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STUDY OF PARAMETERS AFFECTING THE EFFECTIVENESS OF MORINGA OLEIFERA IN HARDNESS & TURBIDITY REMOVAL

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Abstract:-This research involves the study of effects due to changes in various parameters such as pH (range; pH 4-9) and temperature (0ºC-50ºC) on effectiveness of Moringa Oleifera. Turbidity measurement has been considered during research for observing the effectiveness of Moringa Oleifera with the help of 40 NTU, 80 NTU and 160 NTU solutions. Synthetic hard water varied from 300ppm to 900ppm as calcium hardness. Inductively Coupled Plasma Spectrophotometry (ICP-OES OPTIMA 5300 DV) instrument has been used for hardness determination, whereas ELE430-257 turbidity meter used for turbidity measurement. Very negligible effect was observed in the hardness removal efficiency of Moringa Oleifera with the variation of pH and temperature. The turbidity reduction was higher for higher initial turbidity samples and only 52.5% reduction was observed for initial 40 NTU sample. The maximum reduction in turbidity of 75% was found at pH-7 and hence this was observed as the optimum pH. It was also noticed that the efficiency of Moringa Oleifera increases by increasing temperature and maximum turbidity reduction of 67.5% was observed at 50ºC sample whereas only 18.75% reduction was noticed with 5ºC sample.

Keywords: Moringa Oleifera, pH variation, temperature variation, turbidity measurement.

INTRODUCTION:

Amount of cloudiness is referred to as turbidity in water; it is normally caused by different suspended materials. According to degree of turbulence, the size of the suspended materials varies in water. Particles of colloidal rock are responsible for turbidity in lakes and rivers. These rivers and lakes passes through certain areas where it finds the industrial or domestic wastewater and untreated water while moving towards ocean, and this kind of wastewater adds a huge amount of organic and inorganic material that causes turbidity. Washing of streets are also a big contributor in producing turbid water, because when it moves towards rivers and lakes it contains microorganisms which causes turbidity in rivers and lakes. Wastewater containing phosphorous and nitrogen leads to algae growth in water which also causes turbidity (N.Sawyer, 2003). Methods of wastewater treatment involves coagulation/flotation precipitation, filtration, sedimentation, electrochemical techniques, biological process, chemical reactions membrane process and ion exchange, and every different method has its advantages and disadvantages according to its cost and availability. At present, evaluation trend of some cheaper and local materials is increasing for elimination of these pesticides and pollutants from water. For the safety of biosphere a variety of inexpensive materials including agricultural and industrial wastes are being used to remove various pollutants for theirs nontoxic disposal (Akhtar et al. 2009). Moringa Oleifera is a very famous tree and also known as 'Horseradish or drumsticks tree', it is from Moringaceae family which has 12-14 species and all belongs to one genus 'Moringa'. It is cultivated all around the world but most of the species were first found in India and from there they are now introduced into many tropic countries. Moringa Oleifera is a very crucial plant because all the parts of it such as flowers, leaves, pods, and fruits are used as nutritious vegetable. It is generally produced in India, Philippines, Hawaii, Thailand, and in many regions of Africa. The leaves of Moringa Oleifera are very healthy, it contains high amount of vitamin A and vitamin C and provides natural antioxidants to the body. It is also used for traditional medicinal purposes (Maleeha M. et al. 2007). Moringa Oleifera seeds act asnatural coagulant which has antimicrobial properties and it is also used for water purification. The extracted oil from seeds can be used in cosmetics, lubrication and cooking.

This research will deal with the various parameters which affects the efficiency of the natural coagulant. There are many coagulants which can be used for hardness removal like ferric, alum etc, but the chemical compositions, high cost and less availability are the main considerable factors especially in the developing countries. Laboratory refrigerators & incubators and pH meter with sodium hydroxide and hydrochloric acid will be used for temperature and pH variations respectively. Turbidity measurement is also an important parameter in this study and it will be determined by using ELE430-257 turbidity meter.

