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WHEAT BRAN DIETARY FIBER AS SORPTION MATERIAL

KVIEŠU KLIJU ŠĶIEDRVIELAS KĀ SORBĒJOŠS MATERIĀLS

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Introduction

The necessity of ecological standards observance compels to search new dissolution of technological processes development and more effective utilization of natural resources.
The use of sorption processes is known to help of dissolving of different ecological problems connected with removal of harmful impurities from wastewaters.
Ion-exchange resins are successfully used for this purpose. Besides that, there are some natural materials having sorption and ion-exchange ability. These materials have much smaller sorption capacity as compared with ion-exchange resins, but low cost of renewable natural materials might do the use of them attractive.
At present the utilization of different native products after minimal treatment for removal of impurities are intensively investigated [e.g,1, 2].
Earlier we have studied the sorption ability of pea bean dietary fiber [3].
The aim of present study is to evaluate sorption properties of dietary fiber isolated from wheat bran.

Materials and Methods

Wheat bran dietary fiber (DF) was isolated from commercial wheat bran by treatment with 0.5N NaOH solution, 0.5N HCl solution and washed with water. The absence of water soluble organics was controlled by permanganate oxidation.
Cu(II) ions sorption experiments were done in static conditions using NaCl or Na_2SO_4 solutions containing 50mg Cu(II)/l. 0.1g of DF was shaken with 100ml of solution during 1h. DF was preliminary swollen in water.
Desorption of Cu(II) ions was done using 10ml of 1N HCl solution. The time of contact was 0.5h.
Concentration of Cu(II) ions was measured photometrically at 435nm as complex with tetraethyltiuramdisulfide in acidic DMFA solution.
Methyl violet (MV) sorption was conducted from 0.05M acetate buffer solution containing 0.01mg MV/l, 0.1N NaCl and having pH 5.55. Kinetics experiments were done using 0.1g of DF and 10ml of MV solution.
Desorption of MV has been done by treatment with acidic water-acetone solution.
MV sorption dynamics has been studied using column (D-1cm, H-9cm).
MV concentration was measured photometrically at 540nm.

Results

Wheat bran appears to be the attractive source of non-soluble fibril polymers. Preliminary experiments testified about its sorption ability towards heavy metal ions, in particular, Cu(II) ions from solutions containing rather large concentration of neutral salts. The analyses revealed ion-exchange capacity of DF (Table1) which might be attributed to carboxylic functional groups.

Table 1

Physico-chemical parameters of DF

Effective density, g/l	Specific swelling in water, ml/g	Static exchange capacity in 0.1N NaOH, mg-ekv/g	Sorption capacity towards Cu(II) ions*, mg/g
0.27	10.0	1.0	4,7

*-from solution containing 0.5g Cu(II)/l and 0.5g Na_2SO_4/l

FTIR spectra of DF and DF after treatment with NaOH confirm this assumption. Carbonyl peak at 1727 cm^{-1} decreases after carboxylate groups appearance (peak at 1646 cm^{-1}) (Fig.1).

