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RESEARCH ARTICLE OPEN ACCESS

Treatment of Water Using Sapodilla Seed as Natural Coagulant

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ABSTRACT
Water is undoubtedly the most vital element among the natural resources. In many developing countries, access to clean and safe water is a crucial. More than a six million people die because of diarrhea. Various methods are used to make water safe and attractive to the consumer. The method employed depends on the character of the raw water. One of the problems with treatment of surface water is the large seasonal variation in turbidity which is caused by polluted water. Commonly used chemicals for various treatment units are synthetic organic and inorganic. The synthetic water sample was prepared by using kaolin clay powder. The initial parameters of the synthetic water were assessed using Turbidity, pH, TDS, Electric conductivity, Total hardness, Alkalinity, DO, BOD and Temperature measured as 114 NTU, 8.4, 195 ppm, 390 µS/cm, 156 mg/ltr, 96 mg/ltr, 3.25 mg/ltr, 0.64 mg/ltr, and 24.7oC. By using Sapodilla seed powder as a natural coagulant, it has been observed that optimum dosage was observed to be 2ml for a reduction in turbidity with a reduction efficiency being 95%. By conventional coagulant i.e., Alum it has been observed that optimum dosage was observed to be 8ml for a reduction in turbidity with a reduction efficiency being 95%. For the proportion 40:60 of Alum and natural coagulant it has been observed there is a reduction in turbidity with an reduction efficiency of 96%. It was found that sapodilla seed have the turbidity removal properties and using Alum and Natural coagulant in proportion the turbidity removal of water is more efficient.

Keywords - Natural coagulant, Sapodilla seed powder, Alum, Synthetic water, Kaolin clay powder.

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I. INTRODUCTION

Water supply is a basic need required for living creatures and human being specifically. Developing countries and third world countries and facing potable water supply problems because of inadequate financial resources. Water is an indispensable component for human life and other life forms. The continuing use of water makes it impure, so the purification of water is essential. Raw water coming from different sources may contaminate due to pollution in the environment. Major reason for pollution is industrialization and rapid urbanization. As we know that the Surface water either from rivers or rain fed ponds is the main source of water supply. This water is vulnerable to various forms of pollution generated from different sources mainly households, agriculture and industries. The removal of organic and inorganic material from raw water is essential before it can be disinfected for human consumption.

The cost of water treatment is increasing and the quality of river water is not stable due to suspended and colloidal particle load caused by land development and high storm runoff during the rainy seasons. During the rainy seasons the turbidity level increases and the need for water treatment chemicals increase as well, which leads to high cost of treatment which the water treatment companies cannot sustain. As a result, the drinking water that reaches the consumer is not properly treated.

Therefore, it is of great importance to find a natural alternative for water coagulant to treat the turbidity. In this world the number of resources available to living creatures are limited. Safe drinking water is essential to the health and welfare of a community, and water from all sources must have some form of purification before consumption. Drinking water treatment involves a number of combined processes based on the quality of the water source such as turbidity, amount of microbial load present in water and the others include cost and availability of chemicals in achieving desired level of treatment. Conventional methods used for purification of water include coagulation, sedimentation, filtration, aeration and also chemical

treatment. In drinking water treatment, the coagulation process is used to destabilize suspended particles and to react with organic materials in the raw water. Proper coagulation is essential for good filtration to performance and for disinfection by product (DBP). Common coagulants are aluminium sulphate, ferric chloride, poly aluminium chlorides and synthetic polymers. The use of coagulants such as alum is one of the commonest methods employed and it reduces the repulsive force between particulate matter, encouraging particle collision and floc formation. Recent studies have indicated a number of serious drawbacks linked to the use of aluminium salts such as Alzheimer's disease associated with high aluminium residuals in treated water, excessive sludge production during water treatment and considerable changes in Water chemistry due to reactions with the OH^- and alkalinity of water. In addition, the use of alum salts is inappropriate in some developing countries because of the high costs of imported chemicals and low availability of chemical coagulants. Also, monomers of some synthetic organic polymers such as acrylamide have neurotoxicity and strong carcinogenic properties and because of this, there has been considerable interest in the development of natural coagulants which are safe for human health and biodegradable. A number of studies have pointed out that the introduction of natural coagulants as a substitute for metal salts may ease the problems associated with chemical coagulants.

Use of natural coagulants in water treatment may help in reducing the health effect and cost of chemical coagulant. Some of the natural coagulants that can be used are Sapodilla seeds, Moringa oleifera, C. Cyminus, Capparis Decidua, Dolicho lablab, Cicer arietinum, Tamarind seed, etc. In rural area, the use of natural coagulant is quite popular. It has been used for more than 2000 years in India, China and Africa. This coagulant may be derived from seeds, leaves and roots of plants and trees.

II. MATERIAL AND METHODS

II.1. Preparation of fine seed powder

Fig. 1. Manilkara zapota

Fresh seeds of sapodilla (Manilkara zapota) of the Sapotaceae family were purchase from online. The seeds were washed severally with water, sun-dried for a week, sorted to remove bad ones and shelled. The dried seeds were ground to fine powder by domestic blender. This powder was sieved through 450µm sieve. The 10 g of fine powder was mixed well with 100 ml distilled water solution and the suspension was stirred using a magnetic stirrer for 10 minutes for homogeneous mixing. The solution was prepared fresh before each set of experiment. The seed solution was then used as the coagulant.