1.Material and methods

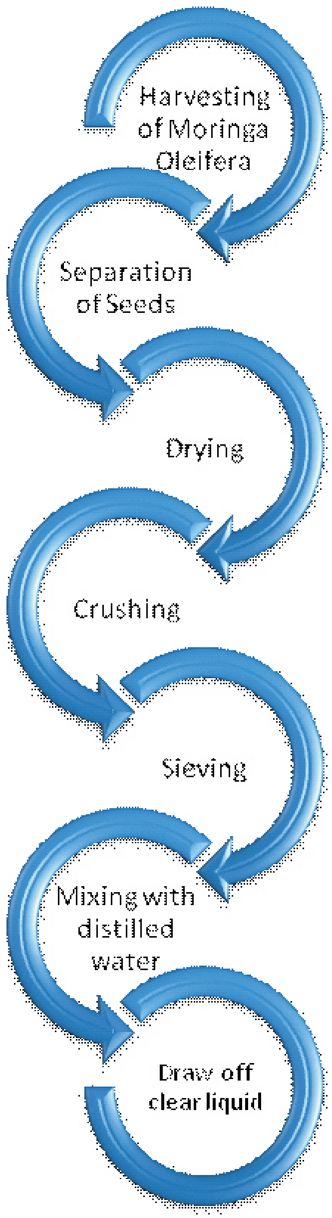

Figure (1): Flow chart for preparation of suspension

1.1 Synthetic water preparation

Synthetic hard water was prepared with the help of calcium chloride dihydrate (CaCl2.2H2O). Samples of various concentrations such as 300mg/l, 500mg/l, 700mg/l and 900mg/l were used for this experiment. Stock solution of 1000ml was prepared for each different concentration. Calcium chloride dihydrate has a molecular weight of 147.02; hence 1.004gm, 1.834gm, 2.567gm and 3.301gm of it was added in a litre of deionised water to give 300ppm, 500ppm, 700ppm and 900ppm respectively. The stock solution was then be distributed in six different beakers of 500ml (150ml each), and varying amount of seed suspension such as 200mg/l, 400mg/l, 600mg/l, 800mg/l, 1000mg/l and 1200mg/l was added separately in different beakers.

1.2 Preparation of suspension

The good quality of Moringa Oleifera was selected for this research; the coats of Moringa Oleifera were removed followed by wings, than it was kept under sunlight for about 4-5 days for drying. After complete removal of moisture from seeds, it was crushed with the help of mixer. Fine powder was obtained which then sieved through 1mm aperture size by sieving apparatus for removing coarse particles, and this finely sieved powder was selected for making powder suspension.

The suspension was prepared by adding 2gms of Moringa Oleifera powder in 200ml of deionized water for making a paste of it, it was mixed properly using hot plate magnetic stirrer. The sample was allowed to settle down for few minutes and when flocs formed and sedimentation took place due to gravity. After proper settling, the upper clear part of solution was drawn off into beaker, this solution was diluted up to 500ml by deionized water which made the stock solution of about 4000mg per litre of seeds suspension and the pH was settled around 6.5. The estimated amount of suspension was used for every different concentration solution for treatment as the sample was of 4000mg/l. Example; in 150ml of synthetic water of 300ppm, the amount of suspension required for 200mg/l powder of Moringa Oleifera seeds was 7.5ml.The fresh stock solution had been prepared whenever required to avoid the change in results due to environmental conditions. Similar procedure had been followed for making suspension while performing turbidity tests.

1.3 EXPERIMENTAL METHODS

1.3.1 Turbidity Measurement

A range of turbidity solutions were prepared such as 40NTU, 80NTU and 160NTU by using hydrazinium sulphate and hexamine as follows:

5gms of hydrazinium sulphate was dissolved in approximately 400 ml of distilled water and it was slowly dissolved completely. 50gms of hexamine was dissolved in approximately 400 ml of distilled water. The hexamine was dissolved more rapidly. Once both compounds have completely dissolved they were combined into 1 lire volumetric flask and diluted to volume with distilled water. This resulting mixture was mixed thoroughly, covered and then allowed to stand for 24hrs at a temperature between 22 º C to 28º C. During this time the formazine suspension was developed, this was a 4000NTU stock solution (ELE Manual).Likewise different turbidity solutions were prepared from the stock solution by further diluting it according to desired level of concentration.

