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Extraction of Mannan from Plant Raw Materials.

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ABSTRACT

The possibility of mannans extraction from brans, which are cheap waste of grain processing industry is shown in the article. It reduces the cost of obtaining the final product considerably and contributes to its competitiveness in the market. The identification of mannans hydrolysates carried out revealed the presence of mannose and mannooligosaccharides of different molecular weight and a small amount of impurity compounds.

Keywords: mannans, mannose, mannooligosaccharides, brans, non-starch polysaccharides.

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INTRODUCTION

Plant raw material has a complex structure and chemical composition, for the most part it is composed of cell walls. The presence of another specific group of non-starch polysaccharides - mannans in plant raw material was found by numerous scientific studies of the last decades. [1]**.** Normally mannans exists in the cell as a complex with glucan and protein. These chemicals together with arabinoxylans, beta-glucans, pectins belong to the group of non-starch polysaccharides and are not digested in the organisms of productive animals by their own enzymatic systems (fig. 1).

In most cases, in the main chain the sugar residues are interconnected with β-1.4-glycosidic bonds, and side chain substituents - with the main chain with α-1.6 bonds, however other structures are also observed.

Linear mannans are homogeneous linear polysaccharides which consist of linear chains formed by β-D-mannopyranose residues interconnected by 1.4 bonds, and contain less than 5% galactose.

Galactomannans are found in the seeds of eight botanical groups, three of which cover the temperate climate zones.

Glucomannans are polysaccharides present in large quantities in the hemicellulose fraction of softwood. They comprise chans in which β-1.4-linked D-mannose and β-1.4-linked D-glucose residues in a ratio of 3: 1 and a degree of polymerization of more than 200 are randomly arranged. Hard wood contains glucomannans with a ratio of glucose and mannose of 1: 1.5-2. The content of glucomannan in conifer wood is about 11%.

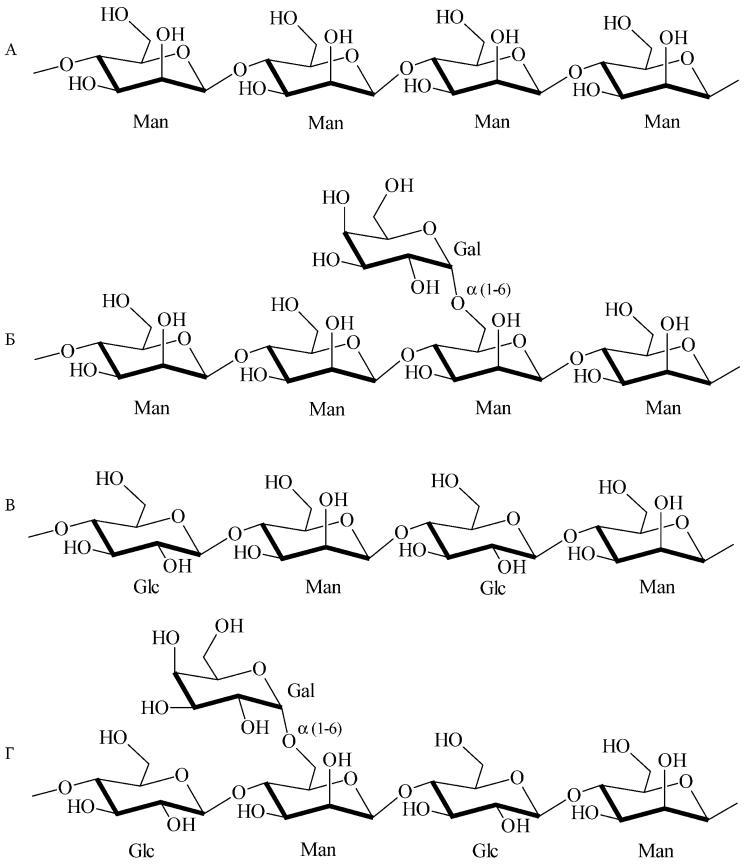

Figure 1: Different types of mannans A - mannan B - galactomannan C - glucomannan, D - galactoglucomannan

Galactoglucomannans are polysaccharides. Their main chain consists of β- (1 → 4) -D-mannopyranose and β- (1 → 4) -D-glucopyranose residues, being joined by α- (1 → 4) -D-galactopiranose units. They are the major components of the hemicellulose in softwood [2]. Galactoglucomannan extracted from spruce chips has the following structure: the degree of polymerization is in the range of 11 - 20, the molar ratio of mannose / glucose / galactose is 4: 1: 0.1, about 1/3 units of mannose are substituted by O-acetyl groups which are distributed between the 2nd and the 3d carbon atoms [3].

