

# A REVIEW: WASTE CORN COB AS A NATURAL ADSORBENT FOR WATER TREATMENT

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**Abstract:** Water is a vital element for life. From Industrial revolution and today till date there has been a considerable enhancement of toxic matters in air, water and land. Out of which water element is much focused in this study. The water obtained for domestic utilization from sources like rivers, lakes are contaminated with industrial waste. So heavy metal, dyes and toxins which get dissolved in water is studied using the waste corn cob as an adsorbent for removal of such impurities from water. The corn cob has proved to be more effective in removal of heavy metals in increasing order of removal efficiency as Ni>Cr>Fe>Zn>Pb>Cr<sup>+6</sup>>Cu for activated Corn cob Charcoal. And for Corn cob Charcoal order of removal efficiency as C<sub>16</sub>H<sub>18</sub>ClN<sub>3</sub>S> Cd. Corn cob waste and its derivatives like corn cob charcoal, cob powder, Activated cob corn etc. have proved to be best for removal of heavy metal.

**INDEX TERMS:** Adsorption, Activated corn cob, Corn, Heavy metals, water treatment.

## I. INTRODUCTION

Day by day with increasing industrialization the extent of pollution on earth is extending its boundaries on air, water and land. Water is a daily need of all floras and faunas in the ecosystem. Due to the industrial pollution in the water streams, lakes and rivers we need to tackle this complication by use more suitable, eco friendly, economical techniques. During the study it was found that the use of chemicals and some conventional techniques has although gave sufficient results but the cost of treatment and the use of chemicals which may have some effects left due to the traces prevailing after the treatment in water which could lead to health hazards it is essential to opt for natural material for water treatment. Hence after going through the researches it was found that waste Corn (Maize) cobs had an immense potential in adsorption of heavy metals and Purifying water with good results.



Image 1: Corn Cob



Image 2: Corn Cob Powdered Form

Corn is an agricultural commodity. It is a crop with consumption for humans as well as fodder for herbaceous animals mainly milch animals, Horses, Camels etc. Its production in our country is at a large scale. Hence it gives better economy but also it has certain properties which are favorable for water purification. Corn is a fibrous material. It consists of Fibers like Hemicelluloses, Cellulose, lignin etc. A research was attempted by a student who constructed a water filter model using crushed corn cob as a filtering media. This project was a feasible and performed very well. The waste corn cob as a material is possess some filtration properties which are seen further in the paper.

## II. LITERATURE REVIEW

*IS. Christica et.al. (2018)* studied that the use of corn as a food ingredient also increase corn production which is also leaves cobs waste that has not been optimally utilized. Therefore to increase the economic value and utilization of this plant, the corn cobs can be utilized as a bio adsorbent through activation process. Determination of heavy metal absorption of Ferrous, Copper and Lead in

industrial waste was using Inductively Coupled Plasma (ICP). Result showed that addition of 1 gram corn cob activated carbon decreased level of ferrous, copper and lead as much as 60.20%; 59.24% and 59.67% respectively. The addition of 1.5 gram corn cob activated carbon decreased level of ferrous, copper and lead as much as 80.01%, 79.5% and 79.89 % respectively. Based on the result, it can be concluded that activated carbon from corn cob (*zea mays*) could decrease level of ferrous, copper and lead in industrial waste

*Nsikak B. Essien et.al. (2017)* carried out a study to investigate the adsorption efficiency of maize cob for the removal of  $Pb^{2+}$  and  $Cr^{2+}$  from aqueous solution using batch process. The results obtained indicated that maize cob is an effective adsorbent for the removal of  $Pb^{2+}$  and  $Cr^{2+}$  from aqueous solution because it has some useful functional groups (including C=N stretch, N-H O-H and C-H stretches), in addition to other adsorptive properties. The adsorption of  $Pb^{2+}$  and  $Cr^{2+}$  from aqueous solution is consistent with the mechanism of physical adsorption; it is time, concentration, adsorbent dose and pH dependent. Its adsorption characteristics best fitted the Freundlich, Temkin and Dubinin-Radushkevich adsorption models. The study reveals that maize cob is an excellent adsorbent for the removal of lead and chromium ions from aqueous solution.

