EFFECT OF COAGULANT EXTRACTED FROM ALMOND NUTSHELL (*Prunus Amygdalus*) ON SYNTHETIC TURBID WATER

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ABSTRACT

A survey and inventory of indigenous knowledge and plants used by rural peoples to purify water was came out vis-à-vis the inherent local water crisis challenges in the existing water purification technologies. The findings indicated that from time immemorial indigenous people have had to use rich knowledge base to treat their water. Plants identified were *Moringa oleifera*, *Jatropha curcas*, *Pleurotus tuberregium*, *Citruss aurontifolia*, *Strynos potatorium*. A review of the potentials of these plants coagulants with respect to turbidity removal and disinfection of water borne diseases vis-a vis the pitfalls of chemical coagulants and disinfectants such as Alum and Chlorine have been presented. Studies conclusively demonstrates that bio-coagulants especially *Moringa oleifera* seeds are as efficient as Alum is purifying water and wastewater at low cost. A coagulant was prepared from Almond Nutshell to be used for the treatment or purification of turbid water. Different operating parameters such as coagulant dose, pH and concentration of synthetic turbid water were optimized. It reported 70% removal of turbidity at 0.5 gram of crude extract dose by coagulant size of 03mm. The pH was best adjusted by using 2.0 gram of extracted coagulant. The coagulants were also compared with inorganic coagulants such as Alum. Coagulant activity of Almond nutshell was about (70%) found to be equal to other natural organic coagulants. This process of obtaining natural coagulants from Almond nutshell is very commercial and environmental friendly so government should bring it on commercial scale.

***Key words*:** Water Treatment, Environment, Almond nut shell , Turbidity, car wash Water, Coagulant

1. INTRODUCTION

Water is very essential compound on earth for survival of life. In daily life applications either home or industrial, water is extensively used. With rapid growth in population, industrial processes, demand of water is increasing day by day. On the other hand, availability of fresh water is at alarming situation due to harmful effects by the waste directly thrown into rivers, lakes etc. The waste from industries which pollutes the water reservoir consists of textile, steel mills, pesticides, fertilizer and refining effluents mainly. Water treatment can be done mainly using three methods which are: primary, secondary and tertiary or advanced processes [1]. Primary treatment removes suspended particles and grease from water while secondary treatment which is mostly used and known as biodegradation process for removing biodegradable compounds. Tertiary methods are used for removing non-biodegradable waste and impurities. Baluchistan is largest province by area of Pakistan which is facing shortage of water now a day. Water table has been down too much. If we talk about ground water of Baluchistan, the makran coastal zone and there are several other zones which contain high salted ground water. Local bodies use ground water here with total dissolve solid high as 3000 mg/l for drinking purposes, as there is no substitute. High fluoride content has been found in the area of mastung valley. Mostly areas have high quantity of fluorides found in ground water [1]. The drinking water sources contain rivers, streams, reservoirs, ponds, springs, and wells. As water flow on the surface of the land it absorbs naturally occurring minerals and also some radioactive material picking up some substances causing from the presence of human or animal activities. The pollution in source water like ground water or spring water contain microbial contaminants such as bacteria or virus. These pollutants can arrive from septic system, sewage water treatment system, wild life, and agricultural livestock processes. The inorganic pollutants such as metal and salts, which can be naturally occurring or causing of urban water runoff, gas and oil production, domestic and industrial waste water discharges, farming or mining, pesticides and herbicides, these may come from many sources such as urban storm water runoff, agriculture and

residential uses just like organic chemical pollutant including volatile and synthetic organic chemicals, these are the byproduct of industrial operations and petroleum production, and septic system and urban waste water runoff and radioactive pollutants which occurs naturally in mining and due to the result of gas and oil production processes. Sand, silt, clay and other suspended particles are causes which makes the water turbid.

