Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 115, 2021: 72-76
(Ann. WULS - SGGW, For. and Wood Technol. 115, 2021: 72-76)

Management of post-production wood waste in the aspect of circular economy

MAGDALENA KOMOROWICZ[1], DOMINIKA JANISZEWSKA[2], HANNA WRÓBLEWSKA[1], KINGA STUPER-SZABLEWSKA[3]

[1]Environmental Protection and Wood Chemistry Laboratory, Łukasiewicz Research Network – Wood Technology Institute, Poznan;
[2]Wood-based Products and Biocomposites Department, Łukasiewicz Research Network – Wood Technology Institute, Poznan;
[3]Faculty of Forestry and Wood Technology, Department of Chemistry, Poznan University of Life Sciences;

Abstract: *Management of post-production wood waste in the aspect of circular economy*. Sustainable resource management involves turning waste into resources. The estimation of various waste streams and their potential use as secondary raw materials underlies the circular economy. The management of wood waste in terms of the Circular Economy should assume material use of this waste before energy use. One of the possibilities of material management of this waste is the use of biological treatment through composting. Input materials for the composting process should have technological and physical-chemical characteristics, respectively.
The aim of this study was to characterize the wood raw material (wood waste as a by-product) and qualify it for the composting process on the basis of its composition. Based on the literature research, it was found that there is possibility of using these wastes for management through biological disposal.
The obtained composts from wood waste can be used as a raw material to supply the soil with humic substances and mineral compounds.

Keywords: wood waste, post-production wood waste, recovery, circular economy

INTRODUCTION

The long-term strategic goals of the European Union's ecological policy until 2050 assume, above all, increasing the efficiency of material resources use (UE Roadmap 2050 A resource-efficient Europe). In view of the continuous increase in the extraction and consumption of these resources, unfortunately, an inefficient resource management continues. Unfortunately, a large percentage of the waste produced by European citizens is landfilled. Threats from insufficient resources such as minerals, wood and water, fertile soil, clean air, biomass as well as energy influence the actions taken by decision makers. The danger of losing liquidity in the sourcing of raw materials leads to a more efficient use of resources, as well as to increasing their reuse, recycling or substitution. "Resource-efficient development is the way to fulfill this vision" (UE Roadmap 2050 A resource-efficient Europe). Wood is one of the most commonly used materials of natural origin. It is used, among others in construction, for the production of furniture, composites, packaging, bioenergy. Due to the desired properties and processing possibilities, new and new possible directions of its use are being created, e.g. for the production of composites, fuel, value-added products etc. (Berger et al., 2020, Cesprini et al. 2021, Hossain et al., 2019, Mehmood et al., 2010, Sala and Kowaluk 2020, Thandavamoorthy 2015). Such numerous possibilities of application result in the formation of a large amount of waste as a result of wood processing, e.g. in the form of sawdust, cuttings, wood chips or dust.

Sustainable use of resources assumes that using them wisely will allow the economy to produce more - using less. Resource-efficient development involves turning waste into resources. Of the large amount of waste that is thrown away (2.7 billion tons of waste in the

EU), only a minor part (98 million tons) is hazardous waste requiring disposal. As much as 60% of the remaining waste is disposed of in a landfill or incinerated (UE Roadmap 2050 A resource-efficient Europe). As can be seen, the potential of waste as a resource is large and still not sufficiently managed through various material applications or recycling. A resource-efficient economy must integrate aspects such as life-cycle product design, improved waste collection and treatment processes, and anti-waste and recycling initiatives. The use of waste as a resource takes precedence over energy use. Obtaining energy from waste is allowed only for non-recyclable materials (UE Roadmap 2050 A resource-efficient Europe). Wood waste generated in the wood industry during the production and processing of wood and wood materials, as well as waste generated after the end of life cycle of wooden products are characterized by a high content of organic matter. Therefore, the management of this waste should be in accordance with the principles of organic waste management.

The aim of this study was to characterize the wood raw material (wood waste as a by-product) and qualify it for the composting process on the basis of its composition based on the literature research.

METHODS AND MATERIALS

The review of the current state of knowledge was carried out on the basis of information contained in laws, regulations and available international publications, using the following databases: Scopus, Google Scholar, Web of Science (WoS).

