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CHARACTERIZATION COMPARISON BETWEEN RAW AND TREATED CHICKEN FEATHER FOR WASTE WATER TREATMENT

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Abstract

Waste material, chicken feather (CF), which can be used as biosorbent, was characterized to study its properties to be used in sorption process and also it was treated to enhance its surface properties for the same reason, first CF was treated physically by carbonization at different temperatures (200,300, 400 and 500 ºC), second it was treated chemically by using surfactant (SDS) .Comparison between Raw and treated CF to show the ability for using it in waste water treatment. Surface morphology, surface functional groups and chemical composition of Raw and treated CF were analyzed by using ,scanning electron microscopy(SEM), Fourier transform infrared spectroscopy(FTIR) and EDS element analyzer. The results indicate that the surface morphology changes by different treatment methods which may be helpful in sorption processes.

Key words: Chicken feather, chemical treatment, physical treatment, Waste material, Characterization

Introduction

Chicken Feathers are a waste product generated in large quantities from commercial poultry processing. as they representing about 6.0% of the total weight of a mature chicken, which lead to environmental problems . chicken Feathers are a bio-source with a high keratinaceous protein content (more than 750 g/kg crude protein).Also they are a valuable protein source because it is the most abundant keratinous biomass in the world.[1] Although feathers are deficient in certain essential amino acids **,** [2] they contain other essential amino acids such as cystine, arginine, and threonine [3-4**]**.Chicken Feather waste has been used as feedstuff for poultry and livestock.

Nowadays the use of plant and animal products and by-products as sorbents has become familiar for many researchers in the field of environmental engineering. These materials can be used, either directly or after activation, in the adsorption processes. Many examples are available in the literature concerning the direct use of these materials as adsorbents, for example, leaf mould has been used for the adsorption of chromium from aqueous solutions **[5]** , sphagnum peat moss was used in adsorption of copper **[6]** , rice milling by-products (hulls and bran) was utilized to remove chromium, cobalt, copper, nickel and zinc from aqueous solutions **[7]** and chicken-feathers were used for the removal of phenol from aqueous solutions **[8]** . These materials, as well as many other examples, were used in the sorption process without any pre-treatments.

Different activation methods have been reported in the literature to increase the sorption capacity of adsorbents. These activation methods may be classified into physical and chemical methods. Physical activation is usually used for carbonaceous agricultural solid wastes to produce activated carbon . The process for preparing activated carbon usually involves carbonization process at a moderate temperature to produce chars with rudimentary pore structures. The second activation method is a chemical method, which depends on treating the sorbent with certain chemical agents before the sorption process. Several chemical treatment methods are known. For example, chemical activation by the use of alkali and alkaline Na_2S solution for treating human hair **[9]** , the use of HCl, H_2SO_4, NaOH, and mixtures of NaOH and Na_2S for treating human hair **[10]** , the use of quaternary ammonium cations for treating smectite clay **[11]**, and the use of anionic surfactant to treat waste tea leaves **[12].** These chemical treatments are normally done on these materials before using them in the adsorption processes.

When searching for improving the applications for a particular material, it should be through characterization study for its properties as raw material comparing with the treated ones to show the effect of modification on the sorption process

So the aim of this work is to study the structure and surface properties of the raw Chicken feather. The physical and chemical treated Chicken feather was studied to show the changes in its properties which may investigate their use in wastewater treatment.

Materials and methods:

Chicken feathers were collected from poultry processing facilities. Some of the materials attached to the feathers were first removed, through several washings with tap water and detergent and were then left in the open air for several days to get rid of odors. Because it is difficult to disintegrate the chicken feathers by normal crushing techniques, they have been frozen by liquid nitrogen before cutting into small sizes using an electrical cutter.

Preparation of physically treated Chicken feathers

The previous prepared chicken feathers were physically treated by using a closed stainless steel tube (with length of 12.5 cm and inner diameter 2.5 cm) which full with prepared CF to avoid presence of air , the tube had a small hole in the top for venting gases produced during carbonization process. The tubes were heated in a muffle furnace at (200-300 -400 and 500 ºC) and were maintained at the selected temperature for 1 hour, then left to cool to ambient temperature. The collected solid product was then characterized.

