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Clarification of Water using Moringa Oleifera as a Coagulant

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Abstract - *Water is used for several purposes by humans, but the level of purity of the water being consumed is very crucial. Since, it has a direct effect on human health. Commonly chemical coagulants are used. Optimum doses of these chemical coagulants should be known because excessive addition chemical coagulants effects on human health and causes environmental problems. In this present study, efficiency of Moringa oleifera kernel powder (MOKP) and Moringa oleifer shelled powder (MOSP) as a natural coagulant during water treatment was investigated. Synthetic turbid stock water was prepared using humus soil and diluted for low, medium and high turbid water i.e., 40NTU, 80NTU and 160NTU. Synthetic turbid water (STW) samples were treated with varying concentrations of MOSP and MOKP: 50 mg/l, 100 mg/l, 150 mg/l, 200 mg/l and 250 mg/l respectively. The synthetic water sample was set at three different pH viz. 6.5, 7 and 7.5 to study role of pH on efficiency of natural coagulant.*

Key Words: Coagulation, *Moringa oleifera* (MO), pH, synthetic turbid water (STW), turbidity.

1. INTRODUCTION

About 70% of the Earth's surface is covered with water (Ugwu et al., 2017), in this 97% of Earth's water is salty. Less than 1% of water is available in fresh water form. This fresh water is distributed unevenly. In recent years, fresh water consumption get increased and water getting contaminated, due to increase in population, urbanization and industrialization as well as agricultural activities (S Kalavathy et al., 2016). Now a day, we are facing lacking of fresh water. It was estimated that, around 2025, 1/3rd of human population will live in the lacking of fresh water areas, contamination of the water threatening the livelihood of human beings and it is directly causing adverse effect on human health (Prf. T D Raju et.al 2018). Millions of people dying because of diarrhea caused by contaminated water. Hence, clarification of water should be done before it reaches to the consumers. Presence of suspended particulates in water makes water to lose its transparency, is nothing but turbidity of water. Turbidity is the physical parameter of water, which is considered as measure of the water quality. Phytoplankton, eroded sediments, waste discharge, algae growth, urban runoff are the major cause for water turbidity. The WHO establishes that, drinking water turbidity should not exceed 5NTU. Heat from the sunlight was absorbed by suspended particles and turbid water becomes warmer. Hence, oxygen got reduce in water, warmer water is not suitable for some organisms to survive. Because of these reasons turbidity of water should be reduced.

In clarification of water, coagulation is one of the important processes, which removes, colloidal particles from water. Coagulation is the chemical process in which addition of chemical precipitates, colloidal particles, coagulation of water also affects various parameters of the water like pH, turbidity, TDS, electrical conductivity, hardness, alkalinity etc. the water before treatment may contain suspended, small and large solid particles. Sedimentation and filtration process removes most of the solid particles but minute particles cannot be removed, that remains in colloidal suspension. These particles can be removed, when they clump together to form larger particles, charges of the colloidal particles prevents them to clump together. If we are able to neutralize those charges, then they consolidate into coarse formations. For this purpose we are adding coagulants to neutralize the charges.

Coagulants are chemicals, that are neutralize the charges of colloidal particles so that, smaller particles clump together and forms large particles. These large particles settle down at the bottom to give clarified water. Commonly used chemical coagulants are Aluminium sulfate, Aluminium chloride, Sodium aluminate and Polyaluminium chloride, Ferrous sulfate, Ferric sulfate and Ferric chloride (Mbaeze MC et al., 2017). Optimum doses of these chemical coagulants should be known because excessive addition chemical coagulants effects on human health (Malla Balakrishana et al., 2014). Iron residue in water causes excessive iron in blood which damages the cells and leads to the Alzeimer's disease (A G Liew et al., 2006), excessive Aluminium in water causes Pathophysiology of neurodegenerative disorders. Other disadvantages of using chemical coagulants are cost of the process, operation and maintenance and production of large sludge volume, even during manufacturing process of chemical coagulants, may contaminate with monomers, or other dangerous substances and can react with other chemicals used during water treatment (Lorena L et al., 2015), generates hazardous substances that cannot process, also puts pressure on nation's financial resources (Md. Asrafuzzaman et al., 2011), even excessive chemicals in water after coagulation process causes environmental problems (A M Lawal et al., 2013). Because of these disadvantages of chemical coagulants there is need to find alternative natural coagulants.

