

**PREPARATION AND CHARACTERIZATION OF .
MODIFIED CORNCOBS TO BE USED AS COAGULANT
MATERIAL IN INDUSTRIAL WASTE WATER
TREATMENT**

[2]

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ABSTRACT

In this work, chemically modified corncobs was used as coagulant in waste water treatment. This chemical modification was performed by allowing powdered corncobs to react with ethylene diamintetraacetic acid (EDTA) and epichlorohydrin in alkaline medium. Factor affecting the nitrogen content in the produced amphoteric corncobs (ACC) e.g. reaction time, temperature and amount of (EDTA) added were studied. The product obtained (ACC) was characterized using analytical and spectrophotometer tools, elemental and thermogravimetical analysis besides FTIR and ¹H-NMR .The product obtained was characterized by FT-IR, ¹H-NMR spectroscopy. The adsorption efficiency of (ACC) for metal ions in water as Cu and Zn was determined using atomic absorption spectrometry (AAS). It has been shown that there is a noticeable change in the specification of the treated water by the suggested (ACC) exemplified by least amount of organic matter, turbidity, solid substances and other elements existing in waste water.

Keywords: polyelectrolytes, amphoteric corncobs, water treatment, industrial waste water.

INTRODUCTION

Polyelectrolytes are long chain soluble organic polymers carrying ionically active functional groups along their chain length. When they are placed in water, the type of charge and degree of ionization of these functional groups determine the charge character of the polyelectrolyte. The active groups may be electropositive in which case the polymer will be a cationic polyelectrolyte and thus used as flocculant for negatively charged particles. If the active groups are electronegative, the polyelectrolyte will be an anionic one, and used as flocculant for positively charged particles. Amphoteric polyelectrolytes have both distributed positive and negative sites.

Agricultural wastes such as rice straw, cotton stalks and corncobs are produced in huge amounts during harvest and food production processes and these agricultural wastes were of research concern in many previous works [Agulló *et al.*(2004), Bedelea *et al.* (2006), Argun,(2008)].The utilization of these wastes causes minimization of potential waste disposal problems. However, agricultural wastes represent an effective cheap, biodegradable and environmentally safe for preparation of ion exchangers that are valuable for water treatment [Domard(1996) ,Jeon (2003), Guibal, (2004) and Esam(2008)]. It was realized that ion exchangers have diverse uses and are extensively utilized for treatment of waste water [Muzzarelli (1985) and Ogawa *et al.*(1993)].

Agricultural wastes are mainly composed of a mixture of complex polysaccharides and lignin. The chemical and physical properties of them can be modified by grafting a synthetic polymer onto the backbone of natural polymers [Patilet *et al.*(2000)]. For highly negatively charged colloidal particles,

cationic polymers are more suitable as flocculating agents to remove finely divided solids from aqueous suspension [Roberts, George (1992), Qiu and Zheng (2009) and Shukla *et al.* (2009)].

Because of the charges, polyelectrolytes can coagulate and precipitate colloids. The most important coagulants used in water and wastewater treatment are alum, ferrous sulfate, ferric sulfate, and ferric chloride. These coagulants carry specific charges. The coagulation of colloids is affected by the ions of an added electrolyte that has a charge opposite in sign to that of the colloidal particle; the effect of such ions increases markedly with the number of the carried charges [Degremont (1991), Suhardi (1993)]. Thus, comparing the effect of FeCl_3 and $\text{Al}_2(\text{SO}_4)_3$ in coagulating positive colloids, the latter is 30 times more effective than the former, since sulfate has two negative charges while the chloride has only one. In coagulating negative colloids, however, the two have about the same power of coagulation. Other coagulants have also been used but, owing to high cost, their use is restricted only to small installations. Examples of these are sodium aluminate, NaAlO_2 , ammonia alum, and potash alum.

In this work, we report the conversion of corncobs as agriculture waste into effective, economic, biodegradable and valuable coagulant to be used in water treatment.

MATERIALS AND METHODS

1-Raw material:

Corn cobs were obtained from local farms in Giza, Egypt.

2-Chemicals:

Ethylendiaminetetraacetic acid disodium salt(EDTA) disodium salt was supplied by S.D. fine-chem Ltd POICHA (R)391 340., Epichlorohydrin (99%) was supplied by MERCK-Schuchardt. Copper sulphate and zinc chloride from Merck (Germany) were used as received without further purification for preparing standard metal solutions by dissolving in de-ionized water. Other chemicals of laboratory grade were used.

3-Removing of lignin from corncobs:

The removal of lignin was processed according to previous method [Silva *et al* (2015)] as follows:

The corncobs powder of 10g was added to 200 ml of 4%NaOH in 20 % ethanol and heated at 60°C with stirring for 5 hours to dissolve the lignin. The suspension was allowed to cool to room temperature and filtered through Whatman filter paper. The filtrate of free lignin corncobs (hemicellulose) was dried and grinded into a fine powder then sieved in 200µm sieve. The product was stocked for the preparation of amphoteric corncobs(ACC).

4. Preparation of (ACC):

2g from ethylenediaminetetraacetic acid (EDTA) were dissolved in 50ml deionized water. 2ml of epichlorohydrin were added to the (EDTA) solution. 6 portions of 2g.of free lignin corncobs powder were poured into (10ml) of aqueous (NaOH) solutions. The solution of (EDTA) was added in different amounts to the above mentioned free lignin corn cobs solutions drop wise with continuous stirring in stoppered flasks at different temperature and time on a water-bath. Next, after cooling the reaction mixture to room temperature, the solutions pH was adjusted to 7 using conc. HCl. The resulting substituted

corncoobs amphoteric derivative remained in the aqueous reaction medium. The produced (ACC) were stored until used.

