



Review About Using Limited Organic Wastes in Composting: Comparison Between Few Numbers of the Parameters and the Concentrations of Heavy Metals and NPK Nutrients

Hammam Riyad Al-Eiadeh

Department of Natural Resources and Environment, College of Agriculture,
Jordan University of Science and Technology

ABSTRACT

This paper reviewed studies about the composting process of different types of organic wastes. These wastes can be produced from different sources such as kitchen waste, Municipal solid waste (MSW), human waste, animal waste, agricultural waste, sewage waste, and slaughterhouse waste. The improper management of these wastes can lead to many environmental problems. These wastes can be disposed by many methods, but the best method we can use to overcome these environmental problems is composting because its cheap, effective in organic wastes decomposition. Composting process can be used to degrade all kinds of organic wastes without any exception such as plants, vegetables, fruits, and others. The product (compost) has many uses such as soil conditioner, nutrients for crops, and can be used as contributor in environmental management. However, there are many factors that affect the quality and the efficiency of the compost, which are pH, temperature, moisture content and carbon nitrogen ratio (C:N ratio). By the way using different types of organic wastes means different types and concentrations of heavy metals and different concentrations of the main and the most common macro nutrients exist in fertilizers (N, P, K). The presence of heavy metals gives an indication of the most suitable way that we can use to add compost to soil without any negative effect.

Keywords: Composting, Organic wastes, Biodegradable wastes.

1. Introduction

Due to the progress of time and the development that has occurred in the world with an increase in human activity that have led to dangerous issue, which is the increase in the amount of accumulated organic wastes in the environment. Organic waste has become one of the most important issues globally [1]. There are many treatment methods that can be used in organic waste management such as landfill use and incineration, however the decomposition of organic waste by using biological processes is the most proper one. Composting is the biological process in which organic matter is aerobically decomposed by different types of microorganisms bacteria, fungi and worms into valuable material called compost [2]. It's also can be defined as the natural process of decomposition of the organic matter by microorganisms under controlled conditions [3]. There are many examples of raw organic matter such as crop residues, animal residues, food waste...etc. [3]. Composting is also considered as alternative solid waste management system (SWM). SWM has several uses such as controlling the rise of waste amount, disposing of organic materials by converting it into valuable useful products [1]. The main factors play the most important role of this

Copyright © 2022. The Author(s). This is an open access preprint (not peer-reviewed) article under [Creative Commons Attribution-NonCommercial 4.0 International](https://creativecommons.org/licenses/by-nc/4.0/) license, which permits any non-commercial use, distribution, adaptation, and reproduction in any medium, as long as the original work is properly cited. **However, caution and responsibility are required when reusing as the articles on preprint server are not peer-reviewed.** Readers are advised to click on URL/doi link for the possible availability of an updated or peer-reviewed version.

How to Cite:

Hammam Riyad Al-Eiadeh, "Review About Using Limited Organic Wastes in Composting: Comparison Between Few Numbers of the Parameters and the Concentrations of Heavy Metals and NPK Nutrients". *AIJR Preprints*, 377, Version 1, 2022.

process are microbial activity and the waste itself because this process (composting) is only appropriate for biodegradable wastes. It's also affected by other factors such as temperature, aeration, moisture content, C:N ratio and PH [1]. Compost is a rich source of organic matter (OM). Therefore, it plays a very important role in agricultural sustainability, maintaining soil fertility. Moreover, it also improves soil physical, chemical and biological properties [3]. The studies reviewed were divided into three categories of organic wastes, which are agriculture waste, kitchen waste, and sewage sludge. This paper was written mainly to compare between few number of parameters that we have mentioned before and how the composting process affects on (NPK) nutrients and heavy metals concentrations in each type of these organic wastes.

2. Types of organic wastes:

2.1 Agricultural Wastes.

are the residues from the growing and processing of raw agricultural products such as vegetables, fruits, poultry, crops, and dairy products [4]. Because of the lack of the decomposition methods of organic wastes or poor access to the disposal facilities, so they are usually disposed of by burning process and that is considered as harmful to the environment [1]. These wastes are considered useful for humans, but the most important problems are the cost of collection of these wastes, transportation, and the processing cost is higher than their economic value. The production of these wastes depend mainly on the type of agricultural activities, and they can be defined in several different forms of solid materials, liquid, or slurries [4].

2.2 Kitchen wastes.

These wastes are usually produced by the processes occurred in our kitchens. They are usually disposed of landfills, and this leads to unpleasant (bad) odors and increase the number of accumulated wastes in landfills, which leads to many diseases and environmental problems.

