Energetic valorization of branch dendromass from sweet chestnut (*Castanea sativa*)

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Introduction

Sweet chestnut (*Castanea sativa* Mill.) is a deciduous tree of the family *Fagaceae* and the only species of the genus *Castanea* native to Europe (Conedera, Krebs 2008). It is an important multipurpose species cultivated for timber, nuts, and tannins, while also contributing to forest landscapes (Pereira-Lorenzo et al., 2009).
During the last 200–400 years, it has been grown in southern and southeastern Slovakia, particularly in the Malé Karpaty, Považský Inovec, Tribeč, Krupinská planina, and Ondavská vrchovina regions, at elevations of 200–500 m a.s.l. (Bolvanský et al., 2008).

Sweet chestnut reaches heights of 20–35 m and produces moderately hard wood with an oven-dry density of 440–610 kg·m^{-3} (Enchev 1984). According to EN 350:1994, it belongs to durability class 2 due to its tannin content (Perelygin 1965; Gironi, Piemonte 2011). Often called the "bread tree," its nuts historically substituted cereals during poor harvests (Bounous, Marinoni 2005). In Slovakia, chestnut orchards produce both nuts and pruning biomass, which can be utilized as biofuel in the form of wood chips.
This contribution presents the results of analyses, carried out for the purpose of assessing the following energetic properties of the dendromass of the sweet chestnut branches: density, rate of bark, content of the basic chemical elements in the combustible matter of wood and bark, content of ash in the dry mass and heating value of the dendromass of branches in dry state.

Material and methods

The bark content in branch dendromass was determined according to STN 48 0058:2004. The relative moisture content at sampling was measured following EN 14774-2. Chemical analysis of wood and bark from sweet chestnut was performed at the Central Forestry Laboratory (National Forest Centre, Zvolen). Carbon, hydrogen, and nitrogen contents (Cdaf, Hdaf, Ndaf) were determined using an NCS-FLASH EA 1112 analyser. Ash content was measured in a muffle furnace according to EN 14775:2010 (550 °C) and ISO 1171:2003 (815 °C). The heating value of branch dendromass was calculated as a two-component biofuel (wood and bark) based on its chemical composition and ash content (Dzurenda, Banski 2016).

Results and discussion

The mean dry density of sweet chestnut trunk wood with bark (ρ_0 = 550 kg·m^{-3}) corresponds to previously published values ranging from 444 to 610 kg·m^{-3}. The dry density of branch dendromass (ρ_0 = 703.1 kg·m^{-3}) is 21.8% higher than that of trunk wood with bark. This difference is mainly due to the high proportion of bark in branches (29.72 ± 1.04%), which is close to the maximum allowable limit of 30% according to STN 48 0058:2004. Bark generally has higher density and ash content than wood, which increases the overall density and influences the energetic properties of branch dendromass.

The higher ash content in bark compared to wood is consistent with published findings and contributes to changes in fuel quality parameters. The calculated heating value of dry sweet chestnut branch chips (Q_n = 17,245 kJ·kg^{-1}), determined using Mendeleev's equation, is 7.3% lower than the value specified for broadleaved wood in EN 14961. This reduction is mainly caused by the increased proportion of inorganic substances (ash) and nitrogen content in the branch dendromass.

Conclusions

- The dry dendromass of sweet chestnut branches has a mean density of 703.1 kg·m^{-3}
- The bark content in the dry dendromass is 29.72%**,** representing the upper limit of suitability for energy woodchip production

- Its chemical composition is similar to that of other broadleaved species, except for nitrogen content, which is 2.62 times higher
- The mean ash content is 2.26%
- The heating value of the dry dendromass is 17,245 $kJ \cdot kg^{-1}$

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