5-Analyses:

5-1.Elemental analysis: Carbon, hydrogen, and nitrogen contents of corncoobs specimens were determined using CE instruments EA 110 CHNS-O Elemental Analyzer at microanalysis center, Cairo University.

5-2. Thermogravimetric Analysis (TGA): Thermogravimetric analysis of the corncoobs and its derivatives were performed with Thermogravimetric determinator Leco: Mac-500. ST. Joseph, Michigan-USA. This apparatus provides a continuous measurement of sample weight at a range of temperatures between ambient and 600 °C. Samples were heated in an alumina cell to 600 °C at heating rate of 10 °C/min with nitrogen as the circulating gas.

5-3.IR measurements: The spectra of corncoobs and (ACC) samples (in the forms of KBr disks) were obtained using an IR Instrument (JASCO FTIR 4110, Japan) with a frequency range of 4000-400 cm⁻¹, at microanalysis center, Cairo University.

5-4. ¹H-NMR measurements: The ¹H-NMR of native and (ACC) was measured using Photometer Nanocolor 300D in microanalysis center, Cairo university.

5-5.Water analysis:

5-5-1. Determination of Turbidity of water: Turbidity of water was measured in nephelometric turbidity units (NTU) using Helige digital direct reading turbidimeter.

5-5-2. Determination of organic matter in water: Organic matter was determined by consumption of KMnO_4 in acidic solution.

5-5-3. Determination of metal ions in water: The metal ions in water were quantified using Atomic Absorption Spectrometer, Solaar S-4 S- Series Thermo Electron Corporation UK.

5-5-4. Determination of pH: The initial and final pH of solutions were determined using a cumet pH meter model 810 Fisher scientific.

5-5-5 Determination of zero charge (pH_{pzc}): The point of zero charge (pH_{pzc}) was determined by the solid addition method applying batch technique. A number of flasks, each containing 100 ml of KNO_3 solution (0.01 M) were loaded with 0.1 g of (ACC) after the adjustment of the pH between 1.8 and 12.0. Solutions of 0.1 M NaOH or 0.1 M HCl were used for adjustment of the initial pH. After continuous stirring for 24 h, the final pH of each solution were measured. The point at which the final pH is equal to the initial one is called (pH_{pzc})

5-5-6. Determination of removal efficiency: % Removal of metal ions, were calculated from the following equation:

$$\% \text{Removal} = C_0 - C / C_0 \times 100$$

Where, C_0 and C = metal ion concentration, organic matter and turbidity of wastewater before and after coagulation process by corncobs derivative, respectively.

2.6. Batch adsorption experiments:

Batch experiments were carried out using (ACC) as adsorbent. Cu (II) and Zn (II) were used as the source of Cu and Zn in the synthetic aqueous solutions. The stock solutions of Cu and Zn (100 mg/L) were prepared by

dissolving proper amount of material in deionized water. Solutions containing 30 mg/L of each of the salts were prepared from the stock solution. Adjustment of pH was carried out using 0.1N NaOH and/or 0.1N HCl. All the experimental conditions were optimized to achieve maximum removal efficiency by the prepared (ACC) then the optimized conditions were applied. To maximize metal removal by the adsorbent, batch experiments were conducted at ambient temperature using the optimum conditions of all variant factors such as temperature and time, dose and pH. The change in element concentrations due to adsorption were determined by atomic absorption spectrophotometer according to standard methods.

RESULTS AND DISCUSSION

The grinded native corncob was analyzed using energy dispersive X-ray (EDX) and elemental analysis it has the following specifications:

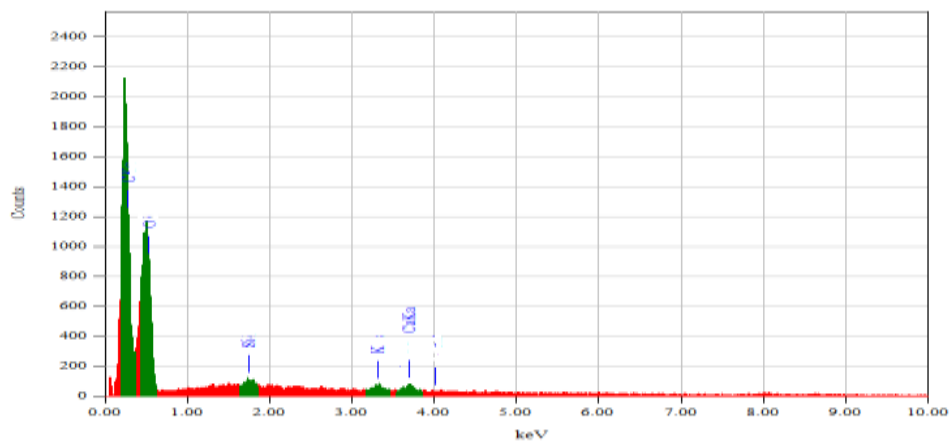


Figure (1): Energy dispersive X-ray (EDX) of native corncobs

Figure (1) The X-ray analysis chart, which show that the native corn cobs contains each of C , Si , K and Ca elements.

