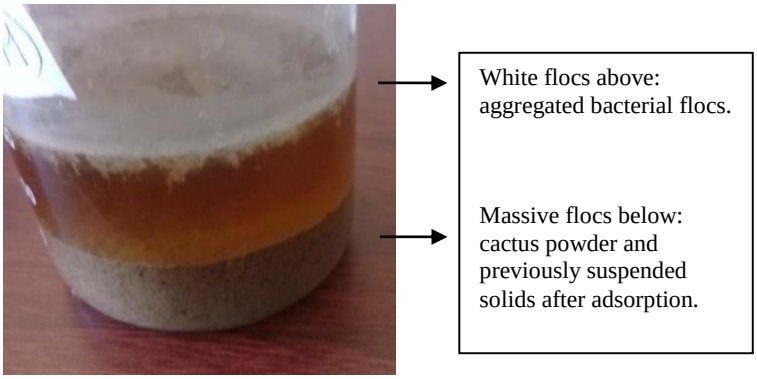

Figure 2: the collected flocs from ~3-liter sample of sewage water.

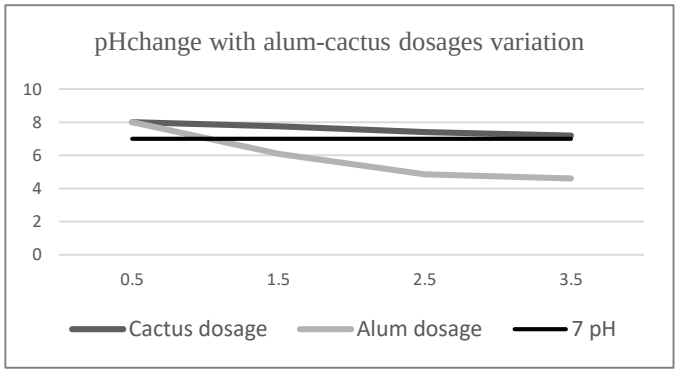

Figure 3: the effect of adding OFI powder on water pH vs

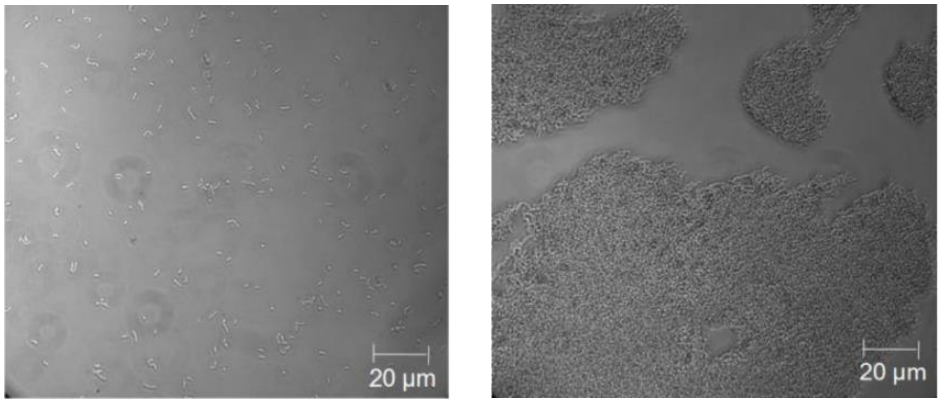

Figure 4: light microscope images of Bacillus cereus in control sewage water (Left) and bacterial flocs (Right).

Moreover, the functional groups of cactus polysaccharides included carboxyl (COOH—), hydroxyl (OH—) and amino or amine (NH_2—) groups, as well as hydrogen bonds. These functional groups are considered as preferred groups for the flocculation process.[1]

Bio-coagulant dosages effect: The increment in removal of turbidity by the increment of the dosage is due to increment of active site of the cactus powder. As the cactus powder dosage was increased, the final pH values of the water sample were relatively unaffected. This means that the cactus powder has no significant effect on the pH with the increment of the dosage unlike alum (as illustrated by figure 3).

Coagulation mechanism: Most of the plant-based organic coagulants predominantly function on adsorption and inter-particle bridging mechanism of coagulation. Our results have supported the hypothesis of adsorption facilitated by inter-particle bridging mechanism where particle destabilization takes place in the adsorption of colloidal particles onto the main chain and side chains of polysaccharides of OFI and forming the bridge in terms of complexes of particle-polysaccharide-particle[2]. Adsorption may take place through dipole-dipole interactions and hydrogen bonding. Due to high molecular weight of polysaccharides, their long chains may stretch into the medium and can adsorb the larger number of pollutants.

The natural electrolytes of mucilage of OFI, specifically divalent ions such as Ca^{+2} and Mg^{+2}, have a synergistic effect on coagulation by enhancing the complex formation. The full mechanism is illustrated in figure *5*.