Turbidity of water is measured with a turbidity meter which passes a beam of light over the water and measures the supply of light scattered by the suspended particles measured. Suspended particles can block valves and foul reverse osmosis membranes [3]. They are typically eliminating filters with pore sizes of from 1 to 20 micrometers. Turbidity is generally the cloudiness or dullness of water caused by the individual particle usually they are suspended particle. They are normally invisible to the naked eye, like smoke in air. The key test of water quality is the existence of turbidity. Water have different type of suspended particle of various sizes. Some of them are big enough and can be settle down in a tank by process of sedimentation if they are regularly agitated. But few particles are small in size called colloidal particle and these small particle results the water to become turbid [3]. When we talk about open water turbidity it is mostly due to the growth of phytoplankton. And also human activities just like construction can disturb land which leads to high sediment levels entering water bodies while storm water, rain water, and create turbid condition. Generally, in urban areas huge amount of turbidity to near water through storm water pollution is from paved surface like roads, bridges and parking lots. When turbidity of water is high, there is more risk that people may suffer from gastrointestinal diseases. There are different effects of turbidity in water as if it is high turbidity, it may the cause barrier of light to the low depth of water bodies, which can inhibit the growth of submerged aquatic plants and hence impact on other species dependent on those plants like fish and shellfish. This phenomenon was mostly noticed regularly. Coagulation is well known and widely used process for purification of waste water [4]. Chemical coagulants are used for the treatment of waste water, for the removal of phosphorus, amplification of the primary or secondary clarification or improvements of the tertiary treatments, such as rapid filtration or membrane filtration. Coagulants are also used for the aggregation of hemi- cellulose and cellulose particles in filterable flocs in the production of paper Coagulation is defined as the addition of chemicals and providing the mixing so that particles and some dissolved impurities to form larger particles, forming aggregate solids which then can be removed by process such as dissolved air flotation, rapid filtration, sedimentation, or membrane filtration [1].

2. METHODOLOGY

2.1. Raw Material Preparation

Before performing the experiment, we collected material sample (Almond nutshell) from market of Quetta. First of all, the waste biomass was washed by distilled water in order to remove dust and any other solid impurities on almond nutshell, then we dried it for half an hour for 120 degree centigrade to remove the moisture contents from it until a constant weight was achieved. After drying the nutshell sample, we crushed it through electric hammer mill but the particles were very coarse then the coarse particles are fine crushed in electric ball mill. Then we pass the crushed material through different sieves of mesh number to obtain the required particle size. These extract is mixed with distilled water after mixing the suspension is stirred using a magnetic stirrer for 15 minutes to extract the active components. Than this suspension is pass through normal filter paper and the filtered material is dried and then used in the experiments.

Figure 1: Raw Material: Almond Nut Shell

Figure 2: Crushed raw material for sieving analysis

2.2. Preparation of Synthetic Water Sample

The synthetic turbid water solution for sample of ground water was prepared by adding kaolin (aluminum hydrated silicate). 1, 5, 10, 15, 20 and 25 gram of measured aluminum hydrated silicate was dried in an oven with the temperature of about 105 degree centigrade and them it was added to 100 ml water to produce different initial turbidities. For our required test of stock solution, we generate different experimental turbidities of 45 NTU, 50 NTU, 55 NTU, 60 NTU, 62, 65 NTU, 67 NTU and 69 NTU

Figure 3: Synthetic Turbid Water Solution

2.3. Preparation of Stock Solution

Coagulation/flocculation activity is the combining of small particles in the water together into larger, heavier clumps which settle out relatively quickly. The large particles are called flocs which will settle out quickly in the sedimentation basin, removing most of the turbidity of water. Coagulants are tested by jar test. The first step in jar test involves the addition of coagulants to the source water and mix the water properly in order to dissolve completely the coagulant in the water. Then the water is mixed slowly for long time duration so that the formed flocs particles clustered together. Finally, the mixer is stopped and the flocs particles are allowed to settle down.