*Lavanya H D et.al. (2017)* has explained that in the present work, that an attempt has been made to remove the fluoride in drinking water using corn cobs powder as a natural adsorbent using a fabricated filter. The Bureau of Indian Standard has recommended the limit of fluoride content of 1mg/l (BIS: 10500-2012). The water samples were collected in different places namely Uppinahally, Doddagatta and Yadapura in Arsikere taluk of Hassan district. The defluoridation is done with corn cobs powder and then the results were compared. Filtration with corn cobs powder reduces the fluoride content for the samples from Uppinahally, Doddagatta and Yadapura with initial fluoride content 2.5mg/l, 1.2mg/l, and 1.4mg/l respectively to 1.01mg/l, 0.9mg/l and 0.8mg/l respectively.

*B. Saritha et.al. (2017)* found the the investigation of adsorption of hexavalent form of heavy metal (Cr) by modified corn cob. The study demonstrated that the corn cob has a moderate potential to remove hexavalent chromium. The equilibrium data very well fitted into the models and the maximum loading capacity was obtained from adsorption isotherms by applying the Langmuir model. The adsorptive removal percentage of hexavalent chromium depends on dosage of adsorbent, pH, time of contact, and initial concentration of hexavalent chromium. The results demonstrated that the modified corncob can be more efficient natural adsorbent for maximum removal of hexavalent chromium.

*Ashwani Kumar Singh et.al. (2017)* revealed that Corn cobs are one of the most plentiful and important agricultural wastes in maize cultivation. Thus, a matter of primary concern is the economical and efficient utilization of these corn cobs for a purpose. As they are porous, they can be used as water filtrates. It was observed that most of the coloured substances present in the effluents are adsorbed in the charcoal layers. The suspended particles are adsorbed in the chaff layers of both long sections and pieces of corn cobs. Maximum adsorption of gasoline waste was found in the powdered corn cob layers. The rate of adsorption was directly proportional to the surface area of the adsorbents. This study reveals a novel and cheap method of cleaning waste water from domestic and industrial sources by utilizing one of the most under-utilized agricultural wastes.

*P. Muthusamy et.al. (2016)* stated that the toxicity of metal pollution is slow and interminable, as these metal ions are non biodegradable. The most appropriate solution for controlling the biogeochemistry of metal contaminants is sorption technique, to produce high quality treated effluents from polluted wastewater. Maize cob readily available was used as sorbent for the removal of lead ions from aqueous media. Adsorption studies were performed by batch experiments as a function of process parameters such as sorption 500ppm, 2.5g, 400minutes, 400 rpm and 5 PH. Concentration, Dosage, time, rpm, and pH. It was found that the optimized parameters are Freundlich model fits best with the experimental equilibrium data among the three tested adsorption isotherm models. The kinetic data correlated well with the Lagergren first order kinetic model for the adsorption studies of lead using maize cob. It was concluded that adsorbent prepared from maize cob as to be a favorable adsorbent and easily available to remove the heavy metal lead (II) is 95 % and can be used for the treatment of heavy metals in wastewater.

*Ojedokun Adedamola Titi et.al. (2015)* has discussed that Presence of heavy metals is one of the many factors that lower water quality. These heavy metals cause harmful effects on health, increase environmental toxicity and affect the aesthetic quality of water. The use of agricultural products and by-products has been widely investigated as an alternative for costly methods of removing heavy metals from water and wastewater. Modification of agricultural by-products could enhance their natural capacity and add value to these by-products. This review is aimed at investigating the use of low-cost adsorbents as an alternative to expensive activated carbon adsorbents used in removing Cu(II) using batch methods from water and wastewater.

*Gholamali Haghdooost et.al. (2015)* has studied that the adsorption of the isotherm of Mn(II), on Corn cob from aqueous solutions. The effects of pH, initial metal ion concentration, contact time, Corn cob dosage and temperature on the adsorption

performance of Corn cob for Mn(II) ions were examined by batch method. Increasing the Mn(II) initial concentration declines the Mn(II) adsorption rate investigated through adsorption Mn(II) removal at pH=5 condition for  $t_C=65$  min in equilibrium-batch mode system. The adsorption equilibrium isotherms were fitted by Freundlich and Langmuir models. It was found that the Freundlich model described the adsorption process better than the Langmuir isotherm, ( $R^2=0.9943$ ), thus indicating the applicability of monolayer coverage of Mn(II) ion on Corn cob surface.