RESULTS AND DISCUSSION

The estimation of various waste streams and their potential use as secondary raw materials underlies the circular economy (CE). Waste management in terms of the Circulation Economy is different than in the case of the Linear Economy, where waste is at the last stage of its life cycle. The growing demand for wood raw material, as well as competition for wood from recipients from various sectors of the economy, including the energy sector, indicates the need to treat wood waste as an important supplementary source of raw material (additional resource), alternative to primary sources (Faraca et al. 2019, Ratajczak et al. 2018).

According to the current legal regulations (Waste Act 2020) composting falls under the concept of "recovery" of waste, not disposal. It follows from the definition of the term that organic recycling is' the aerobic treatment, including composting, or the anaerobic treatment of waste which is biodegradable under controlled conditions using micro-organisms to produce organic matter or methane. Wood and wood materials, also wood waste, contain nearly 90% of organic matter, the main components of which are carbohydrates (65-75%) and lignin (18-35%) (Borazjani et al. 1997, Michel et al. 2004, Rowell 2005). Biological processing by means of aerobic treatment, i.e. composting, is a process consisting in the development of microorganisms (actinomycetes, bacteria and fungi) in the mass of mixed organic wastes with optimal grain size, moisture, appropriate pH and nutritional balance (proportion of carbon to nitrogen C:N and mineral additives) (Jędrczak and Haziak 2005). The mixture of composted materials can be inoculated with microorganisms that accelerate the composting or spontaneously populated with appropriate decomposing microorganisms. Biological utilization of wood waste is based on humification and mineralization of the lignocellulosic complex of wood waste by a group of microorganisms. The enzymatic properties of some microorganisms capable of decomposing cellulose, especially lignin, mean that the decomposition of wood waste is accompanied by its complete or partial detoxification (Büyüksönmez et al. 2000, Kirk 1993, Recycled Organics Unit 2007). For the proper course of the process, it is necessary to aerate the composted mass. Composting can be carried out in closed chambers (bioreactors), natural conditions (piles, compost heaps) or under mixed conditions (initiation of the process in a biostabiliser and continuation under natural conditions) (Recycled Organics Unit 2007).

Possibility of use wood waste and waste of wood-based panels as a input material were tested (Borazjani et al. 1997, Peltola et al. 2000, Schroeter-Zakrzewska et al. 2021, Wróblewska et al. 2008, Wróblewska et al. 2014). In some cases possibility of uses of compost as a growing substrates in in the pot cultivation were approved (Schroeter-Zakrzewska et al. 2021, Wróblewska et al. 2008, Wróblewska et al. 2014, Zawadzińska et al. 2021).

The ready compost, in order to be used for its natural use, must not contain any hazardous substances that are harmful to the environment (Hogg et al. 2002).

The most important before recycling of wood waste, also before composting process is a good quality of waste wood as a input material. Limits of chemical contamination (heavy metals, organic compounds) are described for example in PAS 111:2012 and German AltholzV. The wood waste should be free from chemical contaminations such as potentially toxic elements (PTEs), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOC) or other hydrocarbons; POPs - persistent organic pollutants, e.g. hexachlorocyclohexane, including lindane, as well as pentachlorophenol or polychlorinated biphenyls (PCBs) (2018/C 124/01 - Official Journal of the European Union).
Referring to legislative requirements, the first stage of composting wood waste loaded with ballast substances is its segregation and then the development of a composting technology. This work focuses only on post-production waste and qualify it for the composting process on the basis of its composition.

Wood waste classification can be divided into four classes depending on the way of their processing and the content of chemical substances. The class of wood waste defines of its potential application (AltholzV, Daian and Ozarska 2009, Facara et al. 2019, PAS 111: 2012, PN-EN 13432: 2002, Ratajczak et al. 2003).

- Class A (A I) includes “clean” wood waste, solid wood, wood packaging waste, edgings or cuttings of wood not subjected to any chemical treatment.
- Wood waste partially loaded with protective agents for wood, building structure elements, interior design elements or solid wood furniture may be classified as class B (A II).
- Class C (A III) is wood "processed" or treated with chemicals from municipal landfills, recycling centers. This group includes wood-based materials, such as chipboard, MDF, plywood, OSB and fibreboard and elements from furniture made of those above materials.
- Wood waste containing hazardous substances, such as Copper/chrome/arsenic (CCA) preservation treatments and creosote should be in Class D (A IV). This group of wood waste for incineration.