Comparison between bio-coagulant and alum: As Alum is widely used as a chemical coagulant for water treatment, it was compared with cactus coagulant for treatment of wastewater. Although alum had relatively better turbidity-removal efficiency compared to cactus coagulant, the pH of treated water was much lower in case of Alum. The flocs formed using alum were nearly spherical in shape unlike the thread structured flocs formed by bio-coagulant. The floc size was small in case of alum generating the sludge of poor settling properties whereas the sludge formed by OFI was more compact with bigger flocs. It was also observed that in case of OFI, the sludge stayed compact even after creating the disturbance in water and separated from water easily.

Sand filters and the activated charcoal: The sand filter is used after the water is exposed to screening to get rid of some of the relatively large suspended solids. Activated charcoal is used in the sand filter since it has a large surface area and have tendency to adsorb heavy metal ions. The treated water by cactus is passed

[1] Credit of this hypothesis goes to [7].

[2] Credit of this mechanism goes to [7].

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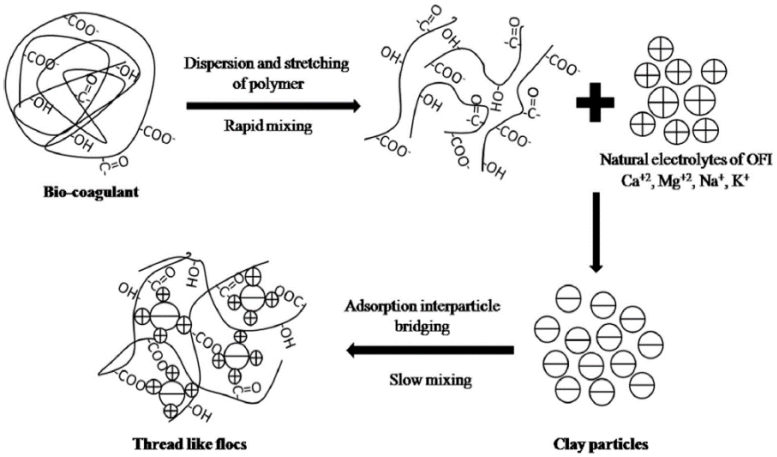

Figure 5: the supposed inter-particle bridging mechanism. Credit to [7]

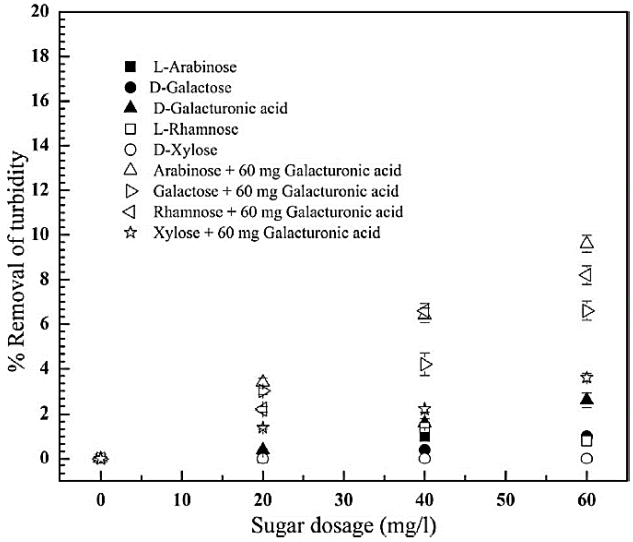

Figure 6: polysaccharides of mucilage with its anti-turbid effect. Credit to [7]

again over activated carbon to adsorb the chlorophyll-A dye present in the water.

V. Conclusion

Considering the discussed investigation, it is obvious that cactus has high potential for water treatment. It has high removal efficiencies for the contaminants of wastewater. It has no unfavourable effects on water during the treatment process. It has a negligible cost compared to the cost of chemical coagulants like Alum and Ferric Chloride; additionally, these chemical coagulants do not have the same potential as natural OFI powder. The first sand filter removed relatively large-sized particles and the second sand filter reduced "Chlorophyll-A" content. The cactus optimized the pH, COD, BOD, TSS, turbidity, heavy metal ions and bacteria presence in the water. Ultimately, clean sterile water suitable for agriculture was obtained.

VI. Recommendations

It is recommended for further investigation that:

1) Trying to combine other coagulants, instead of Alum, with cactus powder to obtain even better results in turbidity removal putting into consideration their effect on water characteristics and the pollutants removal.

2) When the project is applied on a large scale, it is preferred to dry the cactus to obtain the powder by subjecting the cactus (after peeling) to sunlight for about two weeks. This is much more cost-effective than drying cactus in the oven.

3) It is recommended to use pure cactus mucilage extracted with special type of centrifuge, the cactus will be peeled and mashed then it will be put in centrifuge machine which have very small pores that allows the mucilage liquid particles to pass without the other solid molecules, this mucilage should give better results as it will be pure extraction of polysaccharides and ions.

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