**Daniel Muvengei Mwangangi (2015)** has discussed that Lead and cadmium are the main heavy metals in contaminated water and their harmful effects such as lung cancer, mental retardation and nerve disorder cannot be underestimated. Available methods for removing these metal ions from water such as use of activated carbon are very expensive and unaffordable to low income earners. Maize cobs have minimal use after maize harvesting can be utilised to reduce environmental pollution. The primary aim of this study was to investigate the ability of maize cobs derived products to adsorb both lead (II) and cadmium (II) ions and remove methylene blue and turbidity from contaminated water. Maize cobs charcoal was prepared by heating dry maize cobs in a furnace in limited air. Activation was done by use of 1.0 M sulphuric acid and heating the mixture in a closed vessel. Maize cob ash was generated by heating dry maize cobs in a furnace. Ability of these sorbents to adsorb lead (II) and cadmium (II) ions from the solution was investigated by carrying out batch experiment and varying parameters such as contact time, initial metal ion concentration, adsorbent dose, temperature and shaking speed. The data obtained was fitted into Langmuir and Freundlich models. Activated charcoal gave the best fit in Langmuir for lead ions with maximum adsorption capacity of 13.0 mg/g. For removal of cadmium (II) ions, all the adsorbents fitted in Freundlich with maize cob charcoal having the highest adsorption capacity of 24.3 mg/g and  $r^2=0.997$ . Among the three adsorbent only ash was found to have the ability of removing turbidity from water. This implies that maize cob derived products can be used to remove lead (II) and cadmium (II) ions from waste water

**Ali S.M et.al. (2014)** has carried out the work on sample of plant waste (Corn cobs) as it was tested further to determine its activity which gives the best performance in heavy metals removal and other pollutants (TSS, TDS and COD). Adsorption tests showed the corn cobs adsorbents had significant heavy metal removal efficiency. The best removal efficiency 95.05% of Cr was occurred at pH 5.4 and 4.18hr. Higher removal efficiency 99.90% of Ni was occurred at pH 6.5 and 2.38hr. While, lower removal efficiency 91.35% for Zn obtained at pH 6.5 and 0.15hr. Removal efficiency for TDS, TSS and COD were 56%, 65.7% and 83.3% respectively.

**A. K. Azad (2014)** has revealed that The presence of iron is probably the most common water problem faced by consumers. The secondary maximum contaminant levels (MCL) of Iron is 0.3 mg/L. Hence to remove iron from water, a batch study has been conducted by adsorption process using activated carbon prepared from maize corncob as adsorbent and the removal efficiency was studied as function of the parameters such as dosage (1-6 g), pH (3-8), contact time (30-180 minutes) and initial concentration (0.5-5 mg/L). It was observed that maximum removal of iron takes place at pH 5.5. It was also observed that maximum removal of iron occurs after a contact time of 120 minutes. % removal of iron decreases with increase in the initial concentration of solution whereas it increases with the increase in the dosages and achieved equilibrium for 3g of adsorbent dosage. The removal efficiency was found to be about 75%.

**Arunkumar C et.al. (2014)** has discussed that the use of Corn cob as an effective and efficient adsorbent for the removal of Ni (II) from aqueous solution. The influence of Physico-chemical parameters such as Adsorbent Dosage, Contact time, pH and Initial concentration has been examined in Batch studies. The initial and residual concentration of Ni (II) was analyzed using UV-Double Beam absorption spectrophotometer at 394 nm by which the percentage removal can be calculated. The equilibrium data onto the adsorption of Ni (II) was measured using Langmuir and Freundlich Isotherm model. The results revealed that Corn cob, a waste material have good potential as an adsorbent for the removal of toxic heavy metal like Ni (II) from Industrial waste waters.

