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Development Of Bio-Coagulant From Mango Pit For The Purification Of Turbid Water

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Abstract: Coagulant was prepared from Mango pits to be used for the treatment or purification of water. Different operating parameters such as coagulant dose, pH, concentration of synthetic turbid water were optimized. It reported 98% removal of turbidity at 0.5ml dose and pH13. The coagulant was also compared with commercial coagulant such as aluminium sulphate. Coagulation activity of mango pit was (98%) found to be higher than other natural (organic) coagulant. It was also observed that as the pH increases the removal efficiency also increased. This process of obtaining natural coagulants from mango pit is very economical and environment friendly so government should bring it on commercial scale.

Keywords: coagulation, turbid water, water purification, Mango Pit.

INTRODUCTION

During the treatment or purification of water (normally after sedimentation process) finely divided silica, clay and organic matter do not settle down easily and hence cannot be removed by simple sedimentation process, such impurities are generally removed by adding certain chemicals, which produce electric charge that neutralizes oppositely charged colloidal particles and bring about their coalescence. Coagulants are widely used for the removal of colloidal and suspended materials in the form of turbidity. Aluminum and ferric salts are the mainly used coagulants all over the world for the treatment of water and wastewater. These inorganic coagulants are not safe from health point of view. In the past decade research is focused on developing bio-coagulant either from plant residue or animal tissues. These coagulants are biodegradable and are presumed to be harmless for human health and generate less quantity of sludge. Natural coagulant are prepared from Moringa Oliefera, Chestnut, Acorn, Nirmali seed and maize (Raghuwanshi *et al.,* 2002), Mesquite bean and Cactus latifaria (Diaz *et al.,* 1999), Cassia angustifolia seed (Sanghi *et al.*, 2002) and different Leguminose species (Sciban *et al.,* 2005). Since annual production of mango in Pakistan is almost 2250,000 metric tons per year . From which 1/5th of total weight is generated as waste in the form of mango Pits, which increases solid waste production every year, and ultimately effect the Environment and causes the Environmental problems. In the present study Natural coagulant was prepared from mango pit, by washing drying, grinding and sieving and finally extracted. Before using the crude extract as a coagulant it was analyzed for Protein content. The different operating parameters (dose, synthetic turbid water and pH) were also optimized.

EXPERIMENTAL

Preparation of crude extract

Mango pits commonly known as (kernel, seed or embryo) were collected from the parts of Sukkur, Mirpurkhas, Shikarpur and Jamshoro in Pakistan. Upper shell was removed by manual method and distilled water was used to wash the pit. The pit was dried in the oven at the temperature of 120 ºC for one hour. The dried mango pits were ground and sieved through 40 mesh or 0.4 mm sieve and used in the experiments. In one liter of distilled water 50 grams of the prepared powder was dissolved and the suspension was stirred for 10 min using a magnetic stirrer to extract the coagulation active species. The crude extracts was then filtered and kept in a refrigerator. Proten contents were determined as reported (Bradford 1976).

Preparation of synthetic turbid water:

Stock solution was prepared by adding 10 gram of Kaolin (Hydrated Alumineum silicate) in one liter distilled water. Five solutions having different initial turbidities of 17.5,35,50,70, and 90 NTU (Nephelo metric Turbidity Unit) were prepared by adding 2.5,5.0,7,5, and 12.5 ml of stock kaolin suspension to 1 liter of distilled water respectively (Okuda *et al.*, 2001a).

Coagulation test:

The Jar test method was used to determine the Coagulation activity of the seed extract. 300 ml of turbid water was mixed at 200 rpm at constant room temperature 21ºC, different doses of seed extracts were added into the beakers and mixed for 1 min. The suspension was agitated for further 30 min at 80 rpm.. After 1 hour of settling the clarified solution was collected from the top of the beakers. The residual turbidity (T_s) was calculated . The same coagulation test was conducted with no coagulation as a blank. (T_B) Coagulation activity was calculated as:
Coagulation activity (%) = $(T_B-T_S).100/T_B$

RESULTS AND DISCUSSION

Protein content

The coagulation active components in plant extracts are the Protein content (Ndabigengesere et al., 1995, Ghebremichael et al., 2005, 2006). The crude extract samples of Mango pit (Mangifera Indica) were determined for their protein contents. The results of crude material to water ratio (50 grams/liter of water) contained protein as shown in **(Fig. 1).** The crude extract of mango pit (212 mg/l) reported higher protein content than Q. rubba (120 mg/l) and Q robur (150 mg/l) and nearly same protein content to Q. cerris (225 mg/l).