To develop cost effective, environment friendly and easier process of clarification of water, discovering of other safer coagulant is required. Many researchers going on to find natural coagulants to replace chemical coagulants, some plant extracts showed excellent results in coagulation of water. Natural coagulant is one of the most useful and readily available, environmental friendly natural coagulant is *Moringa oleifera*. Many research works concluded that *Moringa olifera* plant possess valuable properties and it gives all the nutrients required by human beings (Lakshmipriya Gopalakrishnan et al., 2016).

2. MATERIAL AND METHODS

2.1 Collection of Soil and Preparation of STW

In this current study, removing of turbidity is from STW (Giridhar V S S Mittapalli et al., 2016). The humus soil was collected from Agricultural land near Shamanur, Davanagere. Tap water was used for the preparation of raw STW. Approximately 250 g of soil was dissolved in 4 leters of tap water (Milind R Gidde et al., 2012). The sample was mixed well and left undisturbed for 24hours for complete hydration (Md. Asrafuzzaman et al., 2011). As per the requirement, stock sample was diluted with tap water to obtain desired low, medium and high turbidity (i.e, 40, 80 and 160 NTU) (Mangale Sapana M et al., 2012).

2.2 pH Meter

pH meter was used to adjust the pH 6.5, 7, 7.5 (Jhon Jairo Feria Diaz et al., 2018) to diluted STW (i.e., 40, 80, 160NTU).

2.3 Collection and Preparation of MO Seed Powder

Dry MO seeds were collected from tree near Siddaganga School Davanagere. Seeds coat and wings were removed. To prepare MOSP, shelled seeds were ground using domestic food blender (Tan Chu Shan et al., 2017). To prepare MOKP, seeds coat, wings and seeds shell was removed. The seeds kernel was ground using domestic food blender, then the powder was directly used as coagulant (Ramaraju Bendi et al., 2014).

2.3 Jar Test Operations

To determine the optimum dosage and turbidity removal efficiency of the coagulant, jar test equipment was used (Jhon Jairo Feria Diaz et al., 2018). Jar test was carried out in laboratory. MOSP and MOKP with varying dosages were used to treat sample. Test was carried out using 1litre capacity jars. This is carried out using STW of 40NTU, 80NTU and 160NTU of pH range 6.5 to 7.5. MOSP and MOKP was weighed to 50mg, 100mg, 150mg, 200mg, 250mg (Kulakarni CP 2017), powder was directly used as coagulant for clarification of water. 5mins, paddles of jar test apparatus was rotated at the speed of 120rpm for rapid mixing then for another 25mins rotated at the speed of 40rpm for slow mixing (Milind R Gidde et al., 2012). Treated sample was left undisturbed for 2hrs (Ramaraju Bendi et al., 2014). After 2hrs turbidity test was conducted for supernatant water (Kulakarni CP et al., 2017).

2.4 Turbidity Meter

Turbidity meter was used to determine initial and final turbidity of the diluted turbid water and treated water sample.mplate sample paragraph .Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

3. RESULT AND DISCUSSION

3.1 Effect of Coagulant Dosage on Clarification of Water

Experiment was conducted for coagulant dosage 50, 100, 150, 200 and 250mg/l. Both MOSP and MOKP removed maximum turbidity at 150mg/l (Fig 1(a,b,c)). At optimum dosage (i.e.,150mg/l), turbidity removal efficiency of MOSP and MOKP for 160NTU is 70.62% and 65% respectively (Fig 1(d)). These results are obtained at pH 7.5.

3.2 Effect of pH on clarification of water

Experiment is to study the effect of pH on coagulation. pH was set at 6.5, 7 and 7.5. During analysis it was clear that, as the pH of sample increases, performance efficiency of both MOSP and MOKP is also increases (Fig 2(a,b,c,d,e)) and hence, at pH 7.5, both MOSP and MOKP showed very good result (Fig 2(e)). MO seed powder as a coagulant will always increases the pH of treated water. This is because, MO has water soluble cationic proteins in its seeds. The basic amino acids present in the protein of MO attracts proton from water and releases OH^- group and hence solution becomes basic in nature (Ramaraju Bendi et al., 2014).