Mannans splitting products are mannooligosaccharides and mannose, which are referred to as bifidogenic factors. Mannose has several functional properties: it refers to a vitamin-like sugars it is involved in the synthesis of glycoproteins and glycolipids, it is also a part of immunoglobulin, it plays an important role in their biosynthesis and improving the immune status [4, 5, 6]. Adsorbents based on mannose bind mycotoxins firmly and protect the intestine from pathogenic bacteria [7]. In poultry and livestock the imported products representing complex with the glucomannanoprotein content of not less than 25% are widely used. There is no industrial output of similar additives in Russia.

MATERIALS AND METHODS

When selecting raw material for the extraction of mannans we paid attention to such criteria as plants being widespread on the territory of the Russian Federation, low cost, high percentage of mannans in the cell wall of plants.

As a raw material for mannans obtaining we studied waste wood production, widely available components of mixed fodders such as sunflower oilcake (rapeseed oilcake), wastes of grain processing industry - wheat and rye bran. All this is available raw material for the production of hemicellulose fraction rich in mannans, which greatly reduces the cost of the product.

However, the phase of mannans obtaining from wood waste production is associated with the additional step of delignification. The process is carried out with peracetic acid. Coniferous species are delignified at a temperature of 75-85˚C for 30 minutes with peracetic acid, which involves the introduction of the additional step of product purification [8].

There is no delignification stage in mannans extraction from meals, oil cakes and cereals brans . The content of of mannans in meals and cakes of oilseeds reached 2.9%, but they are a valuable protein component in fodder production [9].

Unlike oilcakes and meal wheat and rye bran are cheap wastes of grain processing industry. They are crushed shell of grain and are carbohydrate polymers with high levels of non-starch polysaccharides[10]. Thus waste products of grain processing industry are available material for the obtaining of hemicellulose fraction rich in geteromannans. They are low cost and have high mannans content, which significantly reduces the cost of the final product and contribute to its competitiveness in the market.

The mannans extraction scheme from bran is shown in Fig. 2 [11].

In the preparatory phase the bran is milled, mixed with water in the ratio of 1: 2 by weight. The mixture is then treated sequentially with solutions of alkalis to extract the polysaccharide fraction properly and fully. To separate arabogalactans the mixture is treated with the solution of barium hydroxide with a concentration of 10.8% within 20 minutes, potassium hydroxide is then added to a concentration of 10% and the mixture is stirred for another 20 min. The resulting sediment is washed with ethyl alcohol to separate glucouroxilans and then with water to precipitate the sediment from alkali. To extract mannan aqueous sodium hydroxide solution was added to the sediment to a concentration of 1%. The mixture is kept at room temperature for 20 minutes, then the filtrate is acidified with aqueous acetic acid solution for an optimal pH medium, which promotes more complete precipitation of mannans. The filtrate is then mixed with ethyl alcohol, the sediment is dried. The change in concentration or proportion of reagents during mannan extraction resulted in the appearance of impurity compounds in their composition.