Protein Extraction (coagulation active components).

The protein (coagulation active components) can be extracted from seeds by using brine solution as well as distilled water. Different seeds have different extraction efficiency as Aesculus Hyppocastanum (45.6%), Castanea sativa (55.4%) Q. robur (32.5%), Quercus rubra (32.4%) and Quercus cerris (38.5%) as shown in **(Table .1)**. Mango pit (Mangifera Indica) (58%) had the highest extraction efficiency when compared to other seeds.

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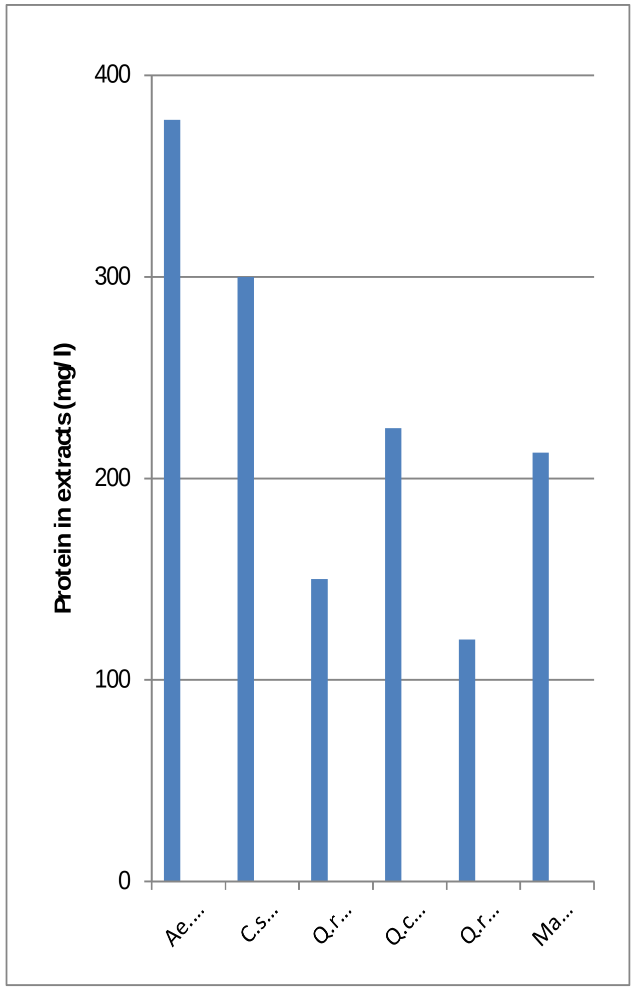

Fig.1 Protein concentration in crude extract (sample: distilled water =50gm:1 L)

Optimization of operating parameters:

For the proper function of coagulation experiments , composition of coagulant, coagulant dose, composition of water, initial water turbidity and pH are important parameters.

Coagulant dose (crude extract).

The coagulation efficiency is highly dependent on coagulant dose, because of the strong bond of coagulant dose and bivalent cations of water (Okuda *et al.*, 2001). Synthetic turbid water having 17.5 and 70 NTU was treated with different doses

Table 1: Efficiency of protein extraction from different plant seeds contains in water.

	Aesculus Hyppocastanum	Castanea sativa	Quercus robur	Quercus cerris	Quercus rubra	Mango pit
Protein extraction efficiency (%)	45.6	55.4	32.5	38.5	32.4	58

of crude extract from 0.25 ml, 0.5 ml, 0.75 ml, and 1 ml as shown in **(Fig. 2)**. 13 % and 14 % efficiency was achieved at 0.25 ml of dose. This has less efficiency because 0.25 ml was too small amount and it produced little amount of charged protein which was responsible for the formation of agglomerates. 0.5 ml of crude extract showed maximum coagulation activity of 56 % and 60 %. The crude extract easily mixed with the turbid water and made more flocks of agglomerates.0.75 ml and 1.00 ml of crude extract when used for water of 17.5 NTU the efficiency was (-11%) and (-13%) respectively, but it showed different behavior when the synthetic turbid water of 70 NTU was applied the efficiency increased (30%) to (40%) respectively. The highest turbidity removal was achieved when 0.5 ml of crude extract was used which agrees with previous research with chestnut and acron (Sciban 2009). Further experiments were conducted by using 0.5 ml dose as constant.