3.3 Effect of turbidity on clarification of water

In this study, low (40NTU), medium (80NTU) and high (160NTU) STW was prepared using humus soil. After treatment with MO seed powder, both MOSP and MOKP decreased the turbidity of water (Fig 3(a,b,c)). But, MOSP and MOKP removed less turbidity in low turbid water and removed more turbidity in high turbid water. At 160NTU, MOSP and MOKP removed 70.62% and 65% of turbidity respectively (Fig 3(c)), these results are obtained at pH 7.5 and at coagulant dosage 150mg/l.

After treatment with MOSP and MOKP, results obtained are

Table 1 (a,b,c): After treatment, residual turbidity for synthetic turbid water

Coagulant Dosage (mg/l)	Turbidity:40NTU					
	pH 6.5		pH 7		pH 7.5	
	MO SP	MO KP	MO SP	MO KP	MO SP	MO KP
50	31	36	29	35	27	32
100	29	34	25	33	24	30
150	27	31	24	30	21	27
200	39	39	31	37	28	36
250	42	45	33	42	32	41

(a)

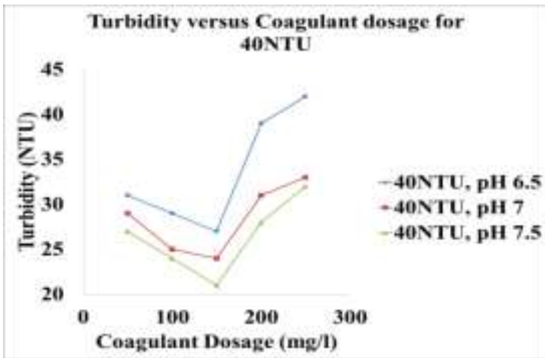
Coagulant Dosage (mg/l)	Turbidity:80NTU					
	pH 6.5		pH 7		pH 7.5	
	MO SP	MO KP	MO SP	MO KP	MO SP	MO KP
50	43	44	41	41	40	40
100	39	40	37	38	34	37
150	37	39	35	37	32	34
200	49	50	47	47	45	44
250	56	58	52	56	46	51

(b)

Coagulant Dosage (mg/l)	Turbidity:160NTU					
	pH 6.5		pH 7		pH 7.5	
	MO SP	MO KP	MO SP	MO KP	MO SP	MO KP
50	62	65	60	64	58	63
100	59	61	57	60	56	58
150	50	60	49	58	47	56
200	63	68	61	65	57	61
250	66	70	64	68	63	65

(c)

3.4 MO shelled powder as a coagulant



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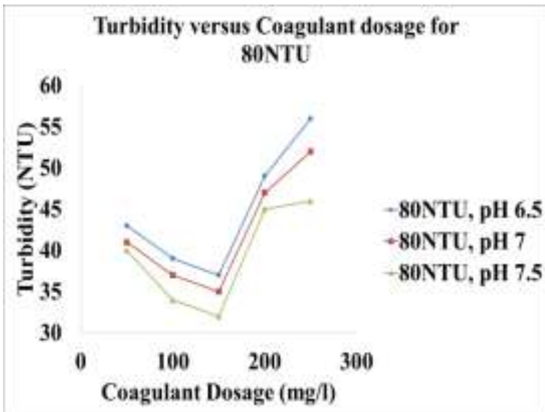

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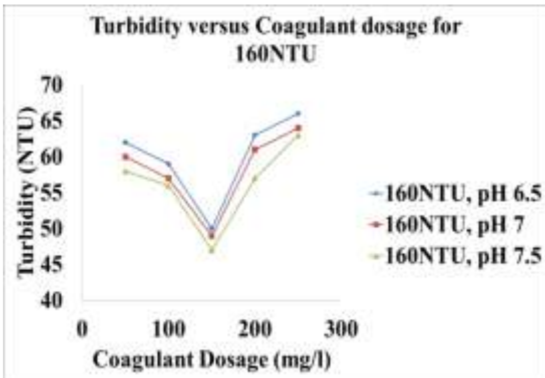

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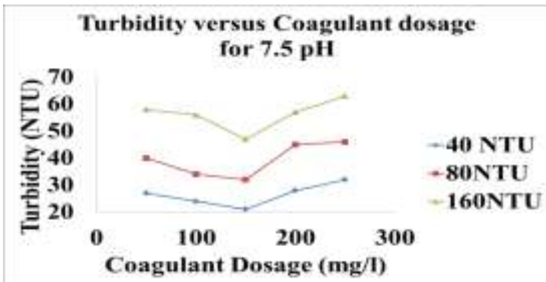