Preparation of chemically treated Chicken feathers

The prepared chicken feather was also chemically treated by using sodium dodecyl sulphate (SDS), which was selected as an anionic surfactant. Two hundred milliliters of surfactant solution, in the concentration 10% were mixed with 20 g of chicken feathers. This suspension was subjected to agitation for 24 hours. Then the treated chicken feathers were separated from the solution by filtration, washed several times with distilled water, dried at 70°C. **[13]**

The raw and treated chicken feathers were characterized using scanning electron microscope (SEM "JEOL JSM 6360 LA"- Japan) for studying surface morphology, elemental analysis of its components finally particle size analyzer (EDS). Fourier transform infrared spectrophotometer (FTIR-8400 S Shimadzu- Japan.) in order to identify the function groups attached to the structure.

Results and discussion

Study of the surface morphology:

The scanning electron micrograph of chicken feathers was illustrated as shown in fig.1. The figures illustrate that chicken feather has a small roughness due to the nature morphology of feather, but with increasing the magnification factor from 50 to 5000 the feather surface seems to be with smooth surface without any pores or capillary helping in removal process. While by chemically treated, the feather with using the anionic surfactant as shown in fig.2, the smooth surface turned to rough one with number of channels and capillaries which increases surface area and the chance of absorption process on the surface. By increasing the magnification factor to 5000 the surface roughness cleared comparing with the same surface and magnification in fig.1. These changes in surface structure after treatment may be helpful in the sorption process for different types of waste.

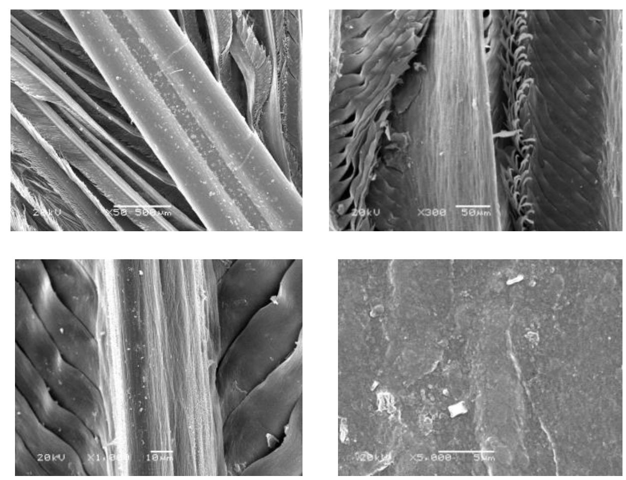


Figure.1 SEM for raw chicken feather surface

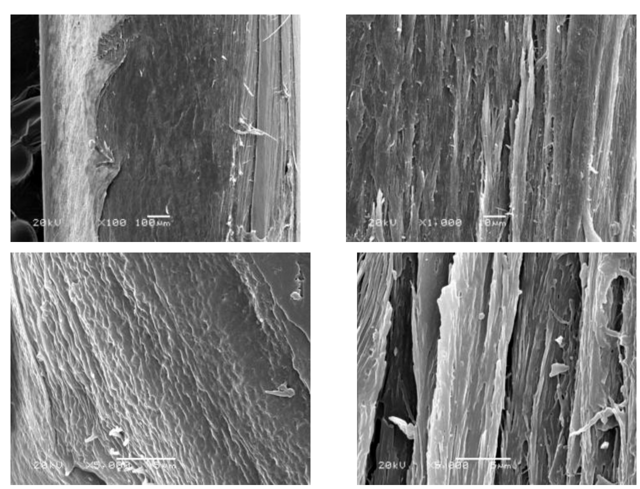
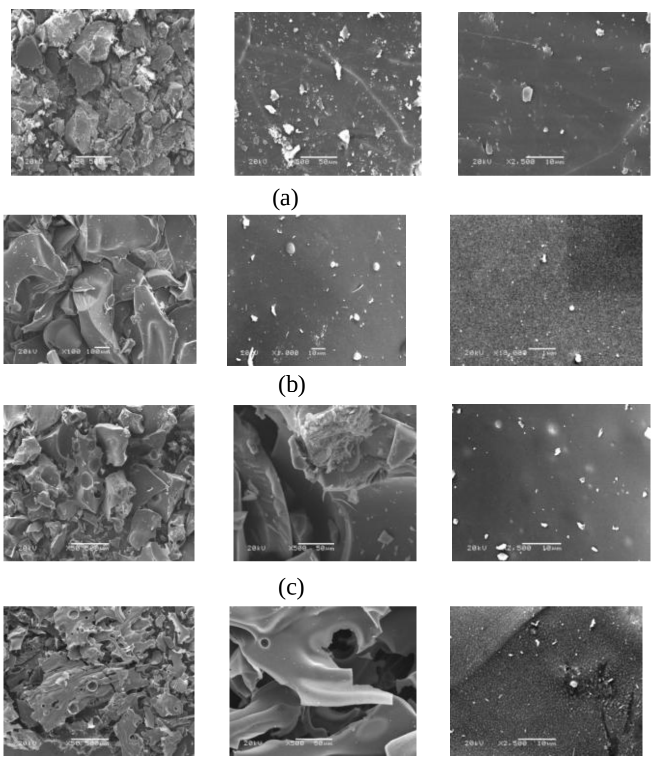