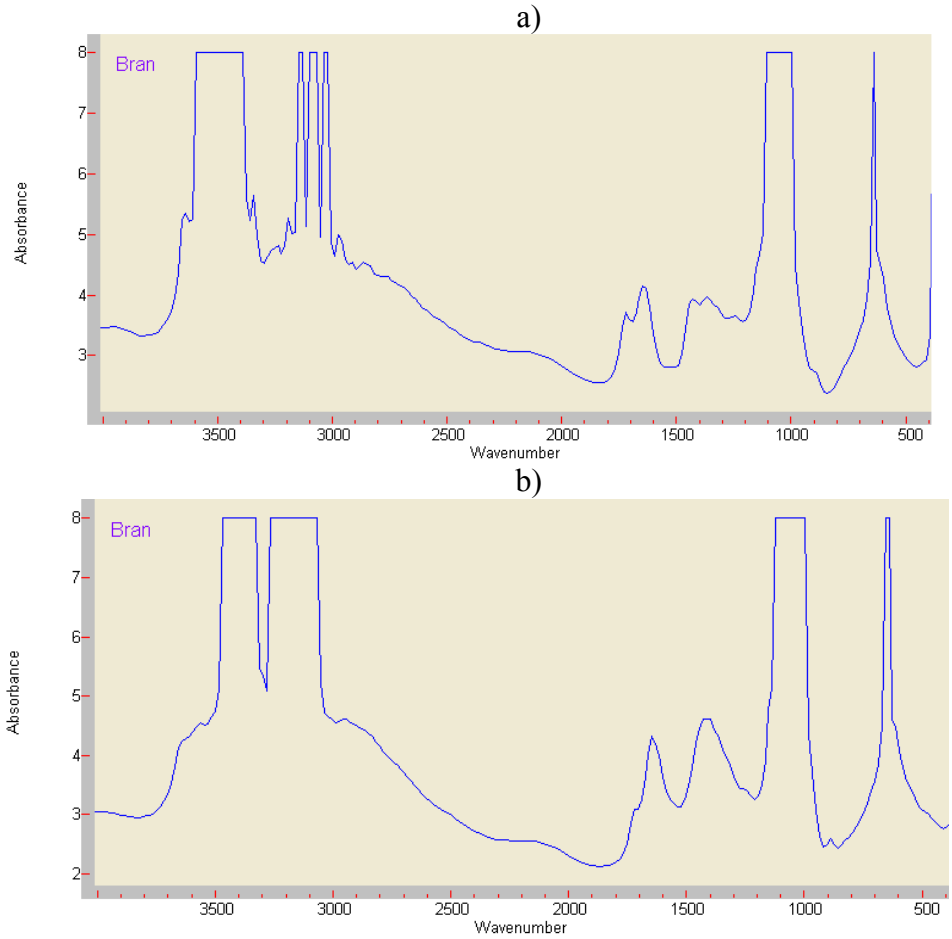

Fig.1. *FTIR spectra of DF (a) and DF- Na^+- form (b)*

Sorption capacity values of DF towards Cu(II) ions from solutions containing 0.5g/l and 5g/l of NaCl or Na_2SO_4 showed that neutral salt concentration tenfold increase arises decrease of sorption capacity (Fig.2). Besides that, sorption capacity from Cl^- containing solution is some higher that from SO_4^{-2} containing medium.

Threefold excess of Ca(II) ions deceases Cu(II) ions sorption value only twice what testify about selectivity of DF towards heavy metal ions. Sorption capacity values calculated from residual concentration of sorbate and concentration in the solution after desorption showed that degree of elution was almost quantitative.

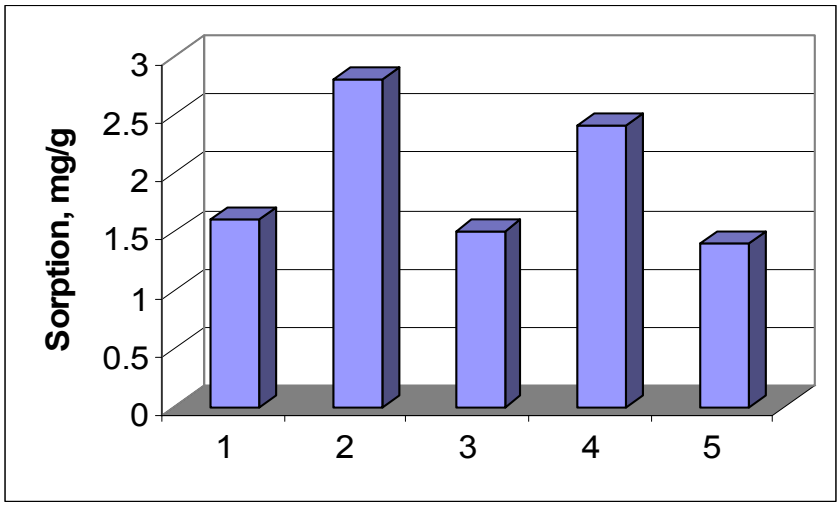

Fig.2. *DF sorption capacity towards Cu(II) ions from solutions containing: 1-5.0g NaCl/l; 2-0.5g NaCl/l; 3-5.0g Na_2SO_4; 4-0.5g Na_2SO_4; and 5-100mg Ca(II)/l and 0.5g NaCl/l*

Kinetics study showed that in conditions of experiment sorption of Cu(II) ions and especially of basic dye MV occurs quickly (Fig.3).