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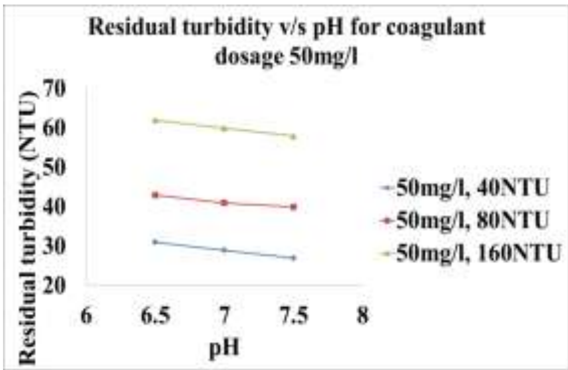
Fig 1 (a,b,c,d): Residual turbidity v/s Coagulant dosage, Effect of coagulant dosage on clarification of water



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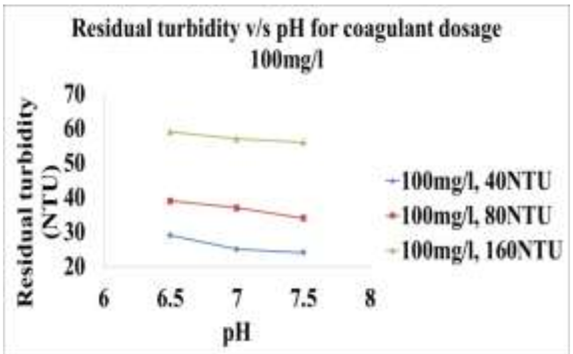

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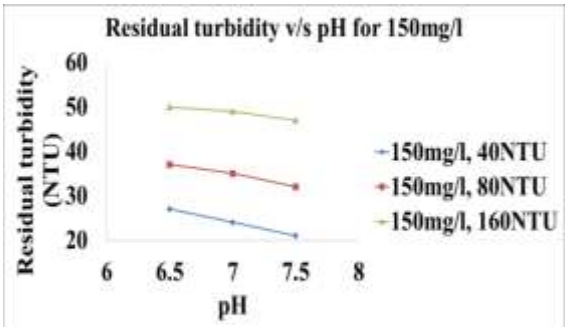

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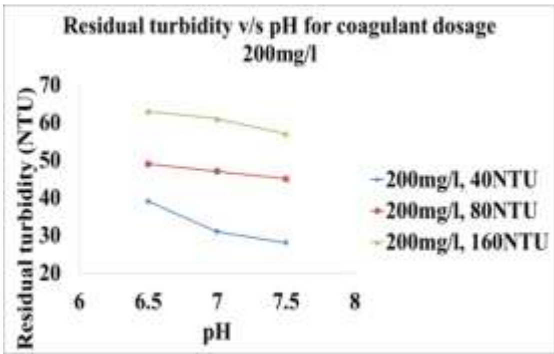

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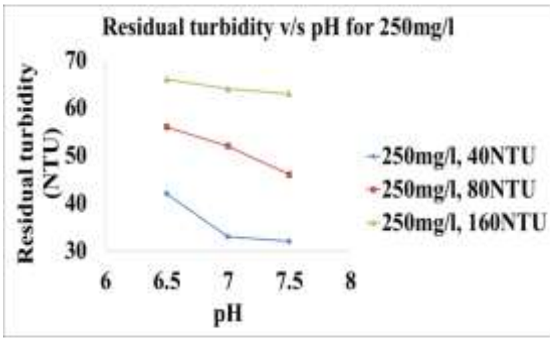

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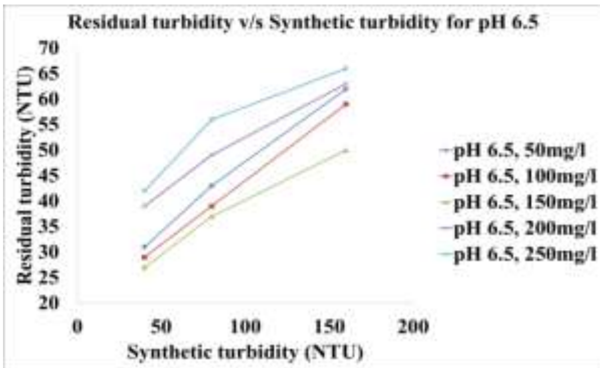
Fig 2(a,b,c,d): Residual turbidity v/s pH, Effect of pH on clarification of water