2.3 Sewage sludge.

Nowadays, there is excessive use of water in our houses which usually goes to the sewage and that led to big problem called sewage sludge, so it must be treated correctly and safely. Sewage sludge is mainly formed through the mechanical, biological and chemical treatment of the sewage [13]. Composting is an effective and alternative method we can use for sewage sludge disposal. Composting of these wastes has a high ability to decompose the organic matter that can be found in the sewage sludge into valuable and stable product [14].

3. Comparison between the Effects on the parameters and the concentrations of heavy metals and (NPK) nutrients.

3.1 Agricultural Wastes.

Taleb *et al* [5] In this study the compost was composed of plant residues and sheep manure mixed with soil. The dimensions of the used compost pile were 1.7 m, 5 m, 5 m high, width and length respectively. During the composting process we observed that the temperature of the pile was 25 °C at the beginning of the composting process, then it started to increase until reached 30 °C (the maximum temperature) after 30 days from the beginning of the decomposition period, then a significant decrease in the temperature was recorded after 50 days, it became 24 °C. The moisture content was decreased after 10 days and it keeps decreasing until reached to the lowest value after (50 days). PH value of the compost pile was 8.38 (alkaline) at the beginning of the process, then it starts to decrease until reached 6.02 (acidic). The percentage of N, P and K nutrients were recorded at the end of composting process as 0.65%, 0.00295% and 0.3640% respectively. We conclude that the availability of P and K content was less than the amount that should be available in the good quality compost.

Janakiram and Sridevi [6] studied the compost that was made from succulent plant, shrubs and trees, and they mixed all together with cow dung. The moisture contents in the compost were varied between 12.30 and 18.28%. PH values were recorded between 7.23 and 7.59 (alkaline). The C:N ratio in the compost pile were 10:1, 11:1 and 12:1.

Karak *et al* [7] studied the compost that was made from different types of agriculture wastes, which are rice straw, wheat straw, potato plant, and mustard stover with fish pond bottom sediment. The total period of this study was 56 days. The composting process was conducted by using a heap, and the dimensions of the used heap were 2.5, 1.5, 1.5 length, width, and height respectively. The temperature at the beginning was recorded between 24 and 26.8 °C, then it increased to 81 °C as the peak or maximum temperature. The pH values at the beginning were recorded between 6.76 and 7.68. Total N concentration were ranged between

14.56 g/kg to 21.57 g/kg. We conclude that the concentration of heavy metals in the composting pile was less than the standard value set by the Indian Ministry of Agriculture and Cooperation.

Zhang *et al* [8] studied the compost that was made from rice straw, vegetable waste, soil and bran. The maximum and minimum temperature around the compost pile was 28 °C and 17 °C respectively, the temperature was increased at the first 6 days of the process and the maximum value was higher than 65 °C. The moisture content at the beginning (initial) was 55%. At the first 6 days pH value was flocculated because of the extensive microorganisms' activities, and the final pH value was recorded between [8, 8.2].

Pagnakorn *et al.* [9] studied the compost that was mainly made from banana peels because it is largely becoming an organic waste in Thailand. The moisture content was 15.55%. PH value was recorded 9.91, which is higher than 7 and this is not proper because it may lead to loss of soil efficient nutrients such as (Fe) and (Mn). Nevertheless, this is suitable for soil located in Thailand. The concentration of nitrogen, phosphorus, potassium (N, P, K) nutrients was recorded as 1.69%, 2.92% and 0.84% respectively, which is considered higher than the standard level. By the way Banana peels were used as fermented organic liquid.

3.2 Kitchen wastes.

Arslan *et al* [10] They used a vessel composter as a new method for kitchen wastes composting. The total period of this study was 22 days. The compost was mixed with 2 kg of sludges and 3.5 kg of sawdust. The temperature was 55 °C at day 2 and maintained at day 7. The moisture content was recorded between 48% and 53%. PH value at the beginning of the process was 5.52 in the composting reactors. In this study the following heavy metals were obtained- cadmium, zinc, chromium, iron, nickel, and copper. The concentration of the cadmium was less than the detection limit, but the concentrations of the others were recorded as 190.7 mg/kg, 22.4 mg/kg, 2641.75 mg/kg, 15.33 mg/kg and 35 mg/kg.

Gautam *et al.* [11] In this study the compost pile was made from vegetables and fruits mixed with kitchen wastes. The compost pile was 4' high and 8' long, and it was flipped manually every 3-5 days for the first 6 weeks of the composting process cycle. The temperature was recorded between 35 °C and 45 °C. However, the highest temperature was observed between 48 °C and 50 °C (at the first three days). The initial moisture content of the pile was maintained between 50% and 60%. A significant decrease was noticed in the moisture content, and it was recorded between 25 and 41%. PH values were recorded between 7.75 and 7.84. The concentrations of (N P K) nutrients were recorded between these ranges 0.03 to 0.07%, 0.002 to 0.005% and 0.32 to 0.36% respectively.