CONCLUSION

Management of post-production wood waste should be a task of research in near future to search new possible directions of uses in aspects of circular economy.

The search for the use of wood waste should be varied and sought at different levels of the supply chains. One of the possible options for the use of post-production wood waste that is difficult to manage in the wood-based materials industry may be the composting of this waste using appropriately selected composting conditions. Based on the literature research, it was found that there is possibility of using these wastes for management through biological disposal. The obtained composts from wood waste can be used as a raw material to supply the soil with humic substances and mineral compounds.

REFERENCES

1. "Altholzverordnung vom 15. August 2002 (BGBl. I S. 3302), die zuletzt durch Artikel 120 der Verordnung vom 19.Juni 2020 (BGBl. I S. 1328), https://www.gesetze-im-internet.de/altholzv/AltholzV.pdf

2. BERGER F., GAUVIN F., BROUWERS H. J. H., 2020: The recycling potential of wood waste into wood-wool/cement composite. Construction and Building Materials, Volume 260, 2020, https://doi.org/10.1016/j.conbuildmat.2020.119786.
3. BORAZJANI H., DIEHL S. V., STEWART H. A., 1997: Production of Compost from Furniture Manufacturing Wood wastes. For. Products J. Vol 47, No. 2, 1997, p. 47-48,
4. BÜYÜKSÖNMEZ F., RYNK R., HESS T. F., BECHINSKI E., 2000: Literature Review: Occurrence, Degradation and Fate of Pesticides During Composting: Part II: Occurrence and Fate of Pesticides in Compost and Composting Systems, Compost Science & Utilization, 8:1, 61-81, DOI: 10.1080/1065657X.2000.10701751
5. CESPRINI E., GRECO R., CAUSIN V., URSO T., CAVALLI R., ZANETTI M., 2021: Quality assessment of pellets and briquettes made from glued wood waste. European Journal of Wood and Wood Products (2021) 79:1153–1162
6. Circular Economy Action Plan. For a cleaner and more competitive Europe, #EUGreenDeal
7. DAIAN G., OZARSKA B., 2009: Wood waste management practices and strategies to increase sustainability standards in the Australian wooden furniture manufacturing sector. Journal of Cleaner Production, Volume 17, Issue 17, November 2009, Pages 1594-1602
8. FARACA G., BOLDRIN A., ASTRUP T., 2019: Resource quality of wood waste: The importance of physical and chemical impurities in wood waste for recycling. Waste Management 87 (2019) 135–147, https://doi.org/10.1016/j.wasman.2019.02.005
9. HOGG D., BARTH J., FAVOINO E., CENTEMERO M., CAIMI V., AMLINGER F., DEVLIEGHER W., BRINTON W., ANTLER S., 2002: Comparison of compost standards within the EU, North America and Australasia. The Waste and Resources Action Programme, The Old Academy, 21 Horsefair, Banbury, Oxon OX16 AH, 2002, p.97
10. MD. UZZAL HOSSAIN, CHI SUN POON, MICHAEL YUE KWONG WONG, AUNG KHINE, 2019: Techno-environmental feasibility of wood waste derived fuel for cement production, Journal of Cleaner Production, 230, 663-671, https://doi.org/10.1016/j.jclepro.2019.05.132.
11. JĘDRCZAK A., HAZIAK K., 2005: Określenie wymagań dla kompostowania i innych metod biologicznego przetwarzania odpadów. Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej; Ministerstwo Środowiska. Zielona Góra, maj 2005
12. Kirk T. K., 1993: Lignin degradation: basic research progress, and aplications in soil remediation and biopulping. In: Kennedy J.F., Phillips G.O., Williams P.A. eds. "Cellulosics: Pulp, fibre and environmental aspects" New York: Ellis Horwood. 1993,
13. MEHMOOD S., KHALIQ A., RANJHA S. A., 2010: The use of post-consumer wood waste for the production of wood plastic composites: A Review, Conference Paper, November 2010, DOI: 10.13140/2.1.1921.3128Official Journal of the European Union 2018/C 124/01 - Waste
14. PAS 111:2021 Specification for the requirements and test methods for processing waste wood. WRAP, BSI 2012.
15. PELTOLA J., JUHANOJA J., SALKINOJA-SALONEN M. S., 2000: Biodegradability and waste behavior of industrial wood-based construction materials. Journal of Industrial Microbiology & Biotechnology, 24, 210-218
16. PN-EN 13432:2002 Opakowania - Wymagania dotyczące opakowań przydatnych do odzysku przez kompostowanie i biodegradację. Program badań i kryteria oceny do ostatecznej akceptacji opakowań.
17. RATAJCZAK E., SZOSTAK A., BIDZIŃSKA G., LESZCZYSZYN E., 2018: Market in wood by-products in Poland and their flows in the wood sector. Wood, 61, 202, DOI: 10.12841/wood.1644-3985.301.05