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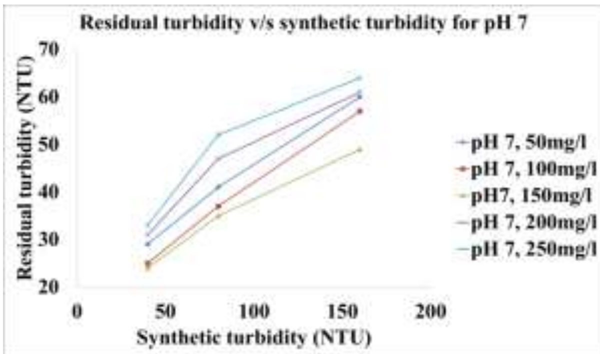

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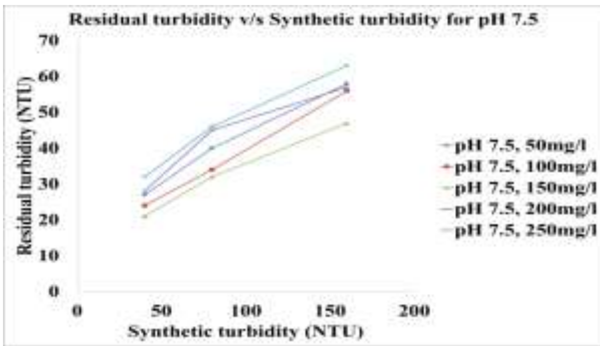

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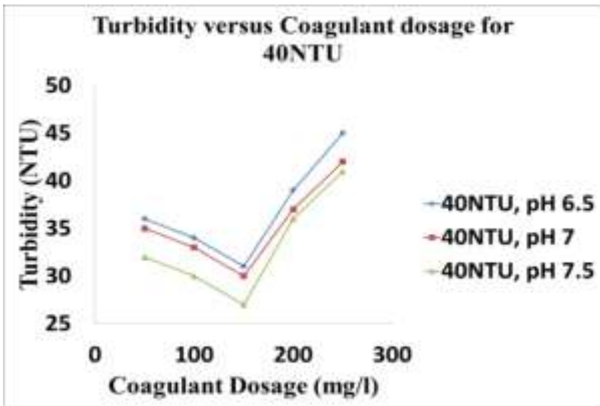
Fig 3(a,b,c): Residual turbidity v/s Synthetic turbidity, Effect of turbidity on clarification of water

3.5 MO kernel powder as a coagulant



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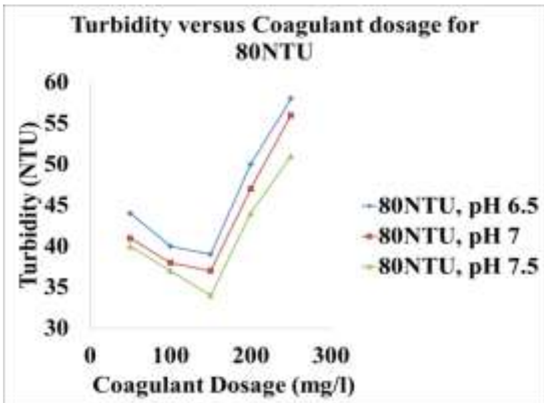

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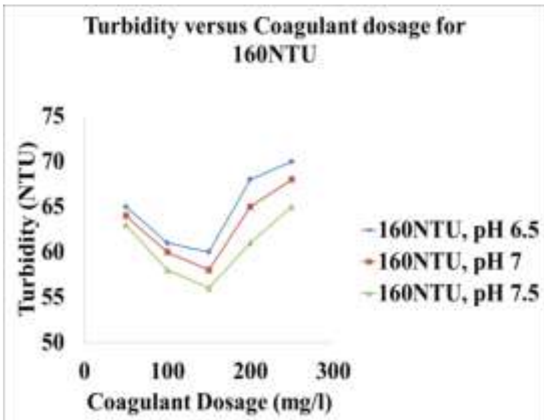