The results of elemental analysis of native corncobs are listed in the following table:

Table (1): the elemental analysis of native corncobs

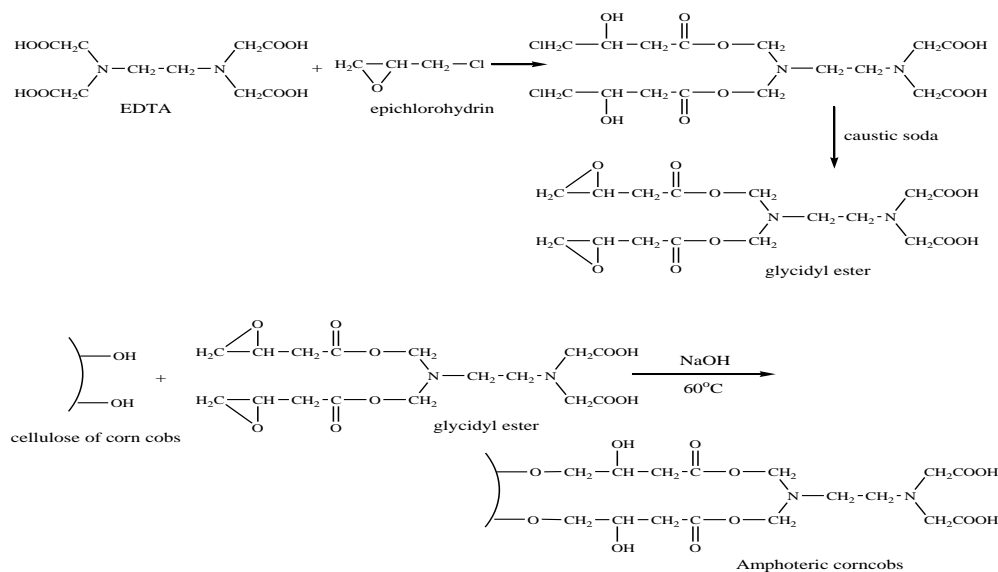
Element	C	H	N	S
Percentage	24.54	4.00	0.17	Nil

- **Tentative mechanism:** The reaction between polysaccharides and alkali oxides had been known for many years and has often been cited in the literature [Khalil and Aly (2001 a),Hafez *et al*(2014)]. The cross-linking method using EDTA has raised concerns since EDTA act as not only a cross-linker but also metal binding sites[Guo (2009) andZhao, (2015)].More importantly, EDTA is cheaper and less toxic in comparison with conventional cross-linkers, so it could be an excellent system for the proposed application.

The application of this reaction to corncobs, however, is somewhat limited. In this manner, (ACC) were prepared by reacting the free lignin corncobs (Hemicellulose) with (EDTA) in the presence of epichlorohydrin in alkaline medium:

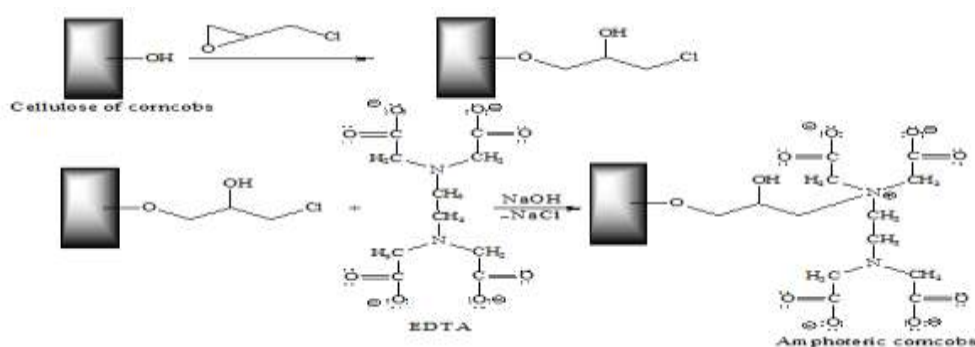
There are two expected pathway for these reactions as represented by schemes (A), (B).

Scheme (A)



Amphoteric corncobs having amino and carboxylic groups

Scheme (B)



Amphoteric corncobs having amino and carboxylic groups

1. Parameters affecting the production of (ACC): The parameters influencing reaction of epichlorohydrin with ethylenediaminetetra acetic acid(EDTA) and corncobs, for example, time , temperature of reaction, and

additionally, corncobs /EDTA proportion are studied to decide the ideal conditions for reaction yield as nitrogen content.

Table (2) represents the effect of reaction conditions on the produced (ACC) by changing the temperature and (EDTA) ml added.

Table (2): The effect of reaction condition on the constituents of the produced (ACC) (C,H,N).

EDTA ml add	Temperature								
	40 °C			60 °C			80 °C		
	C	H	N	C	H	N	C	H	N
0	24.54	4.00	0.17	24.54	4.00	0.17	24.54	4.00	0.17
3	28.36	4.50	0.22	27.15	4.60	0.37	32.13	4.81	0.40
6	28.01	4.48	0.36	34.28	5.23	0.46	37.18	5.51	0.28
9	29.41	4.89	0.38	31.43	4.79	0.39	41.93	5.20	0.08

1-1-Temperature of reaction: Table (2) shows the influence of temperature on the nitrogen content of the corncobs derivatives. There is nitrogen content increment as the temperature is raised up to 60°C. This might be ascribed to the fact that, by increasing the temperature the swelling of corncobs diminished, so that the entrance of the amine through the corncobs granules will be less demanding prompting raise the nitrogen content. Additionally, the mobility of the ions and the molecules increments by raising the temperature of the subsequent in an augmentation in the rate of reaction. All things considered, at a low temperature the consistency of the arrangement expands prompting abatement in the entrance of the amine through the corncobs, which turns out to be more viscous resulting in a decrease in the reaction rate giving less nitrogen content in the (ACC) obtained.

1-2 (EDTA) ml added: The results of table (2) reveal that increasing the amount of (EDTA) at the same time and temperature increases the nitrogen content of the product till 6 ml expect at 80 °C where furthermore increasing of (EDTA) leads to leads to decrease in the nitrogen content.

1-3. Reaction time: The effect of reaction time on the nitrogen content of (ACC) produced is reprinted by Fig.2. It is clear that increasing the reaction time led to an increase in the nitrogen content till 90 min, after that the nitrogen content will kept constant. This may be attributed to the increasing of reaction time leads to increase of the reactivity of the ions and molecules in the reacting medium.