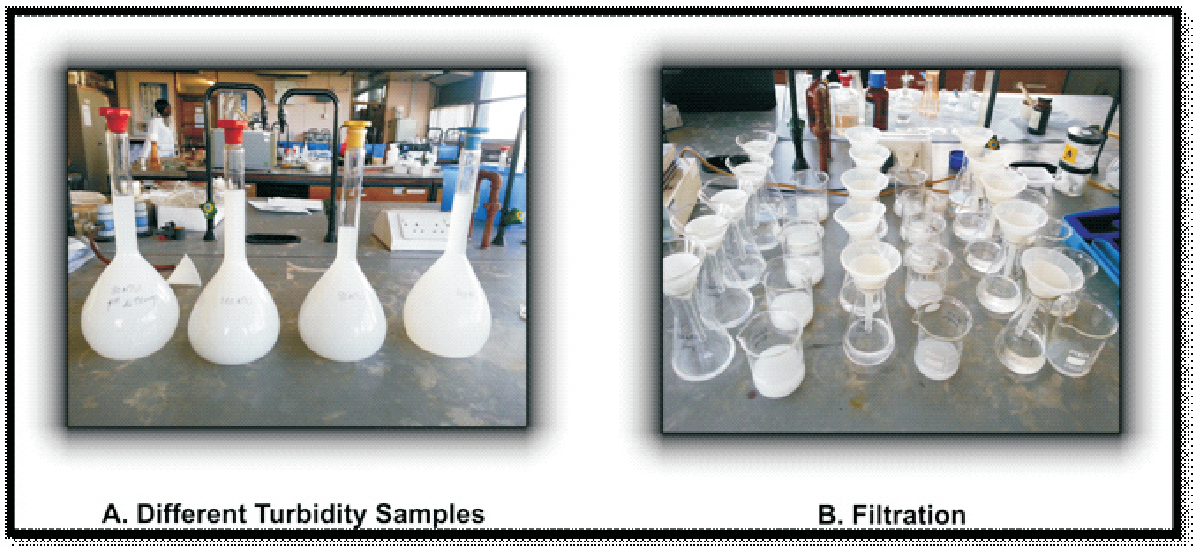

Figure (2): Turbidity Measurement

Then different dosages such as 200mg/l to 1000mg/l of Moringa Oleifera suspension were added in 5 incremental steps in varying concentration turbid solution. The mixed solution was then be stirred by using hot plate magnetic stirrers for 5 min and allowed to settle for 30 min. This solution was then filtered and the turbidity of filtrate was tested by using EL430-257 turbidity meter.

Figure (3):EL430-257 Turbidity Meter

For detailed description of the instrument and the detailed procedure of measuring turbidity of a sample by using ELE turbidity meter EL430-257 is mentioned in the ELE turbidity meter manual.

1.3.1 Coagulation with varying pH

The hardness of different pH samples were estimated by ICP-OES OPTIMA 5300 DV instrument. For performing this experiment, five beakers (500ml) were taken and 150ml of synthetic water of a particular concentration was poured into each beaker. A particular of dose (for example: 600mg/l) of Moringa Oleifera suspension was added in all of the beakers. Hydrochloric acid and Sodium hydroxide were used to vary the pH from 5-9 of prepared samples. The pH was determined by using JENWAY 3505 pH meter and once the pH of different samples has been checked and confirmed to its desired variations, the sample was mixed thoroughly by hot plate magnetic stirrer and after proper mixing it was allowed for settling for about 30 minutes.