Figure .2 SEM for chemically treated chicken feather surface

For physically treated chicken feather carbonization temperature effect was studied as shown in fig.3. By increasing the carbonization temperature the feather turned to black powder with different morphology structure. Carbonized chicken feather was changed to be as cracked particles which increase the surface area for sorption. By increasing carbonization temperature from (200 to 500 °C), small pores started to appear on the surface which cleared at 400 &500 °C (figure C&D). This pores which appeared with different size increase surface area of contact surface and by increasing the magnification factor from 50 to 2500 as shown in fig.3-a small particles observed on the surface. While by increasing carbonization temperature to 300 °C and increasing magnification factor to 18000 the surface include very small particles (figure 3-b). At temperature 400 and 500 °C small pores started to appear on the surface as shown in fig.3-c& 3-d. Beside the small particles which cleared when increasing the magnification factor to 2500 specially at (400 &500 °C) figure 3-d , all the changes in the surface morphology also may helps in entrapping the particles of pollutants in it.



(a)

(b)

(c)

(d)

Figure.3 SEM for physically treated chicken feather surface at different carbonization temperature :
(a) 200 °C (b) 300°C (c) 400°C (d) 500°C

The composition of the raw and treated chicken feather was studied using EDS elemental analysis, as it is a powerful tool for microanalysis of elemental constituents. Table (1) shows a comparison between raw and physically treated samples at different carbonization temperatures and the results showed that by heating chicken feather the mass percentage of oxygen decreased and nitrogen percentage increased than the raw sample. These changes in chicken feather composition may enhance its sorption properties.

Table (1) EDS elemental analysis of the raw and physically treated chicken feather

Mass % / Component	Raw	200 °C	300 °C	400 °C	500 °C
C	38.22	31.33	28.32	34.12	30.66
N	38.64	56.66	50.41	62.34	60.82
O	23.15	12.01	21.06	3.53	8.52

FTIR spectrum of Chicken feather:

The FTIR technique was an important tool to identify functional groups, which are capable of adsorbing pollutant ions [16, 17]. FTIR spectroscopy was, therefore, done for preliminary quantitative analysis of major functional groups presented in chicken feather .The measurement was done in the range of 400-4000 Cm^{-1} as shown in figures.

Fig.4 indicate the FTIR spectrum of the raw chicken feather which showed that the most prominent peaks in the spectrum originate from N-H stretching at (3429cm^{-1}) attributable to the existence of Amines and amides, H-C-H asymmetric and symmetric stretching vibrations (2950.89 cm-1)from alkanes. At (1645 cm^{-1}) is a stretching mode of carbonyls mainly ketons of C=O. intense peaks in region (1533.3 to 1436.8 cm^{-1}) originate from the secondary Amines N-H, while stretching at (1244 &1062.7 cm^{-1}) for C-O come from ethers.