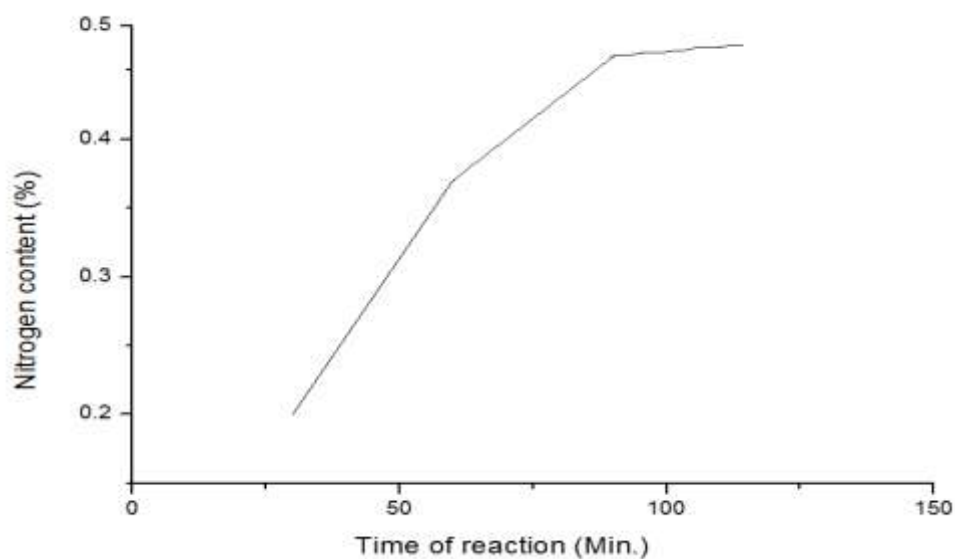


Figure (2) Effect of reaction time on nitrogen contents of (ACC)

2- Investigation of the produced (ACC):

By the changing of previous reaction factors, we were able to obtain 9 samples of (ACC) with different nitrogen contents. The higher one was obtained at the optimum conditions (6ml EDTA, 8% Na OH and 90 min at 60 °C).

2-1. FTIR of the corncobs and its derivative: The infrared spectra of both native corncobs and the produced (ACC) were performed to investigate the changes occurred in the functional groups during the reaction. For corncobs, strong and broad bands appeared at 3430 cm⁻¹ characteristic of the chelated OH groups. The band at 2927 cm⁻¹ is due to the stretching frequency of -CH₂- groups. The infrared of the produced (ACC) showed beside the absorption band at 3430 cm⁻¹, which is characteristic of the unreacted free OH groups, two absorption bands at 1700 and 1730 cm⁻¹ characteristic of the stretching frequencies of the carboxylic and ester groups of the (EDTA) moiety in the final product (ACC).

2-2. ¹H NMR of the native corncobs and its derivative: The ¹H NMR of both native corncobs and produced (ACC) was also performed to confirm the chemical modification of the native corncobs. The downfield signals of the -OH protons appeared at δ = 13.5 ppm in both native corncobs and (ACC). Additionally, the latter showed signals at δ = 3.5 ppm characteristic of deshielded methylene protons attached to the nitrogen atom. Definitely, this indicates the incorporation of (EDTA) moiety in the produced (ACC).

2-3. Thermogravimetric analysis (TGA) TGA is a straightforward and precise technique for detecting the decay design and the warm strength of the polymers. Figures (6) demonstrate the thermogravimetric analysis (TGA) for

corncobs and amphoteric corncobs (represent the higher nitrogen content sample). It is obvious that, the range for corncobs Figure (6) have three characteristic stages for decomposition. The principal arrange begins at 100 °C and ends at 150 °C with a weight reduction of 6 %. This could be perceived as due to the moisture content of corncobs. The second stage, which identified with the primary decay of corncobs macromolecules happens in one stage of decomposition begin at 150 °C and ended at 250 °C with most extreme deterioration temperature of 250 °C and weight reduction of 20%. The third phase of weight loss was identified with the carbonization procedure, which happened up to 400 °C with a weight reduction of 98%.

For the considered corncobs derivatives, the primary stage begins at 100 °C and end at 150 °C with weight reduction of 14%. The second phase of decomposition, representing the main decomposition, continues in two stages. The initial step began at 150 °C and end at 250 °C. The weight reduction in this step for the studied sample was 42 %. This step of degradation simulates and corresponds to main degradation process recorded for corncobs. This degradation, most likely, could be identified with the degradation of (ACC). The third phase of degradation happens up to 400 °C with weight reduction of 92% for the sample.

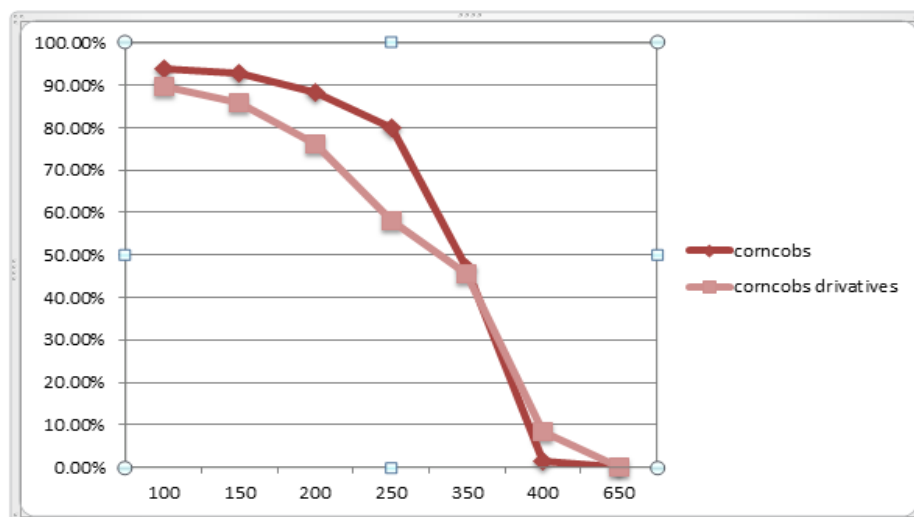


Figure (6): TGA of native corncobs and modified corncobs (ACC)

3-3. Adsorption isotherms of (ACC):

The adsorption isotherms are very important in describing the adsorption behavior of solutes on specific sorbents. They are used to describe the equilibrium between the concentration of the dissolved adsorbate and the amount of adsorbate that accumulated on the sorbent. Adsorption data for adsorbate concentrations are most commonly described by sorption isotherm, such as the Langmuir [Langmuir(1916)] and Freundlich [Freundlich, (1906)] isotherm models.

