Impact of using additives in composting food waste

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Abstract: This research was focused onto food waste composting with some additives. It studies the impact of additive on the process of food waste composting. Additives used were sawdust and biochar. Composting samples were cooked potatoes, cooked rice and vegetables. The objective of this study was to compare 6 composts of different compositions. A–100% food waste, B–10% sawdust and 90% food waste, C–10% sawdust from rat's litter and 90% food waste, D–20% sawdust and 80% food waste, E–40% sawdust and 60% food waste and F–10% sawdust + 10% biochar and 80% food waste. The process of composting took 63 days and the composts were tested for physicochemical properties (temperature, pH, electrical conductivity) and biological properties (phytotoxicity test). The research results revealed that the concentration of 20% sawdust as additive was optimal for food waste compost because the compost exhibited the optimum pH and EC value, and the test of phytotoxicity proved the best results, too. The concentration of 20% sawdust was better than the concentration of 40% sawdust as the latter represented a large volume quantity.

Key Words: electric composter, indoors, sawdust, biochar

INTRODUCTION

The Food and Agriculture Organisation (FAO) said that more than billion tonnes of food are wasted each year. This number associated with food waste (FW), packaging and non-consumble material. The FW presented environmental risk mainly for the negative impact on the environment for the climate change (Morone et al. 2019). Many years ago, FW was disposed in incinerations or landfills. Nowadays, this situation has been changing in the world. Many countries decided for more sustainable methods (Cerda et al. 2018). The life cycle assessment studies showed that anaerobic digestion is the most environmental and economic method of waste disposal. The composting process is in second place before incineration or landfilling (Waqas et al. 2018). All of them comes from degradation biological wastes. The biogas is the final product of the anaerobic digestion. The biogas usually contains gases like methane, carbon dioxide and other gases (Cerda et al. 2018).

The composting process predominates anaerobic digestion for biological waste disposal. More than 90% of garden and FW is being changed into compost. The compost is part of circular economy because compost as a valuable fertilizer represents strategy between biological waste and sustainable agriculture (Razza et al. 2018). The quality of compost determines its application on the soil (Cerda et al. 2018). Compost properties depend on the source and composition of food. For the best properties, is necessary to comply with some criteria such as time, high temperature, pH value, CO_2 and O_2 (Cerda et al. 2018).

Food waste composting is a complicated process. Optimal method for utilizing food waste compost at the best is to use some additives (Kucbel et al. 2019, Maxianova et al. 2018). Possible additives are sawdust, biochar, zeolite, manure (Waqas et al. 2019, Sharma et al. 2018, Waqas et al. 2018). Sawdust is chosen for its ability to absorb moisture and reduce compost toxicity. The addition of sawdust minimizes nitrogen losses during the process and hence improved C/N ratio. Sawdust exhibits a great interaction with pH, total organic carbon and seed germination (Kebibeche et al. 2019). Biochar is produced from biomass by pyrolysis. The structure of biochar depends on biomass composition and temperature. Biomass converted into biochar can improve and optimize the composting of food waste (Waqas et al. 2018).

MATERIAL AND METHODS

Study approach

This research is focused on food waste composting and follows the study of Maxianova et al. (2018). Therefore, we decided to use some additive that could improve the quality of the final compost. We chose sawdust and biochar because they can improve the Carbon/Nitrogen ratio and have a better effect on pH and seed germination (Kebibeche et al. 2019). Subsequently, we compared several concentrations of food waste composting processes by using the additive.

Compost samples

For the compost samples we used representative leftovers from a local canteen. We chose cooked potatoes (different composition), cooked rice and vegetables (different types) at a ratio 2:2:1. The ingredients were used for every process to guarantee the same conditions.