18. RATAJCZAK E. SZOSTAK A., BIDZIŃSKA G., 2003: Drewno pożytkowe w Polsce. Poznań.
19. Recycled Organics Unit. A Literature Review on the Composting of Composite Wood Products, 2nd Edition, 2007
20. ROWELL R. M., 2005: Handbook of Wood Chemistry and Wood Composites, Taylor&Francis Group.
21. SALA M. C., KOWALUK G., 2020: An impact of surface spray and pressing temperature on the properties of high density fibreboards, Annals of Warsaw University of Life Sciences – SGGW, Forestry and Wood Technology, 112, 36-53.
22. THANDAVAMOORTHY T. S., 2015: Wood waste as coarse aggregate in the production of concrete, European Journal of Environmental and Civil Engineering, DOI: 10.1080/19648189.2015.101663
23. Wróblewska H., Kozik E., Czajka M., 2008: Effect of composts from wood waste material on the growth and nutritional status of willow Salix Alba L. Journal of Research and Applications in Agricultural Engineering, 53 (4).
24. WRÓBLEWSKA H., SCHROETER-ZAKRZEWSKA A., GŁUCHOWSKA K., WOLNA-MARUWKA A., KLEIBER T., 2014: Wood, 57, 191, DOI: 10.12841/wood.1644-3985.074.01
25. ZAWADZIŃSKA A., SALACHNA P., NOWAK J. S., KOWALCZYK W., 2021: Response of Interspecific Geraniums to Waste Wood Fiber Substrates and Additional Fertilization. Agriculture, 11, 119. https://doi.org/10.3390/agriculture11020119
26. SCHROETER-ZAKRZEWSKA A., WOLNA-MARUWKA A., KLEIBER T., WRÓBLEWSKA H., GŁUCHOWSKA K., 2021: Influence of Compost from Post-Consumer Wood on Development, Nutrition State of Plants, Microbiological and Biochemical Parameters of Substrates in Zonal Pelargonium (Pelargonium zonale). Agronomy, 11, 994. https://doi.org/10.3390/agronomy11050994

Streszczenie: *Potrzeba zagospodarowania poprodukcyjnych odpadów drzewnych w świetle założeń gospodarki cyrkularnej*. Zrównoważony sposób gospodarowania zasobami zakłada przekształcanie odpadów w zasoby. Oszacowanie strumieni różnorodnych odpadów i potencjalnych możliwości ich zastosowania jako surowców wtórnych leży u podstaw gospodarki o obiegu zamkniętym (GOZ). Zagospodarowanie odpadów drzewnych w ujęciu Gospodarki Cyrkularnej powinno zakładać wykorzystanie materiałowe tych odpadów przed wykorzystaniem energetycznym. Jedną z możliwości zagospodarowania materiałowego tych odpadów jest zastosowanie biologicznej utylizacji poprzez kompostowanie. Zastosowanie odpadów drzewnych jako materiałów wejściowych do procesu kompostowania powinna poprzedzić odpowiednia charakterystyka technologiczna i fizyko-chemiczna. Dojrzałe komposty z odpadów drzewnych powinny znaleźć przyrodnicze zastosowanie do zasilania gleby w substancje humusowe i związki mineralne.

Corresponding author:

Magdalena Komorowicz,
Winiarska 1,
60-654, Poznań, Poland
email: m_komorowicz@itd.poznan.pl
phone: +48 61 849 24 82