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EFFECT OF METAL CHLORIDES ON THE YIELD AND QUALITY 01· FURFURAL AND ACTIVE CARBON FROM CORN COBS

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This study was undertaken to detennine the optimal utilization of corn cobs for the production of furfural and active carbon by digesting them with various hydrolyzing acids. in the presence of added metal chlorides. Corn cobs were refluxcd with various concentrations ofH,S04 and HCl separately for 100 and 140 minutes in the presence of added metal chlorides (t'JaC\, CaC'l,. AlCl, and ZnCIJ. The refluxed material was distilled and furfural was extracted from the distillate. The maximum furfural yield was obtained with 14% H,SO ı and AlCl) at 140 minutes digestion time. The residue left after tl!e extraction offurfural was activated directly at 7000C for one hour for the production of active carbon. The maximum yield of active carbon was obt;wled with 14'X, HCl at lOO minutes digestion time with CaCl,. The active carbon was evaluated for its adsorption capacity using iodine and methylene blue by standard methods. The maximum adsorption capacity of active carbon for methylene blue and iodine was obtained with 16% H_2S0_4 with AlCl) at 140 minutes digestion.

Key words: active carbon. adsorption capacity. corn cob. furfural. metal chlorides

lNTRODUCfION

Furfural-a nve-membered heterocyclic aldehyde. is a degradation product of hemicellulose constituent of the plants. Hemice~lulose is made up of chains of complex sugars called pentosans which can be easily hydrolyzed to pentoses. These are readily converted into furfural by acid hydrolysis in a complex process. Active carbon is a powdered. granular or pelleted form of amorphous carbon characterized by a very large surface area per unit volume. Any cellulosic and carbonaceous material of fossil fuel on carbonization and activation in the absence of air yields active carbon. A number of successful attempts have been made here to produce active carbon and furfural from various indigenous wastes. Among these are Kat. Sawdust. Bagasse. Sarkanda. Khabble grass. Pahari Kikar, Dhabb. etc. (Chughtai et a!" (1986. 1987. 1989. 1990. 1991. 1993. 1996).

After wheat and rice. corn is the most important cereal grain in the world providing nutrients for humans and animals. A number of chemicals such as furfural. active carbon. xylose. etc. can be prepared from corn cobs. The present study was an extension of the previous work and it described the optimal utilization of corn cobs for the production of furfural and active carbon by digesting them with various hydrolyzing acids. However. the present work involved the addition of various metal chlorides along with hydrolyzing acids during digestion. The addition of metal chlorides improved the yield as well as the quality of the products.

MATERIALS AND METHODS

Corn cobs were collected from the Rafhan Maize Products Co. Ltd. Faisalabad. These were first sun-dried followed by oven drying at 105°C to a constant weight. The dried material was pulverized to a fine mesh and stored in a desiccator as stock samples. The stock samples (50 g each) were refluxed with SOOml of various concentrations (14% and 16%) of H_2S0_4 and HCl for different time periods (100 and 140 minutes) with 2% added metal chlorides such as NaCl. $CaC1_2$. zecr, and AlCl,. The refluxcd material was distilled to get furfural which was extracted from the distillate and estimated colorimetrically by the method of Chuulua: et al. (1986). The residue left after the production of furfural was activated directly at 700°C for one hour to get active carbon. The carbonized mass was cooled to room temperature and then ground to a fine mesh Adsorption efficiency of the resulting activated carbon was then tested by methylene blue and iodine decolourizing index using standard methods (Beg and Usmani.19X5). The data thus obtained were analyzed using analysis of variance technique as described by Steel and Torrie (1984).