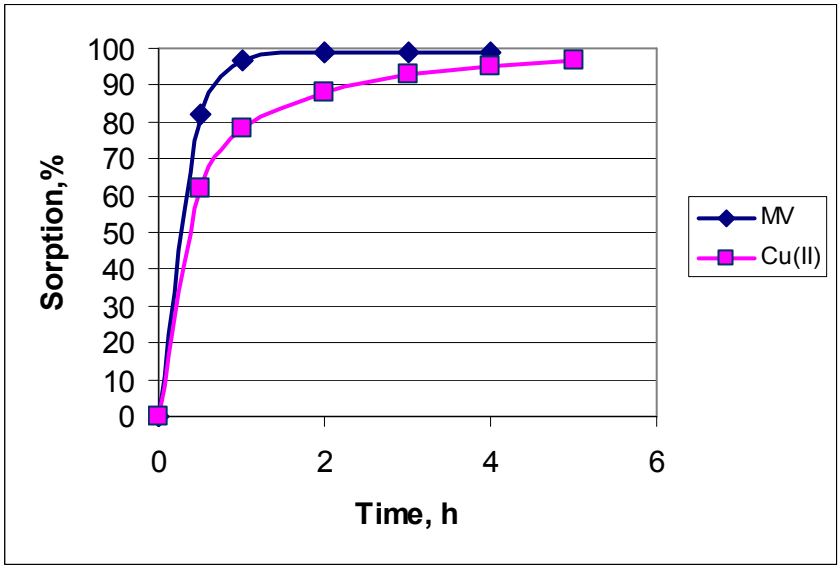

Fig.3. *Sorption kinetics of Cu(II) ions and MV*

MV sorption has been studied also in dynamics from buffer solution containing 10^{-2}mgMV/l (Table 2).

Table 2

MV sorption in column

Process	Passed through volume, $V/V_{sorb.}$	Flow rate, ml/cm^{2}h	MV concentration, mg/g
Sorption	32	150	0
Sorption	18	150	0—$2x10^{-4}$
Desorption	1	45-50	$30x10^{-2}$
Desorption	1	45-50	$6x10^{-2}$
Desorption	1	45-50	$2x10^{-2}$

The first 32 volumes of passed through solution were free of MV.
MV has been concentrated 30-fold in desorbate.

Conclusions

Dietary fiber isolated from wheat bran possesses sorption activity towards Cu(II) ions due to carboxylic groups in its composition.
Sorption capacity towards Cu(II) ions increases with the decrease of neutral salt concentration.
The sorption of Cu(II) ions and basic dye Methyl violet occurs quickly and reversibly.

References

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V.Krilova, L.Bērziņa-Cimdiņa, N.Borodajenko. Kviešu kliju šķiedrvielas kā sorbējošs materiāls. *Parādīta lēta dabīga materiāla izmantošanas iespēja šķīdumu attīrīšanai no vara(II) joniem un bāziskas krāsvielas metilviolēto. Sorbcija uz izdalītām no kviešu klijām šķiedrvielām pētīta no mazas koncentrācijas šķīdumiem. Pamatojoties uz FTIS spektriem tika konstatēts, ka sorbējoša materiāla jonapmaiņas spēju noteic karboksilgrupu esamība šķiedrvielu sastāvā. Demonstrēti dati par neitrālo sāļu koncentrācijas ietekmi uz vara(II) jonu sorbciju statiskajā režīmā. Vara(II) jonu un īpaši bāziskās krāsvielas sorbcija eksperimenta apstākļos notika samērā ātri. Bāziskās krāsvielas metilviolēto sorbcija izpētīta dinamiskajā režīmā. Kolonas procesa izmantošana ļāva pilnīgi attīrīt filtrātu no krāsvielas.*

Krilova V., Berzina-Cimdina L., Borodajenko N. Wheat bran dietary fiber as sorption material.
The opportunity of low-cost native material using for removal of copper ions and basic dye Methyl violet has been shown. Sorption on isolated from wheat bran dietary fiber has been studied from solutions with low concentration. Ion-exchange ability of sorption material is ascertained to be conditioned by carboxylic group's presence in dietary fiber composition what has been confirmed by FTIR spectra. Neutral salts concentration influence on sorption capacity toward copper ions has been demonstrated in static condition. Sorption of Cu(II) ions and especially of basic dye Methyl violet occurred rather quickly in conditions of experiment. The sorption of basic dye has been studied in dynamics. The column process allowed complete purifying filtrate from dye.

Крылова В., Берзиня-Цимдыня Л., Бородаенко Н. Клетчатка пшеничных отрубей как сорбирующий материал.

Показана возможность использования дешёвого природного материала – выделенной из пшеничных отрубей клетчатки – в качестве сорбирующего материала для очистки растворов от ионов меди и основного красителя метилового фиолетового при их малом содержании в растворах. На основании ИКС установлено, что ионообменная способность сорбирующего материала обусловлена наличием карбоксильных групп в составе клетчатки. Представлены данные по влиянию концентрации нейтральных солей на сорбцию ионов меди, полученные в статическом режиме. Сорбция ионов меди и особенно основного красителя в условиях эксперимента происходит сравнительно быстро. Сорбция основного красителя метилового фиолетового изучена в динамическом режиме. При использовании колонного процесса удалось полностью очистить фильтрат от красителя.