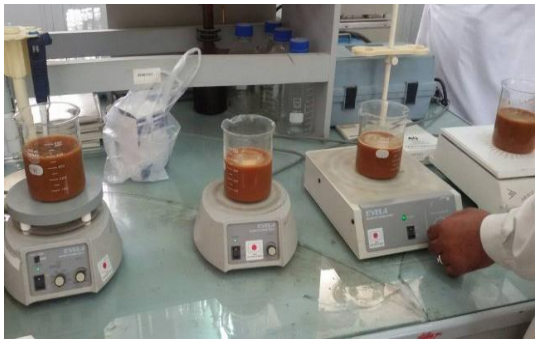

Figure 4: Stock Solution preparation

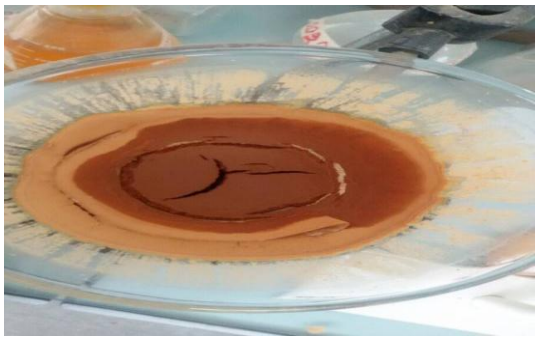

Figure 5: Extraction of Almond nut Shell Coagulant

2.4. Experimental Procedure

Decide on dosages of the coagulant to be used. Take different grams of coagulant to be used for preparing a stock solution from which then active protein should be extracted. This active coagulant would be then used for further coagulation activity. Prepare a synthetic turbid water solution of different turbidities by adding different amount of kaolin powders. i.e. 1, 5, 10, 15, and 20 grams. Weigh the correct amount of chemical substances using an analytical balance. Add the chemical in distilled water. Mixed well the chemicals by utilizing a magnetic stirrer. Measure defined amount of distilled water to be used for preparing a stock solution and synthetic turbid water of tap water**.** Once you weigh the coagulant dose, kaolin amount and distilled water then prepare a stock solution of different coagulant dose and different synthetic turbidities solution. Once the chemicals are added to water stir the solution properly by using a magnetic stirrer to mix them well. The stirring should be done for at least 20 minutes.

After that provide some time so big particles settle by itself. Test the initial pH and turbidity of the prepared synthetic turbid water solutions. Once the particles settle down, filter the stock solution to extract the active coagulant which can be then used for coagulation activity. Now treat the synthetic turbid water solution of different turbidities by the prepared extract coagulant using jar test. Once the extract coagulant is added to turbid water, mix them properly and quickly by a magnetic stirrer for 15 minutes. After mixing, provide 20 minutes' sedimentation time so that the form flocs cluster together with suspended particles and settle down. After sedimentation, check the pH and turbidity of solution. Repeat the steps for performing different test by varying the coagulant dose amount and kaolin powder.

3. RESULTS

Turbidity removal is the main goal of this project through chemical coagulants i.e. through coagulant active protein. For these experiments, model turbid water used has different initials turbidities. Dosage of the protein was varied in steps to see the efficiency for turbidity removal and also some test was performed keeping the same dosage amount while varying the initials turbidities.

3.1. Turbidity reduction analysis using 0.3 mm coagulant particle size

In this test, four samples of the stock solution were prepared by adding 0.5, 1, 1.5 and 2.0 grams of extracted almond nutshell coagulant in each four beakers containing 100ml distilled water. The particle size of this coagulant was 0f 0.3mm by passing through a 40 mesh screen.

Four samples of synthetic turbid water solution were also prepared by adding 1 gram of kaolin powder to each 100ml tap water beakers. The initial turbidities were 70 NTU.

