TECHNOLOGY, MACHINE-BUILDING, GEODESY

UDC 547.97

RATIONAL UTILIZATION OF AGRO-INDUSTRIAL COMPLEX WASTE

KATSIARYNA MAYORAVA,
SIARHEI YAKUBOUSKI, YULIYA BULAUKA
Polotsk State University, Belarus

The article presents the results of the investigation of adsorption activity of iodine and methylene blue from agro-industrial complex wastes: barley husk, radish and peanuts pericarp. It is shown, after the proposed methods for modifying, that microporous structure of the enterosorbents obtained from agro-industrial complex wastes, are close to the industrial enteric sorbents "Polifam", "Polyphepan" and activated carbon.

In conditions of high anthropogenic load on the environment, a number of harmful substances get into bodies of farm animals, and special substances called enterosorbents are used to purify their organisms.

Enterosorbents are medicines that can adsorb various chemicals and biological objects of endo- and exogenous origin in the digestive tract, without reacting with them chemically.

Enterosorbents have a porous structure, it means that there are some cavities in sorbent material in the form of channels-pores. Macropores are distinguished - with a radius of more than 200 nm, mesopores - in size from 100 to 1.6 nm and micropores - with a radius less than 1.6 nm. Micropores adsorb small molecules, while mesopores and macropores adsorb larger organic molecules.

Bonding of adsorbate by the sorbent is dynamic equilibrium process and it can be limited due to the adsorption activity of the sorbent.

Adsorption activity is a property of enterosorbents and is used to characterize adsorption capacity.

According to the chemical structure, enterosorbents are divided into carbon (activated carbon on the basis of birch wood, stone activated carbons on the basis of fruits, shells of nuts, etc.), silicon-containing (hydrogels and xerogels of methyl silicic acid, smectite dioktaedric, attapulgite, etc.) and natural organic (based on dietary fiber, for example, hydrolyzed lignin, chitin, cellulose).

Possibility of obtaining natural enterosorbents for veterinary medicine from agro-industrial complex wastes is represented in the current article.

The following samples of agro-industrial waste were used for investigation: barley husk (Hordeum vulgare), radish pericarp (Raphanus) and fruit pericarps (Arachis hypogaea).

The efficiency of the sorbent's "work" depends directly on its structural and surface properties, therefore, a promising direction in the modification of adsorption materials is to improve the microporous structure, such as grinding and extraction of ballast extractives with water and a dilute alkali solution.

The initial samples were dried to a moisture content of not more than 10% by weight and passed through several stages of crushing: primary grinding on a disk chipper, the second stage, where the particles of the samples were reground to obtain particles of a predetermined granulometric composition up to 1.0 mm, and dry mechanical grinding in a mill. After grinding the samples were subjected to dry fractionation on laboratory sieves, a fraction of 0.25-1 mm was isolated for the study. Then, the samples were processed in three ways:

1) 1 kg of raw material was loaded into an extractor with a stirrer, where distilled water was fed, massed into the raw material: water (1:50) - (1: 100). Process conditions: temperature (23 ± 2) °C and atmospheric pressure. The extraction time is 48 hours with the constant mixing. The solid residue was filtered off with a porous filter and dried at a temperature (103 ± 2) ° C to constant weight. The yield of the sorbent was 82.5% by weight. of the barley husk, 92.3% by weight. % of the radish pericarp and 95.0% of the pericarp of peanuts.

2) 1 kg of raw material was loaded into an extractor with a stirrer, jacket (electric heating) and condenser, where distilled water was supplied, the mass ratio of raw materials: water (1:50) - (1: 100). Process conditions: temperature (100 ± 5) ° C and atmospheric pressure. The extraction time is 3 hours; the mixing is constant. The solid residue was filtered with a porous filter and dried at a temperature of (103 ± 2) °C to constant weight. The sorbent yield was 81.1% by weight. of the husk of barley, 91.2% by weight. % of radish pericarp and 85.5% of peanut pericarp.

3) 1 kg of raw material was loaded into an extractor with a stirrer, jacket (electrically heated) and reflux condenser, where 1 ... 1.5% aqueous sodium hydroxide solution was fed, the mass ratio of the raw material: sodium hydroxide solution (1:50) - (1: 100). Process conditions: temperature (101 ± 2) °C and atmospheric pressure. The extraction time is 1 hour; the mixing is constant. The solid residue was filtered off with a porous filter, distilled water was washed until neutral and dried at a temperature (103 ± 2) ° C to constant weight. The sorbent yield is 39.5% by weight. of the husks (husks) of barley, 45% of the mass. % of radish pericarp and 56.6% of peanut pericarp.

For the obtained products, the adsorption capacity of iodine (according to GOST 6217) and methylene blue (according to GOST 4453) was determined by the titrimetric method.