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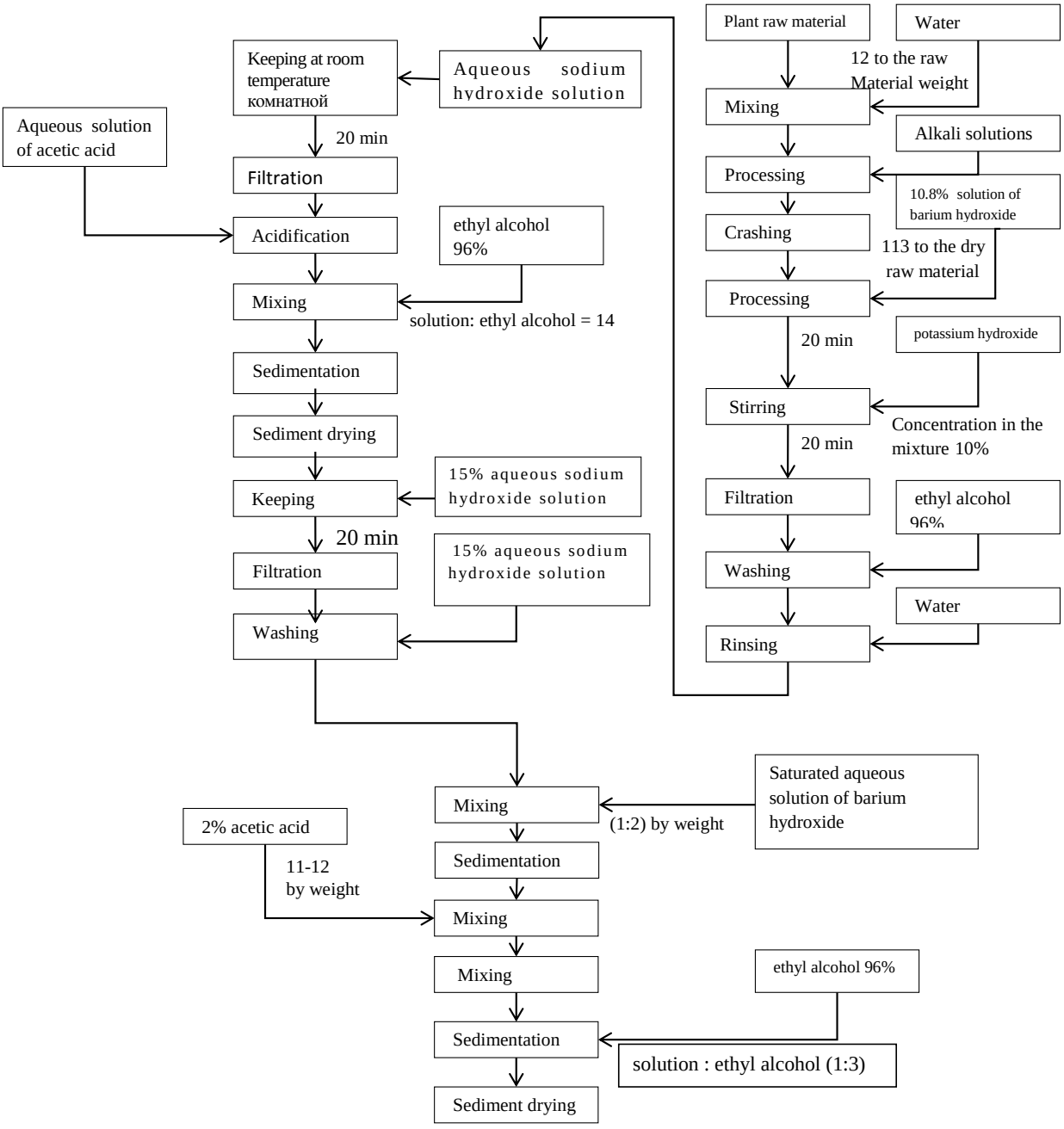

Figure 2: The mannans extraction from bran scheme

Mannans yield ranged from 21.6 to 23.3% for wheat and rye brans, depending on the type of raw material.

RESULTS AND DISCUSSION

Investigation of the obtained products of mannans enzymatic hydrolysis conducted with thin layer chromatography indicated the presence of more mannose, mannooligosaccharides, and small amounts of impurity compounds (fig. 3) [12, 13].

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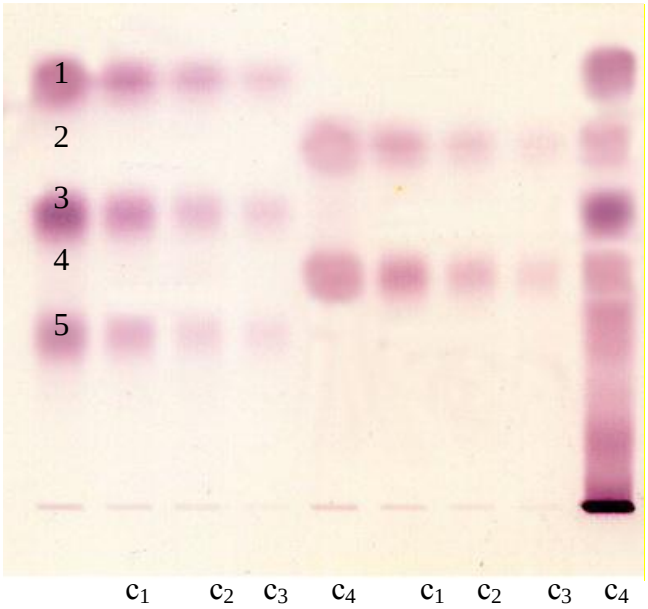

Figure 3: The chromatogram of bran mannans hydrolizates: 1 – mannose, 2 – mannobiose, 3 - mannotriose 4 - mannotetrose 5 - mannopentose, the concentration of mannose and mannanoligosaccharides, g / l: c_1 - 800, c_2 - 400, c_3 - 200, c_4 – 70 (hydrolysis time 3 hours).

CONCLUSION

The proposed method of obtaining mannans from plant raw material allows:

- To receive mannan with high yield,
- To reduce energy costs by carrying out reactions at low temperatures,
- To simplify the whole technological process.

Hydrolysis products of the extracted fraction of mannans were successfully used for the correction of intestinal microbiocenosis that today is the basic component of the treatment of diseases of the absolute majority of both people and livestock.

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