II.2. Preparation of synthetic water sample

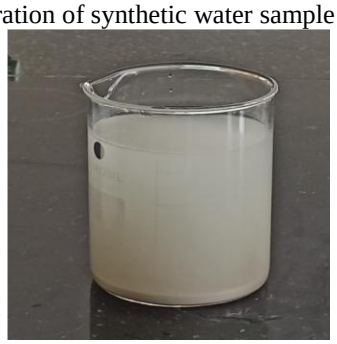

Fig. 2. Manilkara zapota

Synthetic turbid water was prepared by adding kaolin, in raw water for all coagulation experiments. The kaolin suspension was prepared by dissolving 10gram of kaolin powder in 1L of water. The suspension was stirred slowly at 20 rpm for 1hr to achieve uniform dispersion of the kaolin particles. The suspension was then permitted to stand for 24 hr. to allow for complete hydration of the kaolin. This suspension was used as a stock solution for the preparation of water samples of varying turbidity for the coagulation tests.

II.3. Experimental process

II.3.1. Jar test

Fig. 3. Jar test apparatus

Measure the initial turbidity of the water sample. Take 1000ml of sample of water in 6 beakers. Cumulatively add 1ml of coagulant or standard alum solution from 1st to 6th beaker. Switch on the instrument and adjust speed of the peddles to 180rpm and rapid mix the sample for 5minute.

Bring down the speed to 40-60rpm and allow for 10 minutes. Switch off the instrument and allow it to settle for 10 minutes. Take 50ml supernatant from each jar without disturbing the sample.

To determine optimum dosage: Cumulatively add 1ml of coagulant or standard alum solution from 1st to 6th beaker. The raw water sample was then added to make up the 250ml mark and the jars were then placed in the flocculator and the stirrers lowered into each. The stirring speed was set at 150rpm for rapid mixing for 2 minutes and 80rpm, 8 minutes for slow mixing. After this was completed, the samples were allowed to settle. From the results obtained the dosage with the best results in colour and the turbidity removal was taken as the optimum.

2.3.2 Turbidity

Turbidity is the measure of resistance of water to allow the light pass through it. It is caused by the pressure of suspended and colloidal matters such as clay, finally microscopic organisms. To estimate the turbidity of such sample can be made using digital Nephelo turbidity meter. Measurement of turbidity using the photoelectric turbidity meter is based upon comparison of the intensity of light scattered by standard reference suspension under same conditions.

2.3.3 pH

The pH is one if the basic waters and wastewaters characteristics. It expresses the intensity of acid or alkaline conditions by indicating the hydrogen ion activity. Some of the processes in water quality engineering that require pH monitoring and control are the following: disinfection, coagulation, softening, biological treatment etc. Natural waters usually have pH values close to neutral.

2.3.4 TDS (Total dissolved solids) and Conductivity Test

Total dissolved solids comprise inorganic salt, principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulphates and some small amount of organic matter that are dissolved in water.

Conductivity meter measure the ion capacity in aqueous solution to carry electric current. As the range in aqueous solution are usually small, the basis units of measurements are milli Siemens/cm (mS/cm) and micro Siemens/cm (µS/cm)

III. RESULT AND DISCUSSION

The synthetic water sample was prepared from the kaolin clay powder. Below are the initial water properties.

3.1 Before treatment.

Table 1: Characteristics of synthetic Water used for the study

PARAMETER	INITIAL RESULT
Turbidity (NTU)	114
pH	8.4
TDS (ppm)	195
Conductivity (µS/cm)	390
Temperature (^{0}C)	24.7
Acidity (mg/L)	-
Alkalinity (mg/L)	86
Total Hardness (mg/L)	156
Dissolved Oxygen (mg/L)	3.25
BOD (mg/L)	2.86

3.2 Effect of natural coagulant on water sample

A. Turbidity

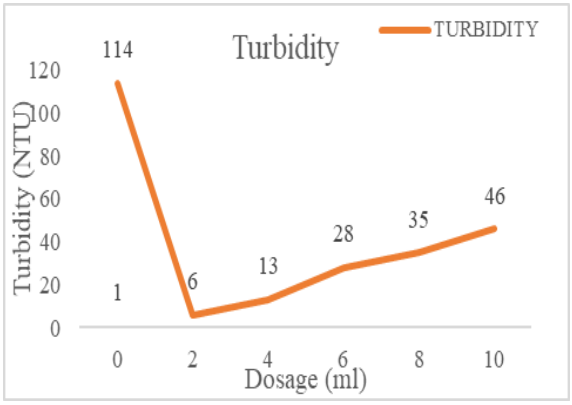

Fig. 4. Graph showing the effect of coagulant dosage on Turbidity

This graph shows the effect of coagulant dosage on Turbidity. The initial reading was 114 for raw water sample, and we add 2ml of sapodilla seed coagulation then it gradually decreases to 6NTU. For 4ml of dosage it increases to 13NTU, then it increases to 28NTU for 6ml dosage. For 8ml dosage it increases to 35 NTU and at the final reading it reaches to 46 NTU for 10ml.

B. Total Hardness

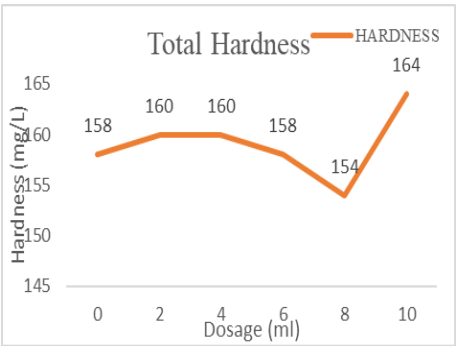

Fig. 5. Graph showing the effect of coagulant dosage on Hardness

This graph shows the result of coagulant dosage on Hardness. The initial reading was 158 mg/L for raw water sample. Then it increases to 160 mg/L for 2ml dosage and it's is constant at 4ml. Then 158 mg/L at 6ml, and it decreases to 154 mg/L at 8ml. then it increases to 164 mg/L for 10ml dosage.

C. Dissolved Oxygen