3.1. Langmuir isotherm: The Langmuir equation may be written as:

$$\frac{C_e}{q_e} = \frac{1}{q_m b} + \frac{C_e}{q_m}$$

Where q_e is the amount of solute adsorbed per unit weight of adsorbent (mg/g), C_e is the equilibrium concentration of solute in the bulk solution (mg/L), q_m is the monolayer adsorption capacity (mg/g) and b is the constant

related to the free energy of adsorption. It is the value reciprocal of the concentration at which half the saturation of the adsorbent is attained.

The essential characteristics of Langmuir equation can be expressed in terms of dimensionless separation factor, R_L , defined as:

$$R_L = \frac{1}{(1 + bC_0)}$$

Where b is the Langmuir isotherm constant (L/mg) and C_0 is the initial bentazon concentration (mg/L). The R_L value indicates the type of the isotherm to be either favorable ($0 < R_L < 1$), unfavorable ($R_L > 1$), linear ($R_L = 1$) or irreversible ($R_L = 0$).

Freundlich model is based on sorption on a heterogeneous surface of varied affinities. The logarithmic form of Freundlich was given as:

$$\ln q_e = \ln K_F + \frac{1}{n} \ln C_e$$

Where K_F and n are Freundlich constants with n as a measure of deviation of the model from linearity of the adsorption and K_F (mg/g (L/mg)^{1/n}) indicates the adsorption capacity of the adsorbent.

The Langmuir and Freundlich isotherms for the adsorption of Cu (II) and Zn (II) on the prepared activated carbon are presented in Figs. 7 and 8. The correlation coefficients showed that the Langmuir model fitted the results better than the Freundlich model ($R^2 > 0.95$). The monolayer adsorption capacity (q_m), as calculated from the linear Langmuir isotherm equation, was found to be 16.97 mg/g for Cu (II) and 18.11 mg/g for Zn (I

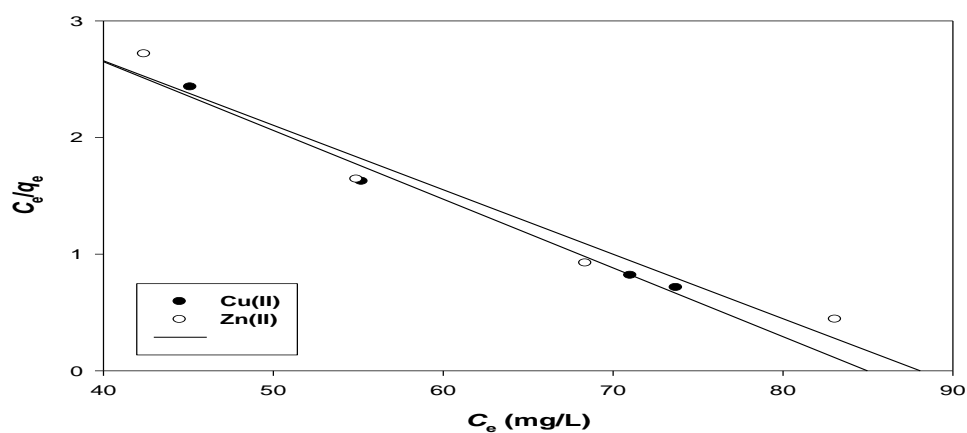


Fig. 7. Langmuir isotherm plot of adsorption of Cu(II) and Zn(II) on (ACC).

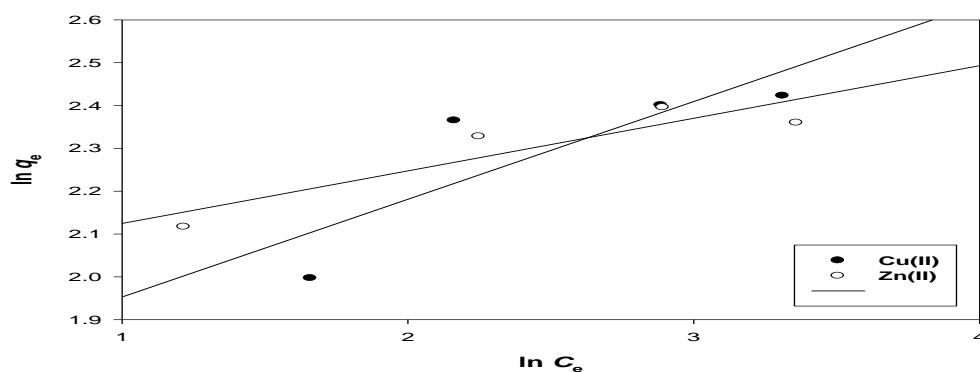


Fig. 8: Freundlich isotherm plot of adsorption of Cu (II) and Zn (II) on(ACC).

Table 3: Langmuir and Freundlich isotherm constants for adsorption of Cu(II) and Zn(II) on ACC.