For these experiments, model turbid water used has initial turbidity of 70 NTU each sample. For the first sample having 70 NTU initial turbidity comes down to 30 NTU having a low efficiency of 58% by using 2-gram coagulant dose. For the second and third sample the turbidity removal efficiency was about 61% and 65%. The highest turbidity removal efficiency is about 71% for the last sample of 70 NTU initial turbidity and which is consider an effective efficiency. The last sample test was performed by taking 0.5 gram of coagulant dose which is very minute amount. As the literature say that the least amount of coagulant can leads to higher efficiency. Hence larger amount of coagulant dose does not lead to higher efficiencies

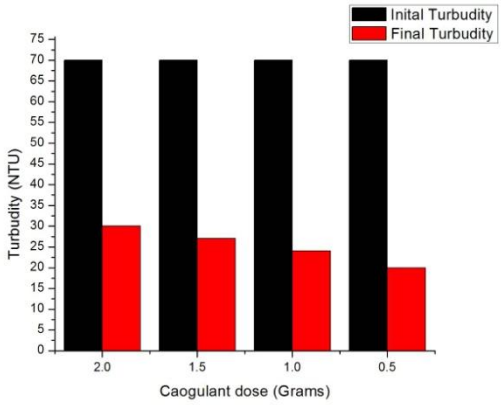

Figure 6: Effect of Coagulant dose variation on turbidity reduction

3.2. Turbidity reduction analysis using 0.27 mm coagulant particle size

In this test, four samples of the stock solution were prepared by adding 5, 10, 15 and 20 grams of extracted almond nutshell coagulant in each four beakers containing 100ml distilled water. The particle size of this coagulant was 0f 0.27mm by passing through a 30 mesh screen. Four samples of synthetic turbid water solution were also prepared by adding 10 gram of kaolin powder to each 1000ml tap water beakers. The initial turbidities of each was 61 NTU.

For these experiments, synthetic turbid water used has initial turbidity of 61 NTU each sample. For the first sample having 61 NTU initial turbidity comes down to 29 NTU having a low efficiency of 52%. This efficiency is less because of using high dose of coagulant. For the second and third sample the turbidity removal efficiency was about 56% and 60%. The highest turbidity removal efficiency is about 69% for the last sample of 61 NTU initial turbidity and which is consider an effective efficiency. The final turbidity comes down to 19 NTU. The last sample results are much better to other because the dose is low as compared to others samples.

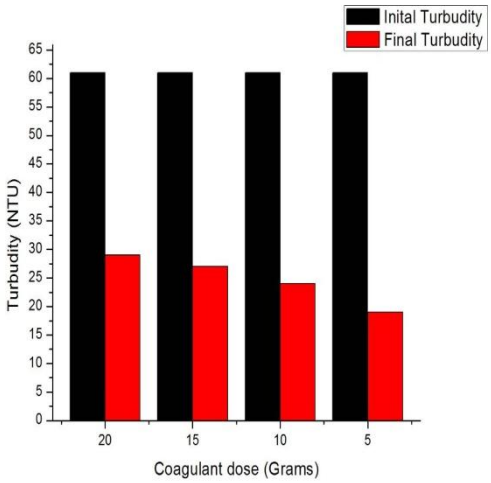

Figure 7: Coagulant dose effect on turbidity removal

3.3. Turbidity reduction analysis using by varying coagulant size

In this test, four samples of the stock solution were prepared by adding 1 gram of each different particle size (1.2mm, 0.5mm, 0.3mm and 0.27mm) of extracted almond nutshell coagulant in each four beakers containing 100ml distilled water. The particle size of these coagulants was achieved by passing through a 16, 30, 40 and 50 mesh screen. Four samples of synthetic turbid water solution were also prepared by adding 1 gram of kaolin powder to each 100ml tap water beakers. The initial turbidities of each sample was 70 NTU.