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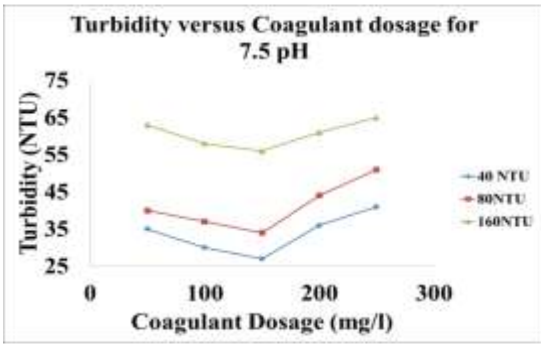

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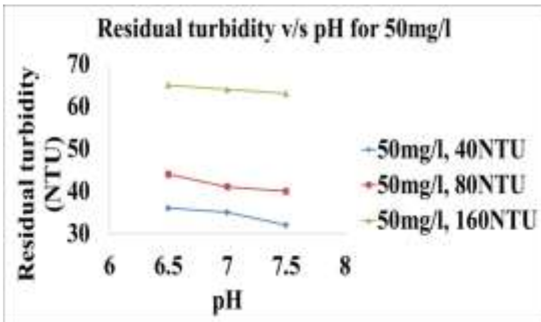
Fig 4(a,b,c,d): Residual turbidity v/s Coagulant dosage, Effect of coagulant dosage on clarification of water



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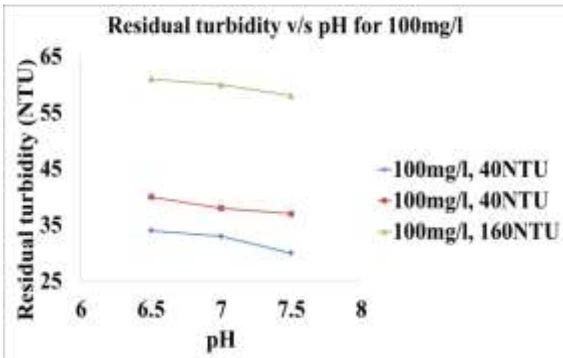

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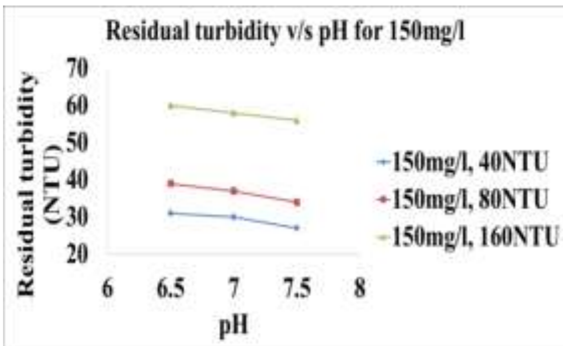

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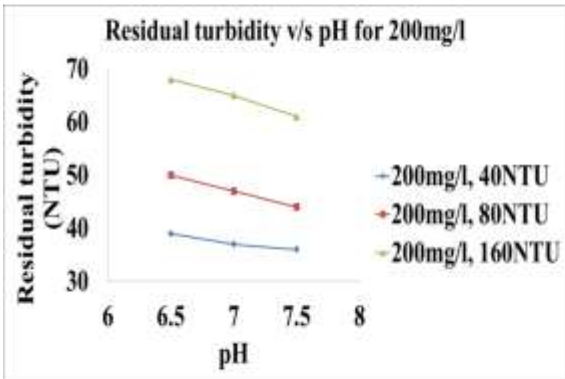

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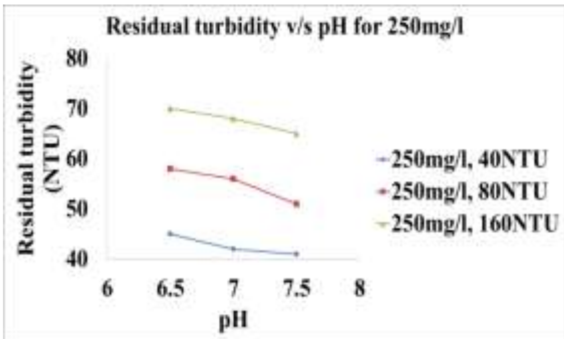