We had 6 composts A, B, C, D, E and F. These composts were mutually compared. The composting process was prepared according to the publication by Maxianova et al. (2018); however, the additives were included at the beginning together with the food waste samples. A was without any additive, it was only food waste. The other composts were of the following composition: B (10% sawdust and 90% FW), C (10%sawdust from rat's litter and 90% FW), D (20% sawdust and 80% FW), E (40% sawdust and 60% FW), F (10% sawdust + 10% biochar and 80% FW). The sawdust was bought at a pet shop because it is modified and treated to the same quality. The sawdust from rat's litter was used because of improved activity of microbes. The biochar was produced from cereal husks and cellulose fibres heated to 600 °C.

The composting samples were mixed together and put into an electronic composter Green Good 02. This household composter of 27 kg in weight has 457 mm width, 457 mm length and 762 mm height. It was made for small consumers like homes, school canteens and offices. It can compost more than 4 kg of food waste per day and turn this waste into compost within 24 hours when the waste is reduced to 80–90%. This composter has power consumption 60–90 kWh/month (oklininternational.com). The electric composter is one of the composters which can compost food waste. The composting process of food waste is different than green composting because food waste can contain also animal products or products full of microbes, so it is necessary to kill these pathogens at higher temperatures. This composter is designed for heat up to almost 70 °C. This temperature is important in the process of hygienic treatment or thermophilic phase. This phase begins when the temperature reaches up to 55 °C. Then almost all pathogens are eliminated (Waqas et al. 2019).

The process of composting took 9 weeks, but the process was divided into two stages. The first stage included the first 4 weeks when the samples were in the composter (D0–D28). The manufacturer informs that food waste will be transformed into mature compost already after 24 hours in the composter. After those 4 weeks, the compost was taken out into a bucket where its maturation stage started, which took other 5 weeks (D28–D63).

Testing method

The composts were tested for physicochemical (temperature, pH and electrical conductivity) and biological (phytotoxicity) properties. The temperature was measured according to Waqas (2018) every day by digital thermometer. The thermometer was put in the center of the composter. The pH value and electrical conductivity (EC) value were measured by using a pH/EC meter HQd portable Meter at 1:5 dilution (waste/distilled water) with standard deviation 0.1. Method was used from Unified work procedures by Central Institute for Supervising and testing in Agriculture. These values were measured every week during the composting process in the composter (D0, D7, D14, D21, and D28) and in the maturing phase (D35, D42, D49, D56, D63). The phytotoxicity test was conducted by using the Phytotoxkit made by MicroBio Tests. It was tested two times, after the composting process in composter was ended (D28) and after the maturing phase (D63). The phytotoxicity test was measured according to Maxianova et al. (2018).

RESULTS AND DISCUSSION

Table 1 presents results of samples from physicochemical and biological properties. From physicochemical properties was chosen pH and EC. The limit for pH was 5. Despite the optimal pH for compost ranges from 6-8 value (Plíva et al. 2016), but many researchers provided the lower pH (5–6) of compost from FW (Kucbel et al. 2019, Pandey et al. 2016, Yu et al. 2009). Limit for EC was 4 mS/cm (Kucbel et al. 2019). Table shows samples which met limit for EC, pH and phytotoxicity, however it shows that no compost did not meet limit in all tested properties.

