EMISSIONS OF BTEX FROM IN SMOKE FROM THERMAL DECOMPOSTION AND COMBUSTION OF SELECTED BIOMASS

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Abstract:

This paper reports the results of the level of benzene, toluene, ethylbenzene and *p, m, o* – xylene (BTEX) compounds in smoke from combustion and thermal decomposition of apricot stone, plum endocarp (separated from fresh fruit before the fermentation process "fresh", left in fermenting mixture during alcoholic fermentation "fermented", left in fermenting mixture during the process of fermentation and distilling process "fermented and distilled"), the poplar wood pellets and sawdust of poplar clone I-214 (P. x euramericana cl. I-214 cultivated in Serbia). Benzene was detected in all investigated samples except for fresh plum endocarp. Level of benzene formed during combustion range from not detected (fresh plum endocarp) to 1.79 mg kg^{-1} (poplar wood sawdust). Toluene, ethylbenzene and *m+p* xyilene were detected during thermal decomposition for all three plum endocarp samples, while during thermal decomposition only for fermented and distilled.

Keywords: poplar, apricot, endocarp, BTEX, plum, pellet, sawdust

1. Introduction

Biomass is a resource that is interesting as a renewable source of energy and chemicals. Biomass represents 3.448 million toe and it participates in the total renewable energy sources potential with 61%. Composition of the cell wall changes with the type of wood or plant, but generally, 40-45% of wood is cellulose, 25-35% is hemicelluloses, 15-30% is lignin, and other compound are represented up to 10%. Lignin is a highly cross-linked polyphenolic polymer, with molecule masses over 10000, whose structural units doesn't repeat regularly and which presents one of the most complex organic aromatic polymers in nature. Lignin fraction of biomass is important source of benzene, phenol and dihydroxybenzenes during combustion.

2. Material and methods

The measurements were performed under the same experimental conditions (fuel combustion and thermal decomposition) used in our previous study [1]. About 5 g of each investigated sample was measured before treatment. Analysis of BTEX compounds in smoke of combustion and thermal decomposition were examined according to method NIOSH 1501 [2].

3. Results and discussion

Fig. 1 shows approximate time scale for the different combustion and thermal decomposition stages of the investigated samples. The process of combustion of the apricot stone lasted shorter with greater quantity of remaining coal during oxidation conditions, than in the analogous processes of the same mass of pellet and poplar sawdust samples. Fresh and fermented plum endocarp samples were difficult to ignite, and yet if they start burning, they burnt shortly, and left a large amount of charred residue. Fermented and distilled plum endocarp samples did not ignite under conditions of the combustion process, nor did they leave a lot of carbon residues, but they completely transformed in white ash during a thermal decomposition. The final glowing stage was the longest stage for all investigated samples. Smoldering stage of fresh, fermented and fermented and distilled plum endocarp samples lasted longer than for pellet, sawdust and apricot stone samples.