Pathak *et al.* [12] In this study the composting process was done by using bio composter. The period of the process lasted from 2008 to 2011 for 135 days per year. The maximum temperature was 64 °C, the ambient temperature of the compost pile was 32.7 °C. At the beginning the moisture content was 55.8% but at day 36 the moisture content decreased to 21.7% due to the highest temperature. At the first days PH value was in the acidic range because of the production of organic acids, then it start to increase until reached to 8.6, but later it decreased to 6.3. The concentrations of (N P K) nutrients were recorded between 1.16 to 1.20%, 0.03 to 0.053% and 0.30 to 0.38% respectively. The concentrations of heave metals (zinc, Copper, Iron) were (51.1 to 54.4 mg/kg),(45.25 to 48.39 mg/kg), (1134.8 to 1274.2 mg/kg).

3.3 Sewage sludge

Nowadays, there is excessive use of water in our houses which usually goes to the sewage and that led to big problem called sewage sludge, so it must be treated correctly and safely. Sewage sludge is mainly formed through the mechanical, biological and chemical treatment of the sewage [13]. Composting is an effective and alternative method we can use for sewage sludge disposal. Composting of these wastes has a high ability to decompose the organic matter that can be found in the sewage sludge into valuable and stable product [14].

Jonathan and Min [14] In this study the compost was made from sewage sludge mixed with sawdust, where sawdust is used here as bulking agent, and this mixture was mixed with lime by using concrete mixer. The maximum temperature of the compost pile was maintained at 55 °C. The moisture content was maintained during the composting process between 60% and 70%. PH value was increased from 7.3 to 9.2 due to the addition of lime.

Yañez *et al* [15] studied the dewatered sewage sludge that was collected from Seville's (Spain), mixed with Acacia trimming residues that were collected from the municipality of Huelva (Spain). The samples were obtained and composted at the same day. The temperature was less than 40 °C at the first day, the maximum temperature was recorded between 41 °C and 62 °C and that was between day number 2 and 5, then it was decreased slowly to reach above 40 °C, and after 43 days from the beginning of the composting process the temperature was 24 °C. After 80 days of composting, PH values were recorded between 7.7 and 8.

Liu *et al* [16] studied samples of the sewage sludge that were taken from Beixiaohe waste water treatment plant, which is located at Haidian District of Beijing city in China. A Cylinder made of the glass-fiber reinforced plastics was used as composting reactor with dimensions of 200 mm inner diameter and thickness of 7 mm, height of 600 mm, and the height of the sewage sludge in the composting reactor is 500 mm. After 136 h of the composting process, The temperature was increased until it reached the maximum which is 64 °C, then it was gradually decreased to the room temperature after 300 h of composting. The moisture content was recorded between 45% and 55%. PH value was decreased through the composting process, but at the final stage it remains constant. The contents of Ni, Cr were increased, but the contents of Zn, Pb and Cd were decreased.

Amir *et al* [17] studied samples of sewage sludge were taken from an aerobic lagoon in the experimental wastewater treatment plant of Marrakech city (Morocco). After 7 days of the from the beginning of the composting process the temperature was recorded at 52 °C and the PH value was slightly increased to 7.4, then the temperature decreased to 35 °C and pH decreased to 6.7 (acidic). In this study the concentrations of Zn, Cu, Ni and Pb were recorded as 233, 62, 23, and 101 respectively, but the concentration of cadmium (Cd) was not detectable.

4. Conclusions

Based on the previous studies, we conclude that the composting process is safe and eco-friendly method, as well as it showed the ability of the composting process as an effective method to treat different types of organic wastes (biodegradable wastes) and its ability in reducing the volume of wastes in the environment. of the used organic wastes and monitor the previous parameters to check if they fit with the standard values. Compost plays also an important and significant role in many fields such as agriculture and environment because it's used as soil conditioner, provides plant with nutrients, and contributes to environmental health. It also shown that using different types of organic wastes from different sources means different scale on the effectiveness of the composting process and that leads to variation of the quality of the compost. The previous studies also shown that using different types of organic wastes during the composting process affect on many parameters such as Temperature, moisture content, PH value, as well as it affects the concentrations of the heavy metals and (NPK) nutrients, so it's important to know the type and the source of the used organic wastes and monitor the previous parameters to check if they comply with the standard limit to check the quality of the compost. Using different types of organic wastes during the composting process influence the nutrients availability and the concentrations of the heavy metals of the compost pile, which is considered very important because the presence of heavy metals is considered as indicator about the most suitable ways to add this product to soil in right way without any bad effect.