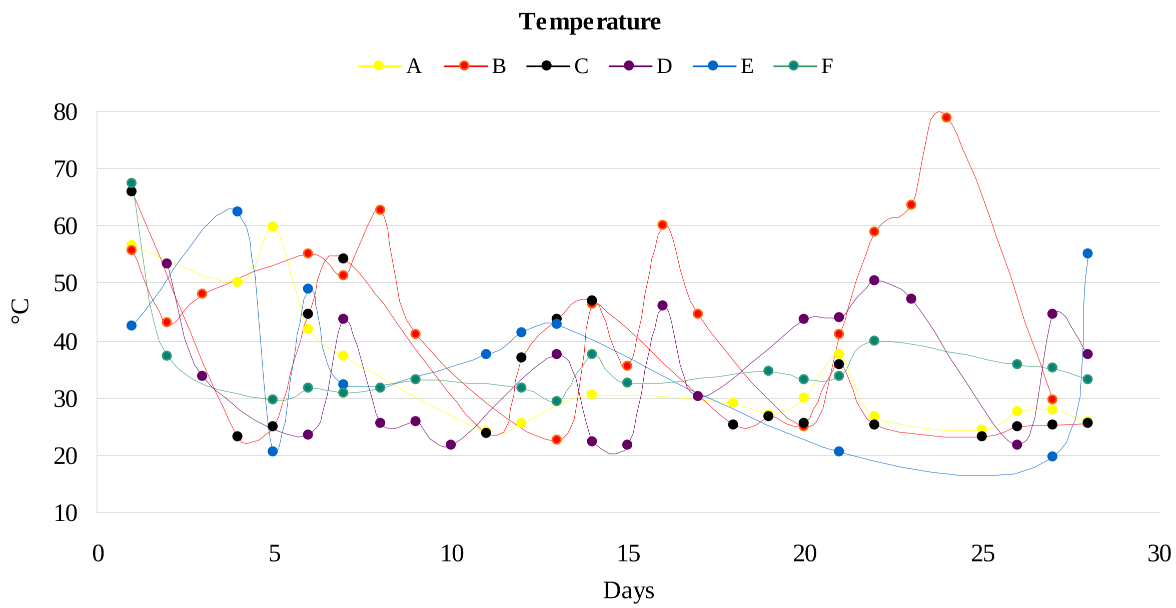
Table 1 Measured properties of composts

Mark	Composition	EC mS/cm	pH	Phytotoxicity D28	Phytotoxicity D63
A	100% FW	-	-	-	-
B	10% sawdust and 90% FW	-	-	-	-
C	10% sawdust from rats' litter and 90% FW	-	-	-	-
D	20% sawdust and 80% FW	+	-	+	+
E	40% sawdust and 60% FW	+	-	+	+
F	10% sawdust + 10% biochar and 80% FW	+	+	-	-

Legend: D28 –the 28th day of composting (end of composting in the electric composter), D63 –the 63rd day of composting (end of maturation phase), + –meets the limits, - –does not meet the limits

Figure 1 shows how the temperature was developing during the composting process inside the electric composter. The figure provides that the electric composter is not suitable for FW composting. The temperature inside the electric composter was increasing and decreasing according to the day which was not good for the process of composting and microbes could have influenced pH and other properties. But in the maturation phase the temperatures were stable around 23 °C.

