 6 months, depending on the substrate used (Figure 5). The main difference between passive aerated windrow and aerated static pile is that the aerated static pile uses blowers that either suction air from the pile or blow air into the pile using positive pressure (Stentiford 1996).
At the base of the composting pile there are located perforated pipes for aeration connected to blowers that introduce or suck air from the composted substrate. The pipes are covered with a porous material made of wood chips or straw to allow a uniform air distribution in the pile. The final coating layer (15 cm) of the compost pile is often made of mature compost or sawdust to absorb unpleasant odors and moisture (Graves et al., 2010; http://compostingtechnology.com/). In this case, the composting pile is not turned. The dimensions of such a compost pile are: height between 1.5 and 2.5 m, the width of 3 – 5 m, while the length of the pile is limited by the air distribution in the pipes, but it should not be more than 21 - 27 m.

In – vessel composting involves the closure of organic waste in a container. Composting process can be done in bins (Figure 6) provided with aeration systems similar to those of aerated static piles or in bins without aeration systems to which it is necessary the regular turning of the substrate in order to maintain the aerobic conditions (Graves et al., 2010).

CONCLUSIONS

Composting cannot be considered a new technology, but amongst the waste management methods it is gaining interest as a suitable option for organic waste with economic and environmental benefits. This process reduces the risk of spreading pathogens and weed seeds and the final product, called compost, can be used to improve soil quality and fertility.

Note

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