**Opeolu B.O et.al. (2009)** has carried out study on Maize cob was used as an adsorbent in order to evaluate its potential for the removal of lead from aqueous solutions and effluents from battery and paint industries with Dowex (synthetic resin) as control. Experimental data were analyzed in terms of Freundlich isotherm model. Equilibrium was attained at 2 h and adsorption rate constants for maize cob and dowex were  $7.26 \times 10^{-2}$  and  $7.58 \times 10^{-2} \text{ min}^{-1}$ , respectively. Equilibrium pH value was 6; shaking at 150 rpm enhanced adsorption with maximum adsorption by both adsorbents in battery and paint effluents. Optimal weight at equilibrium for the adsorbents in  $\text{Pb}^{2+}$  solution was 16 mg/L of solution.  $\text{Pb}^{2+}$  removal by maize cob from battery effluent was 99.99% while it was 47.38% for Dowex. Corresponding values from paint effluents were 66.16 and 27.83%. The study concludes that maize cob has great potentials to remove  $\text{Pb}^{2+}$  from industrial effluents.

**Akporhonor E.E et.al. (2007)** has carried out experiment on maize cob by preparing ,Maize cob carbon by pyrolysis at 300 and 400°C for 35 min. This was followed by steeping in saturated ammonium chloride. The activated carbon which was characterized for bulk density, surface area, surface area charge, abrasion resistance and pH was used in the removal of  $\text{Cd}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Cd}^{2+}$  and  $\text{Zn}^{2+}$ . The surface areas of the maize cob carbon at 300 and 400°C were 0.010 and 0.021 g sample per mg iodine, respectively.

### III. DISCUSSION

The above literature study has found that the maximum heavy metal removal efficiency from waste water was found at pH ranging from 3 to 7. The pH is a vital parameter in heavy metal adsorption. The competitions of H<sup>+</sup> ions with metal ions at active sites on adsorbent have a mutual relation when pH is considered. It was also found that the contact time of dosage to waste water was between 50 minutes to 160 minutes for percentage removal efficiency at equilibrium. With increase in dosage of corn cob the removal of heavy increased up to a equilibrium. As at equilibrium no surface area is available for further adsorption of impurities. Both Langmuir adsorption isotherm and freundlich adsorption isotherm fitted well for removal of heavy metals. The value of n (constant) was found to be ranging from 1 to 10 in Freundlich isotherm which was good for adsorption. Also the value of separation factor R<sub>L</sub> was from 0 to 1 which again is a favorable for adsorption.

The activation of corn cob was done by washing them in distilled water and drying this step was done thrice and then the cobs were grinded in small pieces and soaked in activating substances like HCL, NaoH, H<sub>2</sub>SO<sub>4</sub>, H<sub>3</sub>PO<sub>4</sub> in the above literature papers. The Corn cob used was powdered activated charcoal type. The Corn cob Activated Charcoal had a removal efficiency for heavy metals is Ni>Cr>Fe>Zn>Pb>Cr<sup>+6</sup>>Cu. Corn cob charcoal without activation the order of removal was (Methylene blue) C<sub>16</sub>H<sub>18</sub>ClN<sub>3</sub>S>Cd. For Copper removal it was found that corn cob was best over 13 different natural waste materials. The adsorption capacities of other materials were less than 7.62 mg/g.

The other impurities from waste water removed by activated corn cob charcoal was Gasoline waste which was maximum, Detergents, Fluorine, Color of dyes from water. The corn cobs are also suitable in removing TDS, TSS, COD etc from waste water.

The paper suggests some important factors which could lead to further research in waste water treatment using Corn cob waste.

1. An effort must be made to use the activation agents for corn cob charcoals like Fluorosulphuric acid, Chromic acid, HPF<sub>6</sub>, Acetic Acid etc. removal efficiency could be checked for heavy metals.
2. Comparative analysis should be attempted for using different forms of corn cob waste in form of powder, small solid pieces of cob, and activated cob charcoal for removal a particular or a mixture of heavy metal containing waste water sample.
3. A study should be done on the adsorption properties of corn cob for radioactive waste materials in water.
4. A study for analysis of surface water and ground water properties alterations by filtering the water through crushed corn cob media should be performed to check the effects on water quality parameters.

### IV. CONCLUSION

The study has stated that the use of waste corn cob as adsorption media for heavy metals is very effective along with certain other impurities like color, detergents etc. Truly the corn cob possess a natural property to filter impurities from waste water as the corn cobs are porous, light weight materials basically biopolymer. It is also a low cost water treatment material as it is available free being a waste. The literature papers studied have a common base line which reveals the water purification properties of corn cob. Hence with reference to the review study it is concluded that Waste Corn cob can be used effectively for Heavy metal removal.