Results, their discussion and perspectives. The greatest potential yield of enterosorbent from the three proposed methods, was obtained by the first method. Such ballast extractives as monosaccharides, dyes, glycosides are extracted mainly with cold water. A smaller yield of the sorbent obtained by hot water extraction according to the second method was due to removing monosaccharides, glycosides, proteins, amino acids, pectic substances and mono-oligo- and polysaccharides. The enterosorbent yield is 40-57% by weight from the investigated wastes of the agro-industrial complex was obtained by the third method. By using an aqueous sodium hydroxide solution according to the third extraction method, the following substances can be isolated: resins, fats, polyphenolic acids, lignohumic substances, low molecular weight lignin, poly-saccharides.

Electron microscopic examination showed the presence of micropores measuring 0.3-1 nm, transient pores, less than 3-5 nm in size and macropores, whose size is within the range of 5-50 nm.

Table 1 presents the generalized data on the adsorption capacity of iodine and methylene blue.

Table 1. – Adsorption capacity of iodine and methylene blue

Sorbent	Adsorption capacity			
	Initial form	The first method. After cold-water extraction	The second method. After hot-water extraction	The third method. After alkali extraction
Adsorption capacity of iodine, %				
Radish pericarp	24,36	24,78	26,88	28,98
Barley husk	22,37	22,47	23,52	28,56
Peanut pericarp	17,15	19,47	21,00	24,56
Adsorption capacity of methylene blue, mg/g				
Radish pericarp	146,23	195,23	195,61	225,10
Barley husk	95,11	143,33	180,00	210,00
Peanut pericarp	62,50	71,25	159,17	174,17

Adsorption activity of iodine characterizes the volume of micropores (about 1 nm) and, accordingly, the ability to sorbitolize relatively low molecular organic substances [1-6]. From Table 1, it can be seen that, according to this indicator, these samples are approaching industrial enterosorbents, for example, Belarusian enterosorbent "Polifam" (adsorption activity for iodine is 24.16%) and Russian brand "Polyphepan" (29.63%), that indicates the development of the porous structure of the residues using the proposed methods 1-3.

The adsorption capacity of methylene blue allows us to estimate the content of the microporor in the sorbent with effective diameters of 1.5-1.7 nm. From Table 1 it can be seen that the processing of samples with distilled water and dilute alkali results in the formation of additional pores up to 1.7 nm. It should be noted that according to this indicator, the sorbents obtained by the third method from radish and barley husks are more effective than the commercially produced enteric sorbents with activated carbon (210 mg / g) and Polyphepan (125.8 mg/g).

Thus, the perspective direction of utilization of the waste of the agro-industrial complex is their use as energy sorbents for veterinary medicine.

REFERENCES

1. Особенности микроструктуры отходов сухой окорки сосны как сырья для получения нефтяных сорбентов/ С.Ф. Я кубовский [и др.] // Вестн. Полоц. гос. ун-та. Сер. B, Прикладные науки. – 2011. – № 11. – С. 154–157.

2. Якубовский, С.Ф. Получение сорбента для сбора нефти и нефтепродуктов при их разливах путем утилизации отходов агропромышленного комплекса / С.Ф. Якубовский, Ю.А. Булавка, Е.И. Майорова // Вестн. Полоц. гос. ун-та. Сер. В, Промышленность. Прикладные науки. – 2017. – № 11. – С. 84–89.

3. Булавка, Ю.А. Использование отходов агропромышленного комплекса для получения нефтяных сорбентов / Ю.А. Булавка, С.Ф. Якубовский, Е.И. Майорова // XXI век. Техносферная безопасность. – 2017. – Т. 2. № 4 (8). – С. 38–47.

4. Майорова, Е.И.Получение нефтяных сорбентов на основе отходов растительных материалов / Е.И. Майорова, С.Ф. Якубовский, Ю.А. Булавка // Энергия молодежи для нефтегазовой индустрии : материалы Междунар. науч.-практ. конф. молодых ученых – Альметьевск : Альметьевский государственный нефтяной институт, 2017. – С. 177–183.

5. Mayorava, K. Sorbents for emergency filling oil and of petroleum products on the basis of vegetable raw materials / K. Mayorava, Yu .Bulauka, S. Yakubouski // Abstract book of 9th International Youth Scientific and Practical Congress «Oil and Gas Horizons», Moscow, November 28-30, 2017. – Gubkin Russian State University of Oil and Gas (National Research University). – Moscow, 2017. – P. 34.

6. Bulauka, Yu.Oil-sorbents on the basis of vegetable raw materials for collecting oil spill and petroleum products / Yu. Bulauka, E. Mayorava, S. Yakubouski // Еколого-енергетичні проблеми сучасності / Зб. наук. праць всеукраїнської наук.-техн. конф. молодих учених та студентів. Одеса, 14 квітня 2017 р. – Одеса : ОНАХТ, 2017. – С. 9–11.