

**Isolation and characterization of heteropolysaccharide preparations  
with bioactive properties from rye bran**

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## Abstract

Rye bran is a plant by-product produced in the process of grinding cereal grains into flour. The main component of bran are carbohydrates, and the majority of them are dietary fiber, which includes, among others, arabinoxylans and  $\beta$ -glucans. In addition, bran is an excellent source of micro- and macroelements and vitamins, especially B group. They also contain bioactive substances, including phenolic acids, especially ferulic and sinapic acids, as well as lignans, plant sterols and alkylresorcinols. Arabinoxylans, as a component of dietary fiber, have a beneficial effect on the human body. They have prebiotic, antioxidant, lowering LDL cholesterol, antidiabetic, anticancer properties - especially cancers located in the digestive system, and also strengthen the immune system. Rye bran is used primarily in the production of whole grain and graham bread. Thanks to their health-promoting properties, high-fiber preparations are obtained from them. Considering the positive impact of dietary fiber on the human body, technologies that introduce dietary fiber into food production and biotechnological processes are constantly being sought.

Based on scientific literature reports on the important health-promoting properties of heteropolysaccharides (HPS) in the field of medicine and food production and the possibility of using the extraction process to isolate fiber preparations from rye bran, the aim of the work was to obtain a water-soluble fraction of heteropolysaccharides isolated from rye bran with potential health-promoting properties.

The aim of the work was to determine the influence of the origin of the raw material, the year of cultivation and the size of the bran particles from which the preparations were obtained on their bioactive properties and to establish the conditions of the preparation isolation process in which they will show significant antioxidant potential. The effectiveness of the extraction process was assessed taking into account physicochemical analysis (including protein content, dietary fiber, carbohydrate profile) and biological analysis (including antioxidant potential, tests on cancer cell lines).

The conducted research has shown that as a result of using an appropriate isolation method with properly selected parameters, it is possible to obtain a water soluble fraction of heteropolysaccharides obtained from rye bran, with the least impact on the natural environment. It has been shown that the origin of the raw material, the size of the bran

particles, the year of harvesting the rye grain and the isolation process method have a decisive impact on the physicochemical and biological properties of the preparations.

Based on the conducted research, it was found that the heteropolysaccharide preparation obtained from the bran from the whole grind fraction from the 2015 rye grain harvest is characterized by the highest antioxidant potential, compared to the finely and coarsely ground fraction and the 2017 rye grain harvest. Weather conditions during the months of rye grain harvesting may also have a significant impact on this fact. Delving deeper into the aspect of the influence of bran particle size on the antioxidant properties of preparations, bran was divided into five fractions of different sizes. The analysis showed significant differences in the physicochemical and antioxidant properties of the obtained HPS preparations. It was found that preparations with larger particle sizes, i.e.  $>315\ \mu\text{m}$  isolated by the first isolation method, regardless of the year of rye grain harvest, are characterized by statistically significant differences in antioxidant tests, compared to bran particles  $<315\ \mu\text{m}$ . Also the isolation method: using the dialysis process or precipitation with ethyl alcohol and the origin of the raw material determine the bioactive properties of HPS preparations. It has been shown that preparations obtained from hybrid varieties of rye grains using the dialysis process have high bioactive potential. The method of the drying process - spray or freeze-drying - significantly affects the microstructure of the tested HPS preparations. Spray-dried HPS preparations have the form of microcapsules. The microstructure of HPS preparations is of particular importance, taking into account the possibilities of using the preparations as a potential carrier in encapsulation processes. Determination of the cytotoxicity of HPS preparations on the Caco-2 and HT 29 colon cancer cell lines confirmed their anticancer activity, especially in the case of HPS preparations isolated from bran with a particle size of  $315\text{-}600\ \mu\text{m}$  and whole grain bran.

Taking into account the obtained research results, it was found that the obtained heteropolysaccharide preparations may constitute an innovative food ingredient and raw material in biotechnological processes, with potential health promoting properties, including significantly increased bioavailability of ferulic acid and significant antioxidant potential, compared to rye bran. Also worth attention is the method used to obtain heteropolysaccharide preparations, which is consistent with the principles of so-called "green chemistry" and does not generate factors polluting the natural environment. What deserves

special emphasis is the fact that the value of the ratio of phenolic acids to the amount of arabinose in a given HPS preparation, determined by the size of bran particles subjected to the extraction process, has a significant impact on shaping the bioactive and biological potential of these preparations.