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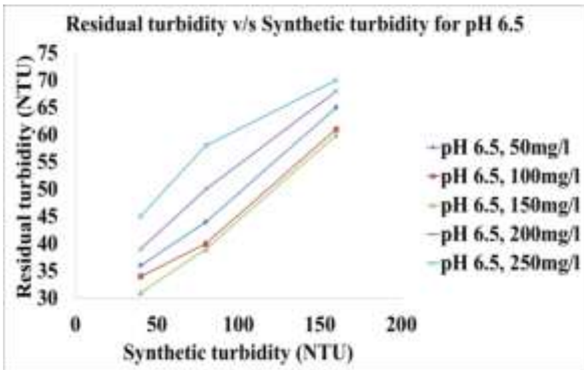
Fig 5(a,b,c,d,e): Residual turbidity v/s pH, Effect of pH on clarification of water



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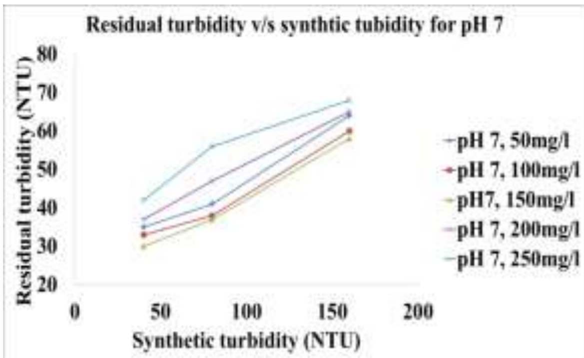

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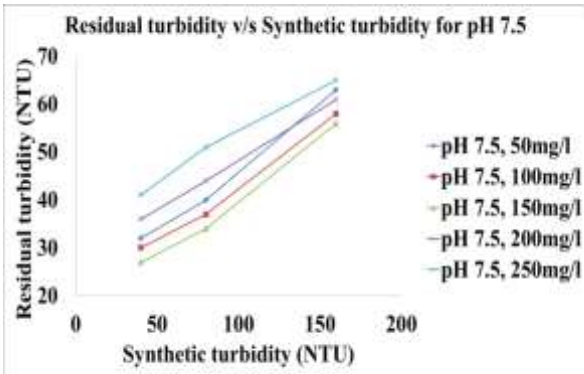

(c)

Fig 6(a,b,c): Residual turbidity v/s Synthetic turbidity, Effect of turbidity on clarification of water

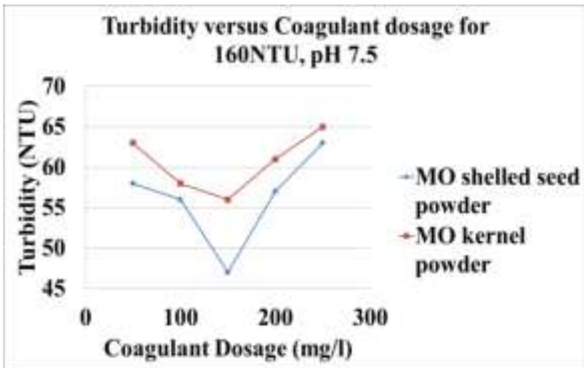

Fig 7: Residual turbidity v/s coagulant dosage

4. CONCLUSION

The main aim of the study is to know efficiency of MO seed powder in turbidity removal of water. Adjustment of pH to the diluted STW has great influence on turbidity removal capacity of the coagulant. Both coagulant dosage and pH are important parameters to reduce turbidity of water. MOSP removes maximum turbidity compared to MOKP. As the coagulant dosage increases, turbidity of water decreases for certain limit, after that turbidity of water increases. Optimum dosage for both MOSP and MOKP is 150mg/l. At high pH (i.e.,pH 7.5), maximum turbidity is removed from both powders. For higher turbid water (160NTU), residual turbidity for both MOSP and MOKP as a coagulant is less. For 40NTU at pH 7.5 and coagulant dosage 150mg/l, turbidity removal efficiency of both MOSP and MOKP is 47.5% and 32.5% respectively. For 80NTU, at pH 7.5 and coagulant dosage 150mg/l, turbidity removal efficiency of MOSP and MOKP is 60% and 57.5% respectively. For 160NTU, at pH 7.5 and coagulant dosage 150mg/l, turbidity removal efficiency of MOSP and MOKP is 70.62% and 65% respectively. From these results, it was clear that, for 160NTU, at pH 7.5 and at optimum coagulant dosage 150mg/l MOSP showed very good result, so that MOSP can be used as coagulant for high turbid water.

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