

UNIVERSITY OF BIELSKO-BIALA

PhD THESIS

(Abstract)

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**THE INFLUENCE OF THE COMPOSITION OF THE WOOL FIBRE
BLEND FROM SHEEP FROM POLISH MOUNTAIN AREAS AND
BAST FIBRES ON THE BARRIER PROPERTIES OF MATS INTENDED
FOR THERMAL AND ACOUSTIC INSULATION**

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Abstract

The doctoral thesis discusses the influence of the composition of the wool fibre blend from sheep from Polish mountain areas and bast fibres on the barrier properties of mats intended for thermal and acoustic insulation. The main thesis assumes that the increase in the proportion of sheep wool in a blend with bast fibres reduces the heat conductivity coefficient and reduces the sound absorption capacity of barrier materials made of these fibres.

The bibliographic part represents literature report on sheep wool, bast fibres and the use of these fibres in products intended for thermal insulation and absorbing sound waves. The literature review on wool contains data related to the scale of sheep fleece production, information on the structure of wool, types of wool cover, factors influencing the quality of wool and its properties in the context of applications. The bibliography on bast fibres includes data on the global production of flax fibre as well as the area of flax and hemp cultivation in Poland. Additionally, information on the structure of the bast plant stem and the structure of bast fibre as well as the methods of extracting the fibre from fibrous plants is presented. Properties of bast fibres were distinguished in terms of their applications. Information on the use of the above-mentioned fibres in barrier and sound-absorbing products were presented, including a review of natural fibre-based insulation products available in Poland.

The experimental part contains the characteristics of the research material used to carry out the work and information on the preparation of bast fibres blended with wool for the production of mats, with particular emphasis on use of wastes evolving during the manufacture of strings. It also covers the preparation of a blend of flax and hemp fibres for the production of mats. In order to select the material for research, the criterion of the necessity to use the waste of native natural fibres and the production of bio-products was adopted, implementing the assumptions of the zero-waste strategy and the circular economy. This part also presents the process of manufacturing mats on an industrial scale with the use of a series of devices designed for processing bast fibres.

Bearing in mind, the global growing interest in natural fibres on the one hand and the problems of sheep growers on the second hand, resulting from difficulties in selling and managing domestic wool from sheep breeds grown especially in southern Poland, the review was conducted taking into account sheep breeds from the above-mentioned areas. Besides, the wool from different breeds was characterized in terms of the potential for applications in combination with bast fibres. Particular attention was paid to the breeds of typical mountain

sheep, whose wool is thick and heterogeneous, and practically its quality make it impossible to produce high-class products for clothing purposes. Therefore it is a challenge for both, entrepreneurs and scientists in terms of indicating its effective use. The study was carried out on fleeces from 14 different breeds of sheep with mixed (M) and uniform (J) fleece, from different voivodeships in southern Poland. A detailed analysis of the surface structure and cross-sections of the wool was carried out. The fibre diameter, length, content of impurities and fatty substances in greasy wool, hygroscopicity under various conditions of relative air humidity and the colour intensity were assessed. As a result of the conducted analysis, differences in wool were found not only between sheep breeds, but also within the same breeds from different flock. The obtained results of the research and the availability of the raw material on an industrial scale made it possible to select wool from Polish mountain sheep from the Śląskie Voivodeship for test to produce mixed mats with a different proportion of sheep wool in relation to waste bast fibres.

Waste bast fibres were tested thoroughly in terms of length, linear density, strength and hygroscopicity. In the following stage, tests were carried out by manufacturing mats with a different concentration of the percentage of natural fibres, i.e. 100% bast fibres; 25% wool/75% bast fibres; 50% wool/50% bast fibres; 75% wool/25% bast fibres; 100% wool. The mats were assessed in respect of metrological parameters such as thickness, surface weight, tensile strength and elongation, air permeability, as well as parameters determining their barrier properties, such as thermal resistance, thermal conductivity coefficient λ , sound absorption coefficient α and noise reduction coefficient NRC. In addition, the reaction to fire as well as thermal stability and compounds released during pyrolysis combustion were tested.

The obtained results of the study proved the developed thesis and confirmed that mats made on the basis of wool from Polish mountain sheep and waste bast fibres, show barrier properties in terms of thermal insulation and sound absorption of medium and high frequencies. However, the share of individual fibres in the blend has an impact on the properties of the product. Mats made of a blend with a higher proportion of wool are characterized by a lower heat conductivity coefficient, while mats with a higher proportion of bast fibres show a greater ability to absorb sounds.

Keywords: wool, sheep in Poland, flax and hemp wastes, mats, insulation material, thermal insulation, sound absorption.