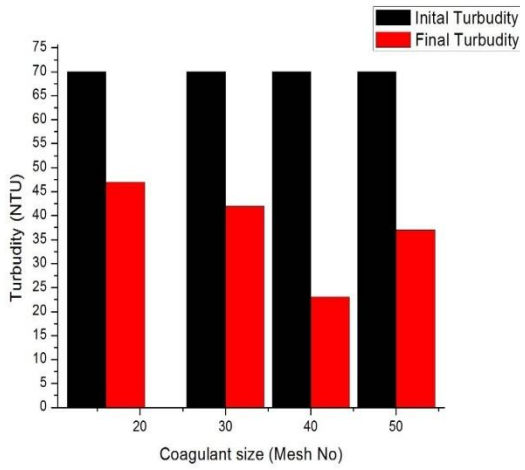

Figure 8: Coagulant size effect on turbidity removal

For these experiments, synthetic turbid water used has initial turbidity of 61 NTU each sample. For the first sample having 61 NTU initial turbidity comes down to 47 NTU having a very low efficiency of 47%. This is because the particle size is greater which does not lead to a better coagulation activity. For the second and third sample the turbidity removal efficiency was about 40% and 47% respectively. The highest turbidity removal efficiency is about 68% for the last sample using a particle size of 0.3mm. The literate also suggests that 0.3mm particle size most efficient and leads to better results. The final turbidity comes down to 23 NTU.

3.3. Optimization of pH

pH is very important factor relating to both charges on protein molecules and coagulation process. After performing experiments, it was observed that ph was also adjusted of the turbid water. The maximum changes were observed at 2.0 gram of coagulant dose. The ph comes down to 7.1 from 8.4. It was seen that increase in coagulant dose increase the chances of ph adjustment.

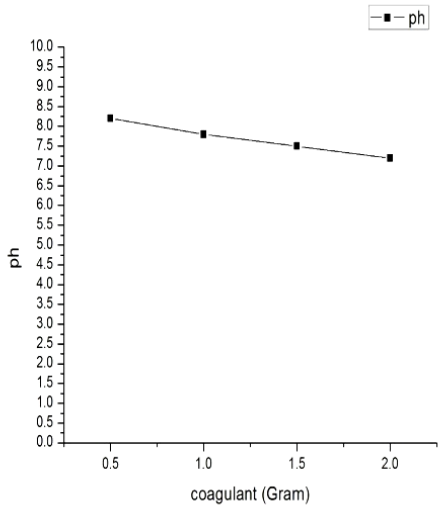

Figure 9: Optimization of pH

4. CONCLUSION

It was found that bio coagulant developed from almond nutshell can be effectively used for treatment of turbid water. This is biodegradable natural coagulant and does not have any harmful effects on human beings. Almond nutshell has the potential to become new source of the environmental friendly and natural coagulant for

the treatment of the turbid water. It was found that crude extract which is extracted from the Almond nutshell removed the turbidity of water up to the 70% at an optimize dose of 0.5 gram.

5. REFERENCES

[1] Diaz, A., et al., "*A preliminary evaluation of turbidity removal by natural coagulants indigenous to Venezuela"* Process Biochemistry, vol.35 no.3–4, pp. 391-395. 1999.

[2] Birima, A., et al. "*Extraction of natural coagulant from peanut seeds for treatment of turbid wate*r" in IOP Conference Series: Earth and Environmental Science, IOP Publishing. 2013.

[3] M. Asrafuzzaman, A. Fakhruddin, and M.A. Hossain, "*Reduction of turbidity of water using locally available natural coagulants"*, International Scholarly Research Notices, 2011. 2011.

[4] Ahmedna, M., et al., "*The use of nutshell carbons in drinking water filters for removal of chlorination by-products*" Journal of Chemical Technology and Biotechnology, vol. 79, no.10, pp. 1092-1097, 2004.

[5] R. Babu and M. Chaudhuri, "*Home water treatment by direct filtration with natural coagulant*", Journal of Water and Health vol. 3, no.1, pp. 27-30, 2005.

[6] A. Ndabigengesere,and K.S. Narasiah, "*Use of Moringa oleifera seeds as a primary coagulant in wastewater treatment"*, Environmental Technology, vol.19, no.8, pp. 789-800. 1998.