Figure 1 Temperature during the composting in the electric composter

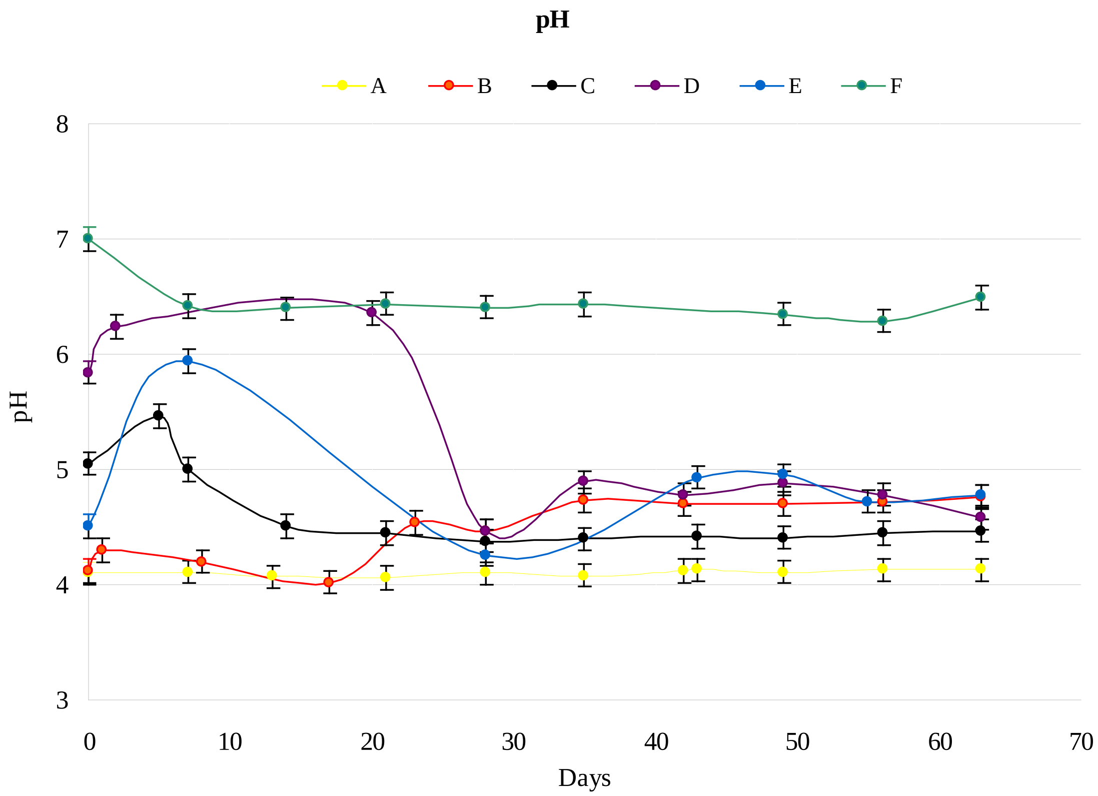


Legend: A–100% FW, B–10% sawdust and 90% FW, C–10% sawdust from rats litter and 90% FW, D–20% sawdust and 80% FW, E–40% sawdust and 60% FW, F–10% sawdust + 10% biochar and 80% FW

Results from another physicochemical methods prove that FW composting has better pH with using additives. Compost A (without additive) had the lowest pH, only 4. All composts with additives had pH under 5. Only Compost F had pH 6.5. The lower pH could have been caused by the decreasing organic matter during the formation of acids (Kucbel et al. 2019). Figure 2 shows the development of pH of food waste composting. At the beginning, the pH was low but when the process of decomposition was started the pH value was creasing to the maximum. At the end of composting, the pH value was steady, mainly in the maturation phase. The best results were recorded in Compost F, which was compost with 10% sawdust + 10% biochar and 80% FW. It was a combination of sawdust and biochar. Both of them can improve compost pH as well as soil quality.

However, the results show that sawdust as an additive can improve quality only at the beginning as seen in Figure 2.

Figure 2 The development of pH value of composts



Legend: A–100% FW, B–10% sawdust and 90% FW, C–10% sawdust from rats litter and 90% FW, D–20% sawdust and 80% FW, E–40% sawdust and 60% FW, F–10% sawdust + 10% biochar and 80% FW, standard deviation of pH/EC meter is 0.1.

Results from EC also confirm that Compost A had the worst results. The EC value of Compost A was almost 9 mS/cm while limit is 4 mS/cm. The reason might have been a huge amount of salt contained in FW. This value might have been decreased due to the use of some additives. Results show us that Compost D, E and F had the lowest EC value and these composts meet the limit for EC value.

Results from biological method also proved that Compost A can not be apply to soil as fertilizer because it is toxic to plant. The phytotoxicity test proves that Compost D and Compost E stimulate seed germination. Compost F has the best results from all tested parameters but the test of phytotoxicity shows inhibition, i.e. no seed germination. Probably the biochar inhibited the process of plant growth which does not prove in other research works (Sun et al. 2017, Waqas et al. 2018).

CONCLUSION

Food waste is a current environmental issue. This research shows that the composting of food waste is difficult. It compares several composting processes with or without the use of additives. The additives used in our research included sawdust or biochar, or a combination of sawdust and biochar. The composts were tested for physicochemical and biological properties. The analysis of results proved that is necessary use some additive for food waste composting. Compost with additives had better results from tested methods than compost without additives. Additive can improve one of tested property but no other. The best results from physicochemical properties had compost with 10% sawdust + 10% biochar and 80% FW but the phytotoxicity test proved inhibiton. The biological method shows that sawdust as additive has good influence on seed germination. However, it is needed do more analysis.

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