RESULTS AND DISCUSSION

The furfural yield obtained with H_2SO, and I-1("lhaving different concentrations and for different digestion periods. using various metal chlorides is shown in Table I. The study revealed that with increasing digestion time and acid concentration. furfural yield first increased up to a certain limit and then declined. These results are in accordance with the results of Chughtai et al. (1986. 19X9) The study showed that the maximum yield of furfural was obtained with AlCl) in case of H_2S0_4 at both concentrations and digestion times. and with $ZnCl_2$ in case of HC\. It was observed that the maximum yield of furfural (17.X%) was obtained with 14% H_2S0_4 at 140 minutes digestion time with AlCl). The yield of furfural in this study was higher than that of the previous study when the sank raw material was hydrolyzed using the same concentrations of these two acids at different digestion times but without added metal chlorides (Nusrat, 1997). This increase in yield of furfural appeared to be due to the addition of metal chlorides.

The results of average percentage yield of active carbon have been presented in Table 2. Yield of active carbon decreased with increasing digestion period and with increasing concentration of both the acids. The maximum yield of active carbon in case of H_2S0_4 was obtained with lnC',. while in case of HCI it was with $CaCI_2$. It was observed that the maximum yield (32.0%) was obtained with 14% HCI at 100 minutes digestion time with CaCI,. Yield and quality of active carbon in this study is better than that of the previous study when the same raw material was hydrolysed using different concentrations of acids for different digestion times without adding metal chlorides (Nusrat. 1997). This again seemed to be due to the addition of metal chlorides.

The adsorption capacity of active carbon evaluated with iodine and methylene blue is given in Tables 3 and 4. The adsorption capacity of each sample was compared with the adsorption capacity of commercially available sample (E-Merck) having values 663 mg iodine/g and 120 mg methylene blue/g of active carbon. The adsorption capacity of thc active carbon increased with increasing digestion time. This is in accordance with the findings of Chughtai et al. (1989. 1990. 1993). However. adsorptive power of the product increased with increasing concentration of both the acids. The maximum adsorption capacity was obtained with AICI) in case of H,S04 and with Znf'l, in case of HCI. It is obvious from the results that the maximum adsorption capacity of active carbon for methylene blue and iodine was 65.00 and 368.78 mg/g respectively, obtained with 16% H,SO, with AICI) at 140 minutes. It may therefore be stated that 16°/', H,SO, in the presence of AICI) (2%) is a better hydro lyzer/act iva tor.

Table I. Comparison between average yield (%) of furfural at various concentrations of H_2S0_4 and HCI, digestion periods and metal chlorides

Metal chloride (2%)	Acid Cone.	Acid used	Digestion time in minutes	
			100	140
NaCl	14%	H_2S0_4	15.35	17.50
$CaCl_2$			15m	17.25
AlCI)			15.46	17.80
lnCI,			14.75	17.m
NaCl		HO	Il.ll	13.50
Caq			II.m	13.00
AICI,			11.25	13.25
zno,			11.35'	13.75
NaO	16%	H_2SO_4	1('.50	125(.
CaCI,			10,30	12.73
AlCI)			lo.XO	12.'J2
ZnO,			15X5	12.10
NaO		HO	IUI	I·W)
CaCI,			11.50	IJXI)
AlCI)			HXI	I·UO
$lnCI_2$			12.m	1·15{)

Table 2. Comparison between average ~'iehl ('~,) of actin' carbon at various concentrations of "lS04 and HCI, digestion periods and metal chlorides

Metal chloride (2%)	Acid Cone.	Acid used	Di~t'stion time in minutes	
			IIIH	I~II
NaO	14%	H_2SO_4	1X,7	15,-1
$CaCl_2$			I')A'	J(•X
Alq			175	1-lA
$lnCI_2$			2fl,ll	17.0
NaO		HO	1!-14	2KX
$CaCl_2$			no	2ıJ,-1
AICl)			.11.0	28,{-,
$lnCI_2$			.IOA	2(d,
NaCI	16%	H_2SO_4	1),(,	II,-1
$CaCl_2$			11.4	11.0
AlCI)			12.0	10.7
$lnCI_2$			l·lO	11.8
NaCl		HO	.nx	2U,
$CaCI_2$			25.5	22,5
AlCI)			2-l0	22,0
$lnCI_2$			23.1	20.X