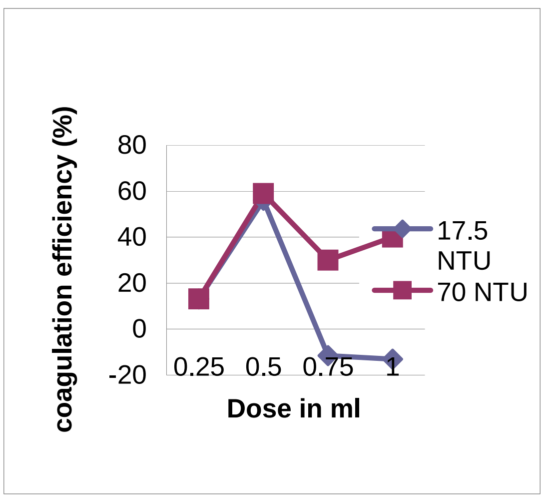

Fig. 2 Dose optimization at 17.5 NTU and 70 NTU at Normal pH

Synthetic turbid water

The optimization of synthetic turbid water is a significant parameter. The dose of 0.5 ml was added in initial turbidities of (17.5, 35, 50, 70 and 90 NTU). The coagulant activity is shown in (**Fig .3)**. These results were observed after 1hour and 3hr 0.5 ml of crude extract was used to treat water of 17.5 NTU after a settling time of 1hr it showed 56 % removal efficiency, while extending the settling time to 2 hours 6 % efficiency increased. Synthetic turbid water of 35 NTU showed 40 % removal efficiency at 1 hour and 62.5 % after 3 hours sedimentation, Similarly linear increment of (40 %, 45.7 % and 48.4 %) efficiency increased at (50, 70 and 90 NTU) respectively. Generally it is observed that higher synthetic turbid water demonstrate higher results but it takes a reasonable time of settling. Maximum efficiency (70 %) achieved at 90 NTU and hence it was selected as optimized parameter for further experiments.

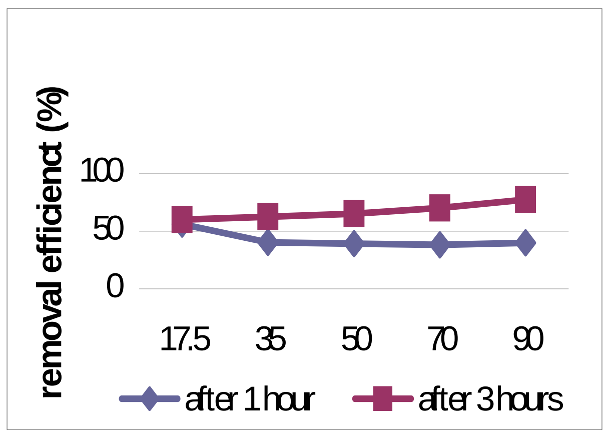

Fig .3 Optimization of synthetic turbid water

Optimization of pH:

pH is very important parameter concerning both charges on protein molecules and coagulation process, the effect of pH on coagulation activity was investigated lastly. Different results were obtained if pH is varied from neutral pH to acidic medium or basic medium as shown in **(Fig .4)**. 95.85 % result was achieved at pH 3 which is maximum value in acidic medium, pH 2 (77.1) gave less result than pH 3. Similarly pH 4 (78.33 %) and pH 5 (73 %) also gave less results, At the neutral pH of turbid water the efficiency of removing of turbidity by applying natural coagulant decreased. The coagulation activity increased from neutral to basic conditions. At pH 13 maximum removal efficiency of 98.65 % was found. Proteins becomes fully charged in strong base as well as in strong acidic medium, charged proteins pull the molecules toward its center and form agglomerates hence agglomerates settle down due to attraction of gravity. These results resembles with the previous work which showed lower efficiency of coagulation activity (Diaz *et al.*, 1999). Further more capabilities of coagulation depend on pH values and initial turbidities (Sciban 2009). It is very interesting to know that the natural water obtained from rivers canals and from sea have pH around (6.5-8.5).