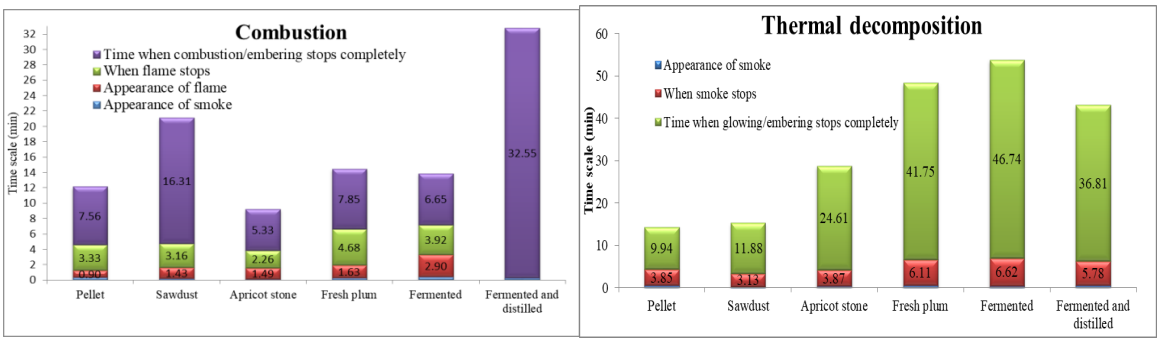
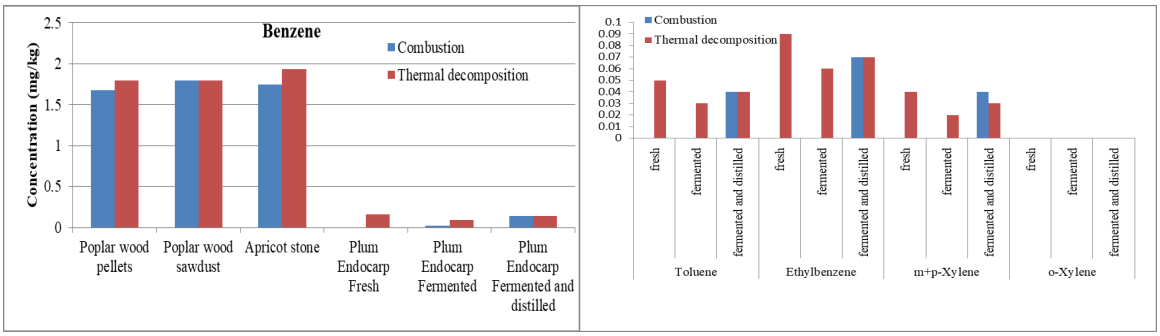


Fig. 1. Approximate time scale for the different combustion and thermal decomposition stages of investigated samples

The obtained levels of benzene as the average of each sample analyzed individually three times during combustion and thermal decomposition are presented in Figure 2.



The average mass of benzene released per unit of fuel mass for pellets (combustion-1.67mgkg^{-1}; thermal decomposition-1.79 mg kg^{-1}), sawdust (combustion-1.79mgkg^{-1}; thermal decomposition-1.79 mg kg^{-1}), and apricot stone (combustion-1.74 mgkg^{-1}; thermal decomposition-1.93 mgkg^{-1}), is in the same size range in all investigated cases. Benzene is produced by thermal decomposition of lignin in wood (i.e., sawdust, pellets). During pelleting of poplar wood sawdust chemical composition doesn't change considerably, so by that very fact, type or amount of the combustion products also doesn't change, which indicates the similarity of mechanism of benzene production in these processes. Since the content of lignin in apricot stone is higher than in the poplar tree, it was expected a higher concentration of benzene during thermal treatment of apricot stone than in pellet and sawdust of poplar, which was confirmed for the thermal decomposition process. During combustion, the fresh plum endocarp sample does not release benzene into the atmosphere, because all three investigated samples apparently completely burned. Only one sample of the three analyzed fermented endocarp succumbed to the normal combustion releasing benzene at concentration 0.024 mg/kg. Thermal decomposition of all three types of plum samples always released benzene. Most benzene during thermal decomposition produced plum fresh endocarp sample, a little less fermented and distilled one (15-25% less), and the least fermented (25-45% less than the fresh) plum sample. In relation to the fresh endocarp, the fermented endocarp is obviously partly delignified, which is indicated by the elasticity expressed at breakage, as well as the low content of the released benzene during thermal decomposition. Toluene, ethylbenzene and *m+p* xylene were detected during thermal decomposition for all three plum endocarp samples, while during thermal decomposition only for fermented and distilled.

4. Conclusion

The level of benzene was more pronounced in smoke from pellets, sawdust and apricot stone during combustion and thermal decomposition processes compared to investigated plum endocarp samples. Toluene, ethylbenzene and *m+p* xylene were detected during thermal decomposition for all three plum endocarp samples, while during thermal decomposition only for fermented and distilled.

[1] B. Škrbić, V. Marinković, S. Spaić, V. Milanko, S. Branovački, „Profiles of polycyclic aromatic hydrocarbons in smoke from combustion and thermal decomposition of poplar wood pellets and sawdust" Microchemical Journal, vol. 139, pp.9-17, 2018.

[2] https://www.cdc.gov/niosh/docs/2003-154/pdfs/1501.pdf (accessed 27.12.2018).