Metal ion	Langmuir Isotherm				Freundlich Isotherm		
	q_m	B	K_L	R^2	n	K_F	R^2
Cu	16.97	0.0117	0.631 - 0.810	0.9861	-	-	0.6992
Zn	18.11	0.0113	0.639 - 0.815	0.9564	-	-	0.8266

3.4. Point of zero charge of (ACC):

The pH of different solutions were determined before and after adding of (ACC) as initial and final pH respectively. It is observed that the addition of (ACC) to acidic solution leads to increase the pH of the solution after adding. Also the addition of (ACC) to alkaline solution leads to decrease the pH of solution after adding. The final pH of each solution plotted against the initial one. From the plot (Fig. 9), the pH_{pzc} of the (ACC) was determined as 6.0 at which the two values of initial and final is approximately the same.

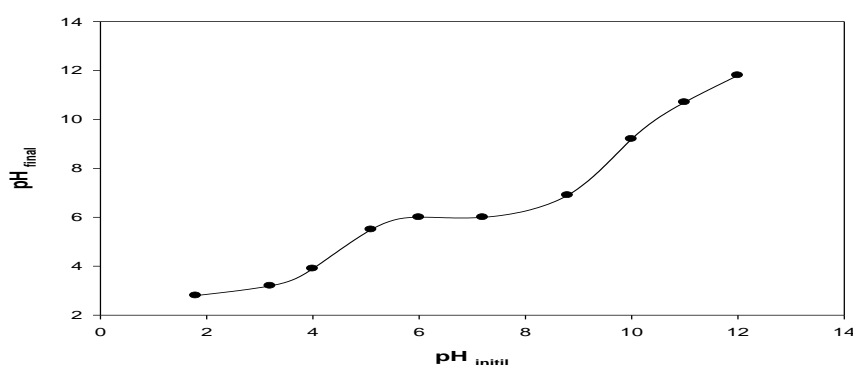


Fig. 9. Determination of pH_{pzc} of (ACC)

3.5. Effect of contact time:

In order to determine the optimum adsorption time for the (ACC) used in this study, the effect of contact time on adsorption was determined by using a stock solution of copper and zinc ions concentration of 30 mg/L. As can be seen from Fig. 10, the copper removal increased rapidly at the beginning of adsorption with increasing contact time and thereafter attained to the equilibrium. The minimum contact time required to reach the equilibrium was found as 90 min for Cu (II) and 120 min for Zn (II). Thus for the following

batch adsorption experiments, the contact time was fixed at these values to be sure that equilibrium was established. The removal percentage was 29.6% for Cu (II) and 33.2% for Zn (II) as shown in Fig. (10).

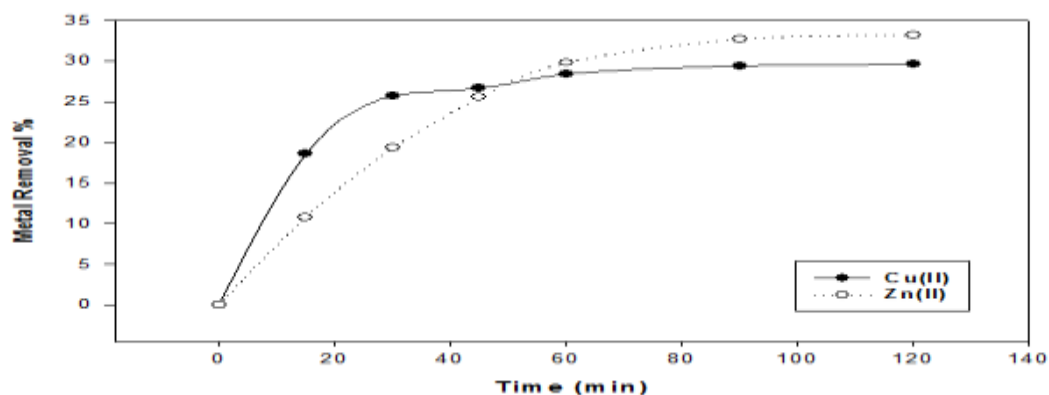


Fig. 10. Effect of contact time on the removal % of Cu (II) and Zn (II) by (ACC)

3.2. Effect of pH:

The effect of pH on adsorption process for Cu (II) and Zn (II) ions on (ACC) was studied at pH range (1.5–5.2) to prevent precipitation of metal ions as hydroxides. At low pH, the surfaces of (ACC) may become positively charged due to the excess of H^+ ions in solution. The electrostatic repulsion between metal cations and the surface of adsorbent decreases the amount of the metal adsorbed. At lower pH, the surfaces of (ACC) may become charged by H^+ ions. Consequently, electrostatic attraction between metal ions and the surface of (ACC) increases the amount of the metal adsorbed (Fig. 11). The maximum percentage removal of Cu (II) and Zn (II) occurs at pH 5.2. This is related to the pH point of zero charge, which was found to occur at pH 6.0, which means that (ACC) surface has a positive charge in solution up to pH

6.0 due to amine groups and a negative charge above this pH due to carboxylate ions.

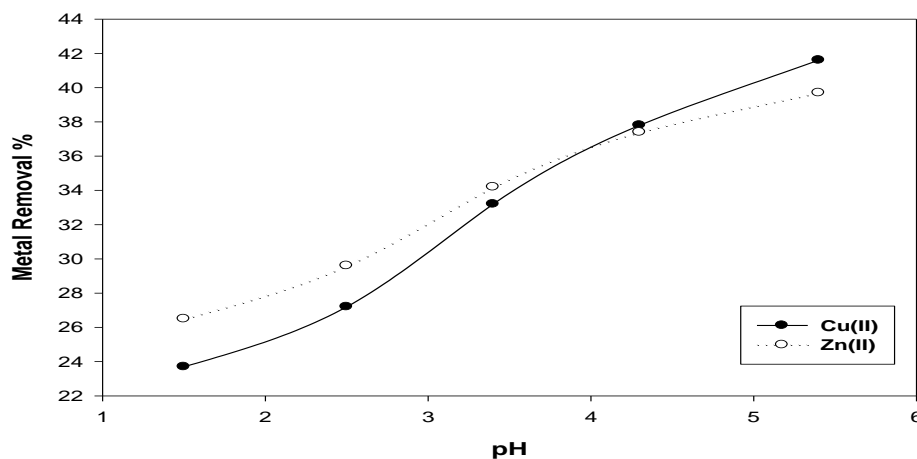


Fig. 11. Effect of pH on copper and zinc removal percent using (ACC).