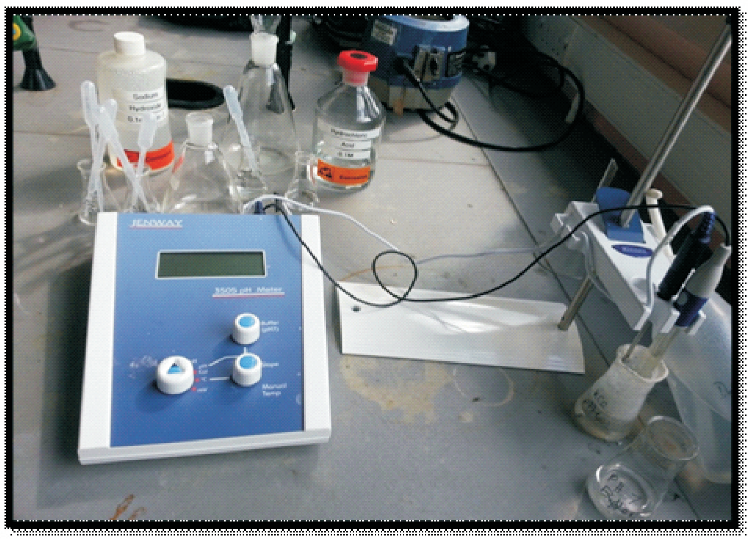

Figure (4): JENWAY 3505 pH Meter

The filtration was took place after sedimentation, and the filtrate was used for estimating the hardness of all samples to study the effect of varying pH on hardness when used with the suspension of Moringa Oleifera seeds. Similar kind of approach was there for measuring turbidity of varying pH by using ELE430-257 turbidity meter, but the solutions were of varying turbidity instead of varying hardness.

1.3.3 Coagulation with varying temperature

Effectiveness of temperature of Moringa Oleifera seeds suspension on hardness was also considered during this research. This experiment was performed with the help of refrigerator and hot plate stirrer as to vary the temperature of hardwater sample. Seven different beakers were taken for this experiment and equal amount of synthetic water was poured into each of the beaker as mentioned before. A particular dose (for example: 600mg/l) of Moringa Oleifera suspension was added into it, but the temperature of sample in different beakers were different. During this approach, a series different of temperature was used such as 0, 10, 20, 30, 40, 50 and 60º C. Temperature of sample was being confirmed by using thermometer before adding suspension into it. After adding the equal amount of suspension into varying temperature of different samples, the samples were stirred for about 2-3 minutes and then allowed to settle down for approximately 30 minutes. After sedimentation, every sample was filtered and was ready to use by ICP-OES instrument for hardness determination, which was showing the effect of Moringa Oleifera suspension with varying temperatures of turbid sample.

2.RESULTS AND DISCUSSIONS

2.1 Temperature and pH Variation Effect on Hardness

The varying pH effect on the efficiency of Moringa Oleifera is graphically represented in figure (5), it has been noticed that there is no effect of pH variation on the efficiency of Moringa Oleifera. And the result remains pretty same for temperature variation as well. Hardness buffers the pH up and allows it to be stable and Every pH level has a correct hardness level so if you drop the pH lower and the hardness is still high, the pH is pushed up ((HAMILTON, 2008), and hence hardness can with pH but not with dosages of Moringa Oleifera.