5. Study Limitations

The lack of a sufficient amount of the previous studies or researches to compare between them and the lack of all parameters in all researches, so there were limitations of the study.

References

- [1] A. A. Kadir, N. W. Azhari, and S. N. Jamaludin, "An overview of organic waste in composting," *MATEC Web Conf.*, vol. 47, pp. 0–5, 2016, doi: 10.1051/mateconf/20164705025.
- [2] E. Walling, A. Trémier, and C. Vaneekhaute, "A review of mathematical models for composting," *Waste Manag.*, vol. 113, pp. 379–394, 2020, doi: 10.1016/j.wasman.2020.06.018.
- [3] R. V. Misra, R. N. Roy, and H. Hiraoka, "On-farm Composting Methods," *L. Water Discuss. Pap.*, vol. 2, no. 9, p. 51, 2003.
- [4] F. Obi, B. Ugwuishiwu, and J. Nwakaire, "Agricultural Waste Concept, Generation, Utilization and Management," *Niger. J. Technol.*, vol. 35, no. 4, p. 957, 2016, doi: 10.4314/njt.v35i4.34.
- [5] T. R. Abu-zahra, R. A. Ta'any, and A. R. Arabiyyat, "Changes in compost physical and chemical properties during aerobic decomposition," *Int. J. Curr. Microbiol. Appl. Sci.*, vol. 3, no. 10, pp. 479–486, 2014.
- [6] T. Janakiram and K. Sridevi, "Conversion of waste into wealth: A study in solid waste management," *E-Journal Chem.*, vol. 7, no. 4, pp. 1340–1345, 2010, doi: 10.1155/2010/549185.
- [7] T. Karak, P. Bhattacharyya, R. K. Paul, T. Das, and S. K. Saha, "Evaluation of Composts from Agricultural Wastes with Fish Pond Sediment as Bulking Agent to Improve Compost Quality," *Clean - Soil, Air, Water*, vol. 41, no. 7, pp. 711–723, 2013, doi: 10.1002/clen.201200142.
- [8] L. Zhang *et al.*, "Impacts of iron oxide nanoparticles on organic matter degradation and microbial enzyme activities during agricultural waste composting," *Waste Manag.*, vol. 95, pp. 289–297, 2019, doi: 10.1016/j.wasman.2019.06.025.
- [9] U. Pangnakorn, "Valuable added the agricultural waste for farmers using in organic farming groups in Phitsanulok, Thailand," no. January, pp. 13–16, 2006, [Online]. Available: <http://www.tropentag.de/2006/abstracts/full/260.pdf>.
- [10] E. I. Arslan, A. Ünlü, and M. Topal, "Determination of the Effect of Aeration Rate on Composting of Vegetable-Fruit Wastes," *Clean - Soil, Air, Water*, vol. 39, no. 11, pp. 1014–1021, 2011, doi: 10.1002/clen.201000537.
- [11] S. P. Gautam, P. S. Bundela, A. K. Pandey, and S. Sarsaiya, "Composting of Municipal Solid Waste of Jabalpur City Central Pollution Control Board , New Delhi , India," vol. 4, no. 1, pp. 43–46, 2010.

-
- [12] A. K. Pathak *et al.*, “Assessment of physico- chemical properties and microbial community during composting of municipal solid waste (Viz . Klitchen waste) at Jhansi City , U . P . (India),” *Recent Res. Sci. Technol.*, vol. 4, no. 4, pp. 10–14, 2012.
- [13] P. Kosobucki, A. Chmarzyński, and B. Buszewski, “Sewage Sludge Composting,” *Polish J. Environ. Stud.*, vol. 9, no. 4, pp. 243–248, 2000.
- [14] J. W. C. Wong and M. Fang, “Effects of lime addition on sewage sludge composting process,” *Water Res.*, vol. 34, no. 15, pp. 3691–3698, 2000, doi: 10.1016/S0043-1354(00)00116-0.
- [15] R. Yañez, J. L. Alonso, and M. J. Díaz, “Influence of bulking agent on sewage sludge composting process,” *Bioresour. Technol.*, vol. 100, no. 23, pp. 5827–5833, 2009, doi: 10.1016/j.biortech.2009.05.073.
- [16] Y. Liu, L. Ma, Y. Li, and L. Zheng, “Evolution of heavy metal speciation during the aerobic composting process of sewage sludge,” *Chemosphere*, vol. 67, no. 5, pp. 1025–1032, 2007, doi: 10.1016/j.chemosphere.2006.10.056.
- [17] S. Amir, M. Hafidi, G. Merlina, and J. C. Revel, “Sequential extraction of heavy metals during composting of sewage sludge,” *Chemosphere*, vol. 59, no. 6, pp. 801–810, 2005, doi: 10.1016/j.chemosphere.2004.11.016.