3.3. Effect of (ACC) dose:As expected, the metal removal percent was increased versus adsorbent dose while keeping other parameters constant. From Fig. 12, it can be observed that for copper and zinc ions concentrations, the removal efficiency increased with increasing the adsorbent dose. It is readily understood that the number of available adsorption sites increases by increasing the adsorbent which results in an increase of the amount of adsorbed metal ions species. The decrease in adsorption density with an increase in the adsorbent dose is mainly because of adsorption sites remain unsaturated during the adsorption reaction whereas the number of sites available for adsorption site increases by increasing the adsorbent dose.

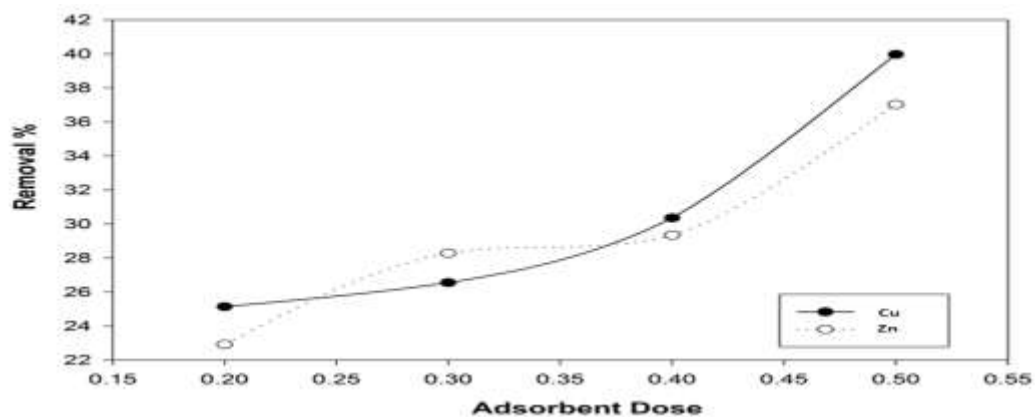


Fig.12. Effect of adsorbent dose on Cu and Zn removal percent using (ACC)

3.4. Effect of Cu^{2+} and Zn^{2+} initial concentration:

From Fig. 13, it can be observed that for such copper and zinc concentrations, removal efficiency % decreased with increasing the initial metal ions concentration (mg/L).

The lower uptake at higher concentration resulted from an increased ratio of initial adsorption number of moles of the metal ions to the available surface area. For a given adsorbent dose the total number of available adsorption sites is fixed thereby adsorbing almost the same amount of adsorbate, thus resulting in a decrease in the removal of adsorbate corresponding to an increase in initial adsorbate concentration (saturation of the adsorbent surface).

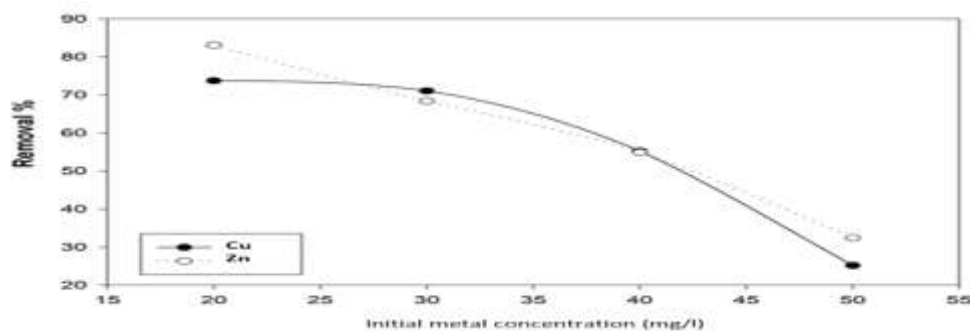


Fig. 13. Effect of initial metal ions concentration (mg/l) on copper and zinc removal percent using (ACC).

3-4. Application of the produced (ACC) in water treatment:

It is widely known that corncobs can build complexes with certain ions such as calcium and magnesium [Shin and Yoo (1998)]. Amino sites are the main reactive groups for organic matter and colloidal silica removal from water.

A comparison was made between (ACC) and either ferric chloride and alum as traditional coagulants. For this purpose a simulation of clarification applying Jar test method which is considered the most applicable way to permit the comparison of various chemicals combination for determining the optimum chemical program was applied. The most important measurements in jar test are coagulation and/or flocculent dosages, flock size, settling characteristics, flock forming time, and finished water clarity. The flocculation in the aforementioned jar test method contains a set of six beakers (1 liter each) in conjunction with multiple stirrers. Each beaker was filled with one liter of waste water and stirred at 100 rpm. The different doses of coagulant were added rapidly and stirred for 3 minutes. The stirring rate

was then reduced to 50 and 20 rpm for a time period of 5 and 10 minutes respectively to allow complete flock formation, and then stirring was stopped. The comparative settling rate, flock size and supernatant clarity were recorded. After a settling time of 15 minutes, 250 ml of supernatant water were siphoned-off for further analysis.

3-4.1 Organic matter turbidity and other pollutants removal from water by corncobsderivatives using jar test:

On comparing the using of (ACC), ferric chloride and alum in different doses, the examined parameters revealed that corncobs derivative is able to remove turbidity, organic matter and gives better water clarity. Table (4) shows that the optimum dose that gave the best result was (6 ppm). While for ferric chloride and alum was 25 and 35ppm respectively. The efficiency of (ACC) is due to protonation of its amino groups in water which makes corncobs positively charged, andthereby very attractive for flocculation and different kinds of binding applications. Since most natural colloidal particles, including organic matter, bacteria and macromolecules, are negatively chargedattractive electrostatic interactions may lead to flocculation. Besides (ACC) possess positively charged groups due to the creative amino groups. Therefore, the corncobs derivative can remove organic matter, colloidal silica and some inorganic elements from water.