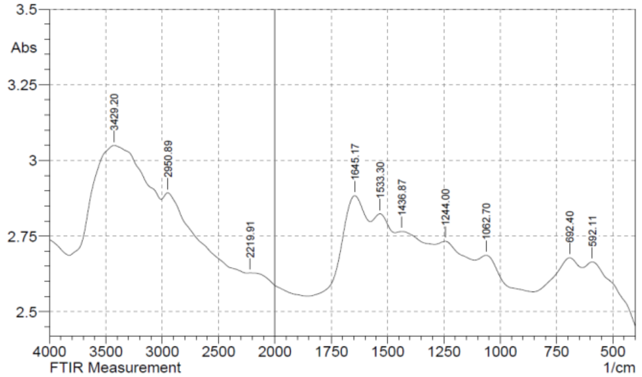


Figure .4 FTIR curve of raw chicken feather

Fig.5 shows a comparison between the samples treated physically at different carbonization temperatures. From the figure it can be observe that by increasing the heat of carbonization the H-C-H peak nearly disappear also C=O & N-H peaks decreased. This changes in peak intensities than raw CF may improve the sorption properties of chicken feather across using it as sorbent material

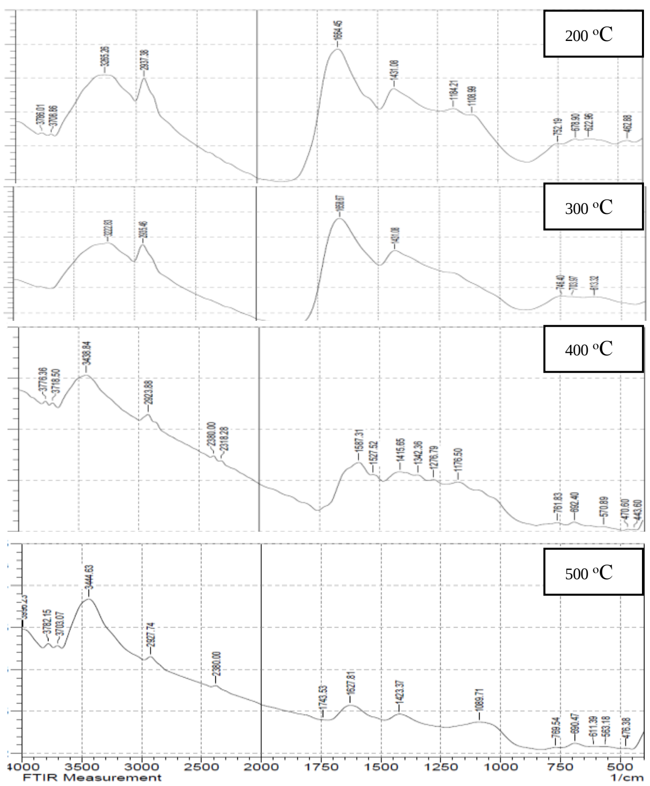


Figure .5 FTIR comparison curve of physically treated chicken feather at different Carbonization temperature

Also we can show small change in intensity for chemically treated CF than the raw material as at N-H peak at (3419 cm^{-1}) and disappear of the duplet peak at range of (750 to 500 cm^{-1}) as shown in figure (6).

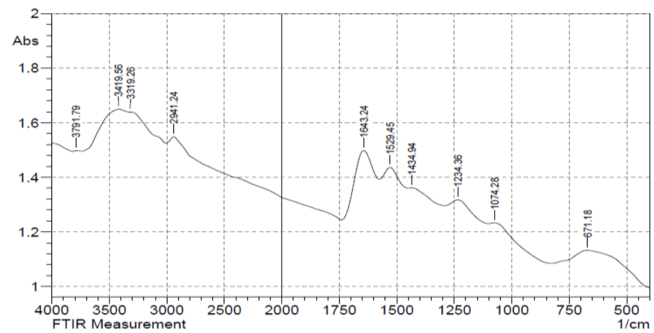


Figure.6 FTIR curve of chemically treated chicken feather

Conclusions

Surface morphology study was showed different changes in Physically and chemically treated CF than raw CF. As by changing carbonization temperature the small pores started to appear on the surface which increase surface area of contact surface beside the small particles as it helps in entrapping the particles of pollutants in it .while in chemically treated ones the surface turned to be more rough than first. EDS and FTIR study showed the different changes by treatment which may be have an effective role for the sorption processes for waste water treatment.

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