Table 3. Comparison between average adsorptien capacities expressed as mg of iodine acJsorhed b~ Ig active carbon (powder form) nhtained frnm residue left after distillation with commercial H_2S0_4 and HCI, at 700°C

Metal chloride (2%)	Acid Cone.	Acid used	Di~t'stion time in minutes	
			11111	1411
NaO	14%	H_2SO_4,	2fl57X	287.20
$CaCl_2$			2fll\6	28175
AlCI)			2fl7 12	2lJ2JO
$lnCI_2$			25'f20	27K3-l

NaCl			195.12	202.56
CaC~		Ha	193.30	200.73
Ala,			196.85	205.75
zeo,			198.34	20734
NaCl			330.12	357.63
Can		H_2S0_4	322.63	362.20
AlCl,			335.30	368.78
$lnC1_2$	16%		32157	353,17
NaG			223,12	242.90
eaq		Ha	219,12	239.50
AICl)			225.59	238.50
$lnCI_2$			226.63	247.85

Standard adsorption capacity of active carbon (E. Merck) = 663 mg iodine/g.

Table 4. Comparison between average adsorption capacities expressed as mg of methylene blue adsorbed by Ig active carbon (powder fonn) obtained from residue left after distillation with commercial "2S04 and HCI, at 700°C

Metal chloride (%)	Acid Cone.	Acid used	Digestion time in mlnutes	
			100	140
NaG			50	58
$CaCI_2$		H_2S0_4	49	56
AlCI,			52	59
zOO,			48	55
NaCI	14%		26	31
Caq		Ha	25	30
AlCl)			27	32
zeo,			29	33
NaO			61	64
$CaCl_2$		H_2S0_4	61	64
AlCI,			62	65
$lnCI_2$			60	63
NaCl	16%		36	45
CaC~		Ha	35	43·
AlCI,			37	44
lnCl..			39	46

Standard adsorption capacity of active carbon (E. Merck) = 120 mg methylene blue/g.

REFERENCES

Beg, AM. and TH. Usmani.. 1985. Low ash activated carbon from rice husk. Pak.. *I.* Sci. Ind. Res. 28(J.):2X2-2R(,

Chughtai, FA, A. Ahmad, MA Rashid '\lld A. Hussain. 1986. Preparation of furfural from Kai *(Saccharum spontaneum).* Pak. 1. Agri. Sci. 23(1): 1-J..

Chughtai, FA, TH.. Syed, A Hussain. G. Rasool and MA Bhatti. 1987. Formation of furfural from Sarkanda *(Saccharum munja).* Pak. 1. Agri.. Sci. 24(3): 190-193.

Chughtai, FA., *I.* Abbas, A Illahi and G. Mohyuddin. 1989. Recovery of furfural from Pahari Kikar *(l'rosopis juJiflora).* Sarhad J. Agri. 5:37-39.

Chughtai, FA, S. Munawar, F. Nisa and S. Nawaz. IYYO Acid hydrolysis of poplar to produce furfural.. Sarhad J. Agri.6(1):21-23.

Chughtai, FA, *I.H.* Nazli and M. Moazzam. IYYI. Chemical activation of various indigenous materials to prepare active carbon. 1. Pure Applied Sciences, 11(1) 11-11.

Chughtai, F.A. I. Ishaq, *I.H.* Nazli and T Azi>.. 19ı)J. Errcct of chemical treatment on the quality of active carbon from Dhabb *(Typha angustata). lAPS.* 30 (J -2):5 1-'iY.

Chughtai, FA, *Z.* IqbaL *I.H.* Nazli and JA.Awall. 19% Activated carbon from sawdust.. *lAPS.* <>(l-.J.)119-120.

Nusrat, S. 1997. Optimal utilization of COrti cobs for the production of furfural and active carbon MSc. Thesis. Univ. Agri., Faisalabad.

Steel, R.G.D. and 1.H. Torrie. 1984. Principles and Procedures of Statistics. 2nd ed. McGraw Hill Book Co. Inc.. New YOlk