Table (4): comparison of corncobs derivative (ACC), ferric chloride and alum doses on the removal of organic matter, turbidity, hardness and colloidal silica of water.

Parameters	Raw water	Water clarified by Ferric chloride 25 ppm	Water clarified by Alum 35 ppm	Water clarified by 6 ppm(ACC)
PH	8	7.49	7.45	7.67
Turbidity	18.2	2.32	2.1	1.12
Total hardness	149	100	125	90
Ca hardness	81.6	45	62	43
Organic matter	11.05	7.9	6.2	7.14
Soluble silica	0.64	0.49	0.28	0.31
Colloidal silica	20.92	18.1	17.13	17.98

3-4-2. Optimum dose for mixture of alum and amphoteric corn cobs to produce the best water clarity.

Table (5): illustrates the results of jar test while changing the alum concentration from 15 to 40 ppm at 4 ppm (ACC) injection. It was observed that the best clarification was in the cup, which contain one liter of water with 35 ppm alum, 4 ppm (ACC). These combined doses give the lowest values of turbidity, total alkalinity, organic matter and colloidal silica.

Table (5): Effect of combination dose of Alum and (ACC) on the removal of turbidity , total alkalinity , organic matter and colloidal silica.

Parameters	Raw water	Alum dose ppm					
		15	20	25	30	35	40
		4ppm (ACC)					
Turbidity	18	1.27	1.25	1.19	1.15	0.97	0.99
Total Alkalinity	152	144	141	140	138	137	137
Organic Matter	10	8.91	8.68	8.12	7.62	7.15	7.18
Colloidal Silica	22.15	18.96	17.84	15.35	12.75	10.89	11.16

3-4-3. Optimum dose for mixture of ferric chloride and (ACC) to produce the best water clarity.

Table (6): shows the effect of adding combination of ferric chloride and (ACC) to the raw water with concentration ranging from 15 to 40 ppm of ferric chloride and fixing modified corncobs injection to 4 ppm. It is evident from table (6) that the best combined dose that gives maximum removal for turbidity, total alkalinity, organic matter and colloidal silica was 25 ppm FeCl_3 + 4 ppm (ACC).

Table (6) Effect of combination dose of ferric chloride and (ACC) on the removal of turbidity, total alkalinity, organic matter and colloidal silica.

Parameter	Raw water	FeCl_3 ppm					
		15	20	25	30	35	40
		4 ppm(ACC)					
Turbidity	18	1.32	1.28	1.01	1.1	1.15	1.64
Total Alkalinity	152	119	117	110	112	114	116
Organic Matter	17	15.57	14.58	13.11	13.39	14.51	15.21
Colloidal Silica	22.15	20.32	19.52	17.35	17.38	17.39	19.40

CONCLUSION

The protonation of amino groups in water makes corncobs positively charged, and thereby very attractive for flocculation. This behavior may be attributed to the fact that most natural colloidal particles in water, including organic matter, bacteria and macromolecules, are negatively charged. Attractive electrostatic interactions may lead to flocculation. Besides (ACC), derivatives possess positively charged groups due to the position of tertiary amino group contains carboxylate group with negative charged sites. Therefore, the corncobs derivative can remove organic matter and inorganic matter carrying positive or negative charge from water.

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تحضير ودراسة خواص مخلفات الذرة المعدلة لاستخدامها كمادة مخثر في معالجة المياه الصناعية

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المستخلص

في هذا البحث، تم استخدام مخلفات الذرة المعدلة كيميائياً كمخثر في معالجة مياه الصرف حيث تم إجراء هذا التعديل الكيميائي عن طريق تفاعل مسحوق مخلفات الذرة مع الـ (EDTA) في وجود الـ epichlorohydrin في وسط قلوي للحصول على مركب امفوتيري يحتوي على مجموعات كاتيونية (مجموعات أمينية) ومجموعات أنيونية (مجموعات كربوكسيلية) منتشرة على المركب المنتج (ACC).

تم دراسة العوامل المؤثرة على المحتوى النيتروجيني لمخلفات الذرة المعدلة (ACC) وتم دراسة زمن التفاعل ودرجة الحرارة وكمية (EDTA) المضافة وتم توصف المنتج الذي تم الحصول عليه (ACC) باستخدام التحليل الطيفي للأشعة دون الحمراء والرنين المغناطيسي إلى جانب التحليل العنصري (CHN) والحراري.

تمتاز المنتجات التي تم الحصول عليها باحتوائها على محتوى نيتروجيني عالي حيث تم اختيار المنتج (ACC) ذو أعلى محتوى نيتروجيني لاستخدامه كمادة مخثرة في معالجة المياه الصناعية. تم تحديد كفاءة الإدمصاص للمنتج (ACC) بالنسبة لأيونات المعادن في الماء مثل Cu و Zn باستخدام مطياف الامتصاص الذري (AAS) وقد تبين أن هناك تغييراً ملحوظاً في مواصفات المياه المعالجة بهذه المادة المتمثلة في أقل كمية من المادة العضوية، والعاكة، والمواد الصلبة والعناصر الأخرى الموجودة في مياه الصرف بعد المعالجة. وأظهرت نتائج البحث أن المادة المحضرة من مخلفات الذرة لها القدرة على تنقية المياه الصناعية بصورة جيدة.

الكلمات المفتاحية: Amphoteric Corncoobs، polyelectrolytes، Industrial water، Water treatment، treatment