### VI. REFERENCES

- [1] IS. Christica, Muchlisyam, R. Julia, “ Activated Carbon Utilization From Corn Cob (*Zea Mays*) As A Heavy Metal Adsorbent In Industrial Waste”, Asian Journal of Pharmaceutical Research and Development, Volume 6(5),pp.1-4, 2018.
- [2] Nsikak B. Essien, Aniefon A. Ibout, Uduak B. Essien, “Maize cob as an adsorbent for the removal of Pb<sup>2+</sup> and Cr<sup>2+</sup> from aqueous solution”, Journal of Scientific and Engineering Research, Vol-4(8), pp.20-29, 2017.
- [3] Lavanya H D, Madhushree C, Vani A, Manjula, “Defluoridation of Ground Water Using Corn Cobs Powder”, The International Journal of Engineering and Science (IJES), Volume – 6, Issue 6, pp78-81, 2017.
- [4] B. Saritha, Dr. M.P. Chockalingam, “Adsorptive Removal Of Heavy Metalchromium From Aqueous Medium Using Modified Natural Adsorbent”, International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 8, pp. 1382–1387, 2017.

- [5] Ashwani Kumar Singh, Mayank Srivastava , Narottam Kumar Rajneesh , Shikhar Shukla, “Corncoobs as Low Cost Bio-Adsorbent for Water and Waste Water Treatment”, International Journal of Innovative Research in Science and Technology, Vol. 6, Issue 10, pp.20487-20491, 2017.
- [6] P. Muthusamy, S. Murugan, “ Removal of Lead Ion Using Maize Cob as a Bioadsorbent”, Int. Journal of Engineering Research and Application, Vol. 6, Issue 6, ( Part -1), pp.05-10, 2016.
- [7] Ojedokun Adedamola Titi, Olugbenga Solomon Bello, “An Overview of Low Cost Adsorbents for Copper (II) Ions Removal”, Journal of Biotechnology and Biomaterials, Volume 5, Issue 1, pp. 1-13, 2015.
- [8] Gholamali Haghdooost and Hossein Aghaie, “ Application Of Corn Cob As A Natural Adsorbent For The Removal Of Mn(II) Ion From Aqueous Solutions And Thermodynamic”, Indian Journal of Fundamental and Applied Life Sciences, Vol. 5 (S3), pp. 615-621, 2015.
- [9] Daniel Muvengei Mwangangi, “Use Of Maize Cobs Derived Products For Removal Of Selected Inorganic Ions, Colour And Turbidity From Contaminated Water”, Thesis for Master of Science (Applied and Analytical chemistry) Kenyatta University, pp1-86, 2015.
- [10] Ali S. M. , Khalid A. R., Majid R.M, “The removal of Zinc, Chromium and Nickel from industrial waste water using Corn cobs”, Iraqi Journal of Science, Vol 55, No.1, pp:123-131,2014.
- [11] A. K. Azad, “Removal of iron from aqueous solution using Maize corncob as adsorbent”, International Journal of Chemical Sciences and Applications, Vol 5, Issue3, pp 122-125, 2014.
- [12] Arunkumar C, Perumal R, Lakshmi Narayanan S and Arunkumar J, “Use of Corn Cob as Low Cost Adsorbent for the Removal of Nickel (II) From Aqueous Solution”, International Journal of Advanced Biotechnology and Research(IJBR), Vol5, Issue3, , pp325-330, 2014.
- [13] Opeolu, B.O., Bamgbose, O., Arowolo, T.A. and Adetunji, M.T., “Utilization of maize (Zea mays) cob as an adsorbent for lead (II) removal from aqueous solutions and industrial effluents”, African Journal of Biotechnology, Vol. 8 (8), pp. 1567-1573, 2009.
- [14] Akporhonor, E. E. and Egwaikhide, P. A., “Removal of selected metal ions from aqueous solution by adsorption onto chemically modified maize cobs”, Scientific Research and Essay Vol. 2 (4), pp. 132-134, 2007

Websites:

<https://tedxinnoventions.ted.com/2016/10/11/what-if-we-could-clean-wastewater-with-corn-cobs>