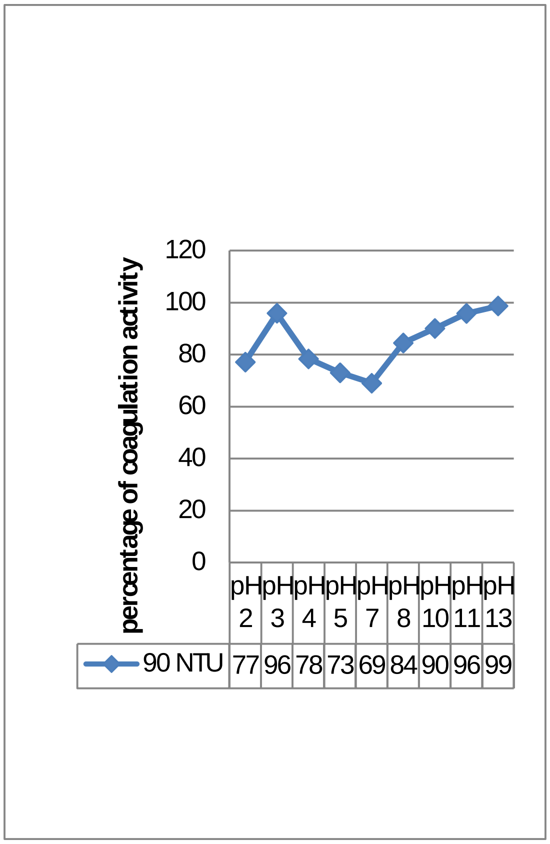

Fig: 4 Optimization of pH. comparison between inorganic coagulant and bio-coagulant

Coagulation activity of mango pit was (98%) higher than other natural (organic) coagulant such as Chestnut (80 %) [Marina Sciban 2009], Moringa Oliefera (86 %), Acorn (70 %) [Marina Sciban 2009] but similar to inorganic coagulant Alum (99 %), as shown in Fig 5. The efficiencies vary according to the protein contents. Mango pit has maximum protein content and showed maximum efficiency as compared to other organic coagulants. Although Alum has much more efficiency of (99 %) but its use is harmful due to its hazardous effects on health of human beings as well as on environment.

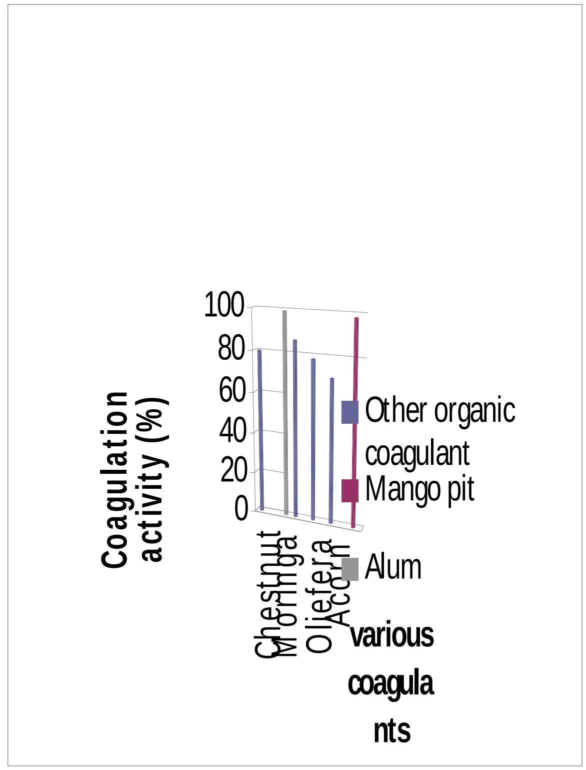

Fig..5 Comparison between organic and inorganic coagulants

CONCLUSON

It was found that biocoagulant extracted from mango pit can be effectively used for treatment of turbid water. This natural coagulant is biodegradable and does not cause any harmful effects on human beings. In both low and medium turbid water coagulating activities were calculated 70% to 98% respectively. Mango pit have 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 extracted from the mango pit removed the turbidity of water up to the 98% at an optimized dose of 0.5ml/liter.

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