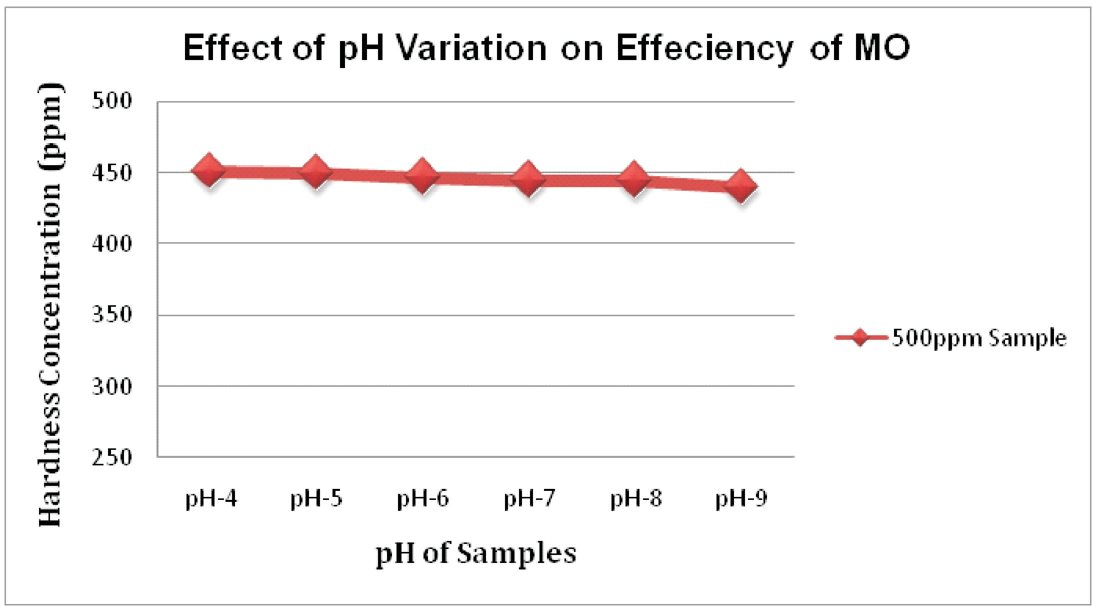

Figure (5): Effect of pH Variation on Effectiveness of Moringa Oleifera

This observation of pH independence will be an asset for the softening industries and more importantly in the developing countries as they can save huge amount of money for importing chemicals required for the pH adjustment in their chemical plants. The similar kind of approach was followed to study the temperature variation effect on Moringa Oleifera efficiency and the observation has plotted in figure (6), there is only slight variation has been found out in hardness reduction due to change in temperature of sample. The effect of temperature is observed less efficient in terms of efficiency of Moringa Oleifera while treating with 500ppm samples

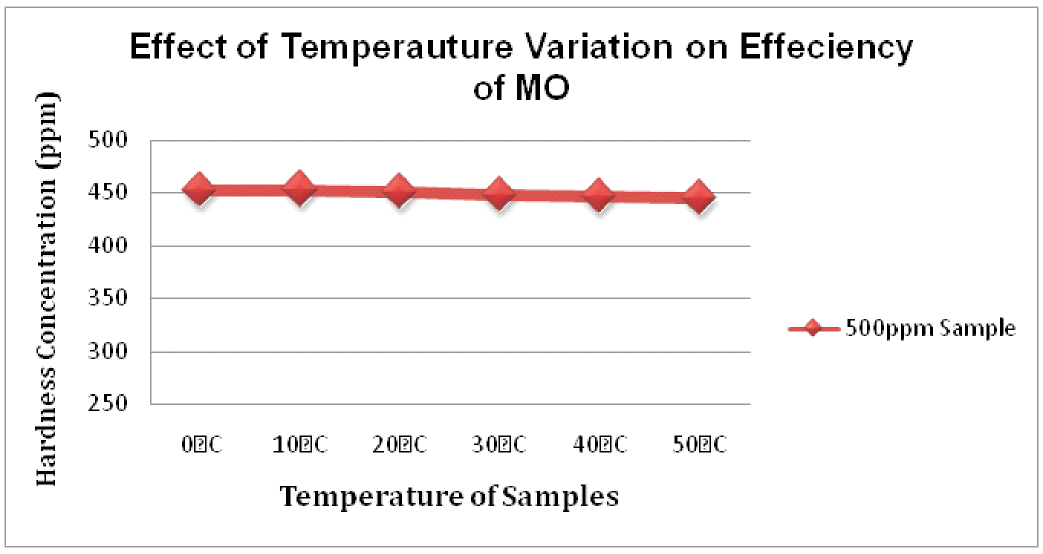

Figure (6): Effect of Temperature Variation on Efficiency of Moringa Oleifera

Whatever reduction was found, it was between 30ºC to 50ºC which shows that low temperatures are not favourable and even the higher temperature till 50ºC was not very effective for calcium hardness reduction. Every different coagulant has different influences on efficiency by temperature (Bratby, 2006). Temperature effects were found to be related with the flocs characteristics as flocs required more time for settling at lower temperatures and effects badly on efficiency of Moringa Oleifera. This is also a quite interesting and advantageous point in terms of saving money and use of unnecessary energy, time and techniques for changing temperature of a sample.

2.2 TURBIDITY

There is low or very little coagulation with lower dosages of Moringa Oleifera (Pritchard M. et al 2010) and hence higher dosage range had been used in this research. The results are shown and graphically represented in figure (7). It is found that the turbidity will be reduced with increasing the dosages of Moringa Oleifera.

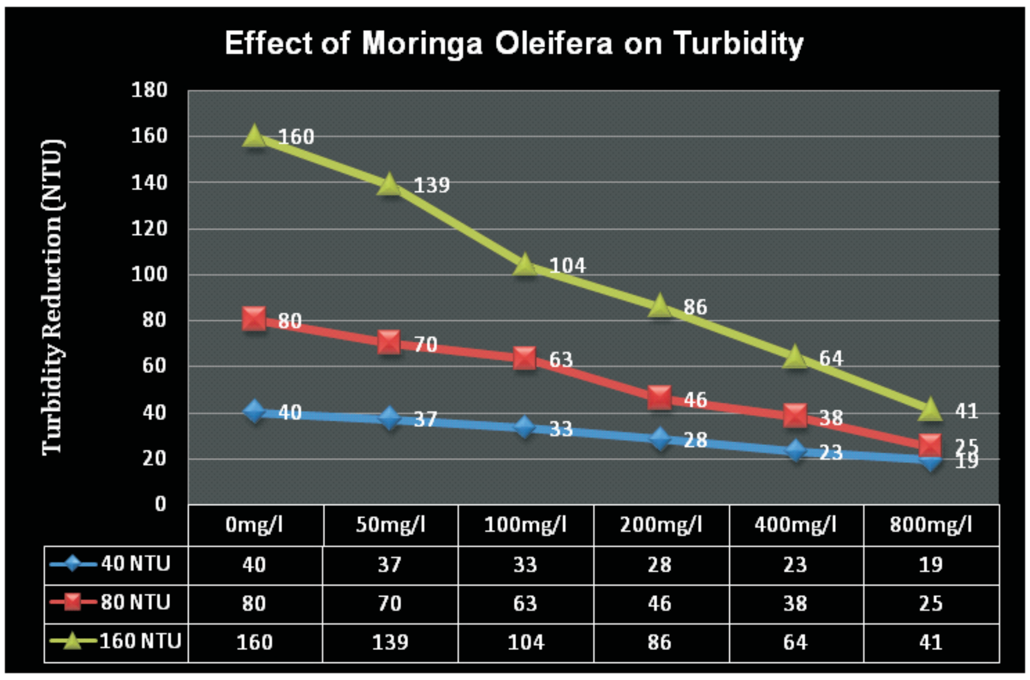

Figure (7): Turbidity Reduction by Using Moringa Oleifera

It is also observed that the reduction in turbidity will be higher in initially highly turbid samples and lower reduction have been noticed in the initially less turbid samples. The turbidity reduction of initially 40 NTU sample is observed only around 52.5% and on the other side, it is 68.75% and 77.5% for 80 NTU and 160 NTU respectively (see figure 8).

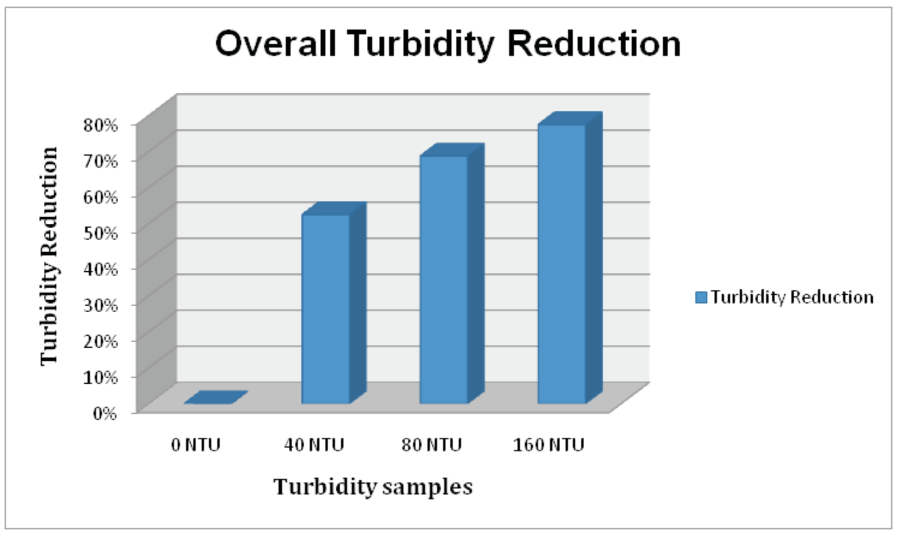

Figure (8): Overall Turbidity Reduction

Lower initial turbid samples are not favourable for treatment because Moringa Oleifera is polyelectrolyte in nature which is not suitable to perform in low turbidity samples. The reason behind it has already been found out by Weber (1972), which states that the lower turbid sample of water has only few colloidal particles and because of that the inter particle system is not very good. The optimum dose has found to be in the range between 100-400mg/l which depends on the initial turbidity of a sample, the optimum dose required will be increased as initial turbidity increases. This study is related with the collision of inter particles and the charge neutralization concept. The higher turbidity samples have more negatively charged ions in it which will require more positively charged ions of coagulant for destabilising the current charges and achieving high efficiency (Ndabigengesere et al. 1995).

2.2.1 Temperature and pH Variation Effect on Turbidity

Data for the effect of pH on the effectiveness of the Moringa Oleifera has been shown in figure (9), which clearly indicates that the higher pH of sample in not desirable for turbidity reduction. Increasing the pH upto 6 results in increasing efficiency of Moringa Oleifera and reduced the turbidity, but it has started to increase at above pH-7.

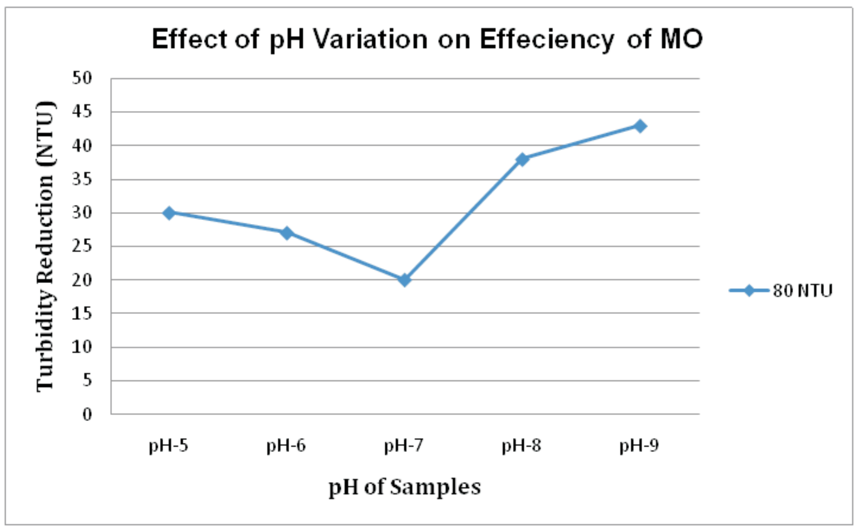

Figure (9): Effect of pH Variation on Effectiveness of Moringa Oleifera

The reduction in turbidity was found maximum at pH-7 with 75% reduction and hence this was observed as the optimum pH of sample for seeds of Moringa Oleifera to act. It also implies that the pH range 5-7 is suitable as it has shown over 75% reduction of turbidity by using Moringa Oleifera. This encourages the use of Moringa Oleifera seeds as coagulant in developing countries as the water sources have similar range of pH in those areas. The reason of U-shaped found in figure (9) is because of the less zeta potentials which reduces the flocculation effectiveness at high pH values and the details about this mechanism is explained by Narasiah and Ndabigengesere (1996). Similarly the influence of temperature has also been noticed in this research. The findings have shown in figure (10) and it details about the effect of temperature on the efficiency of Moringa Oleifera for initial turbidity of 40-160 NTU. Result shows that the efficiency of coagulation of Moringa Oleifera increases with increasing the temperature.

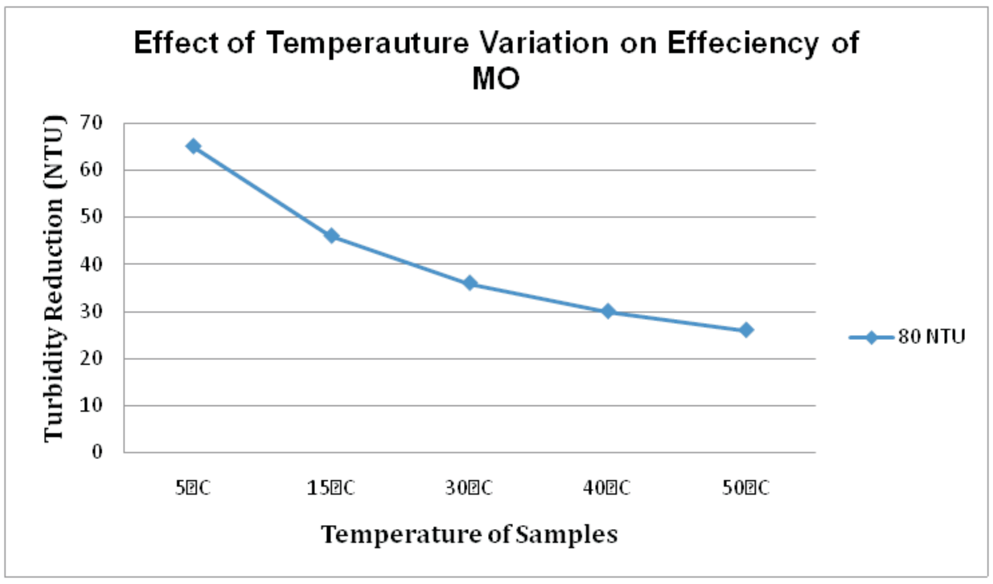

Figure (10): Effect of Temperature Variation on Effectiveness of Moringa Oleifera

For 80 NTU sample the reduction in turbidity was found to be 18.75%, 42.5%, 55%, 62.5% and 67.5% for 5ºC, 15ºC, 30ºC, 40ºC and 50ºC respectively. Effectiveness of Moringa Oleifera was low at lower temperatures because low temperature will lead to more viscous water compared to high temperature water which can adversely affect the flocculation rate (Gregory and Bache, 2007). Inter particle contact can also be a reason for lower efficiency especially in lower turbidity water samples such as 60-100NTU. Higher dosages of Moringa Oleifera in lower turbidity solutions can increase the effectiveness by increasing the inter particle collisions. Usually developing countries have temperature in typical range of 25ºC to 35ºC; therefore it is suitable to use Moringa Oleifera as a coagulant more importantly in those countries. Use of Moringa Oleifera as coagulant has several technical advantages; furthermore it will also be helpful in creating economic advantages as its cultivation will provide jobs for local people.

Moringa Oleifera is also known as natural polyelectrolyte which has chemical composition of polypeptides of different molecular weights 6000-16,000 daltons. It contains about 6 amino acids such as methionine, arginine and glutamic (Jahn, 1986). During experiment it has also been observed that the Moringa Oleifera particles are very light in weight and hence requires more time for settling. And therefore, there may be the requirement of filtration after agitation. This study has shown the possible use of Moringa Oleifera for filtration especially in developing countries and household treatments.

3.CONCLUSION

1.The effectiveness of Moringa Oleifera is found to be independent of pH and temperature in case of hardness removal and just depends on the initial hardness of water used in this research.
2.Moringa Oleifera can give more than 80% turbidity reduction at optimum conditions.
3.The optimum pH for turbidity removal is noticed at pH-7 for Moringa Oleifera.
4.Coagulation is found to be more superior with high temperature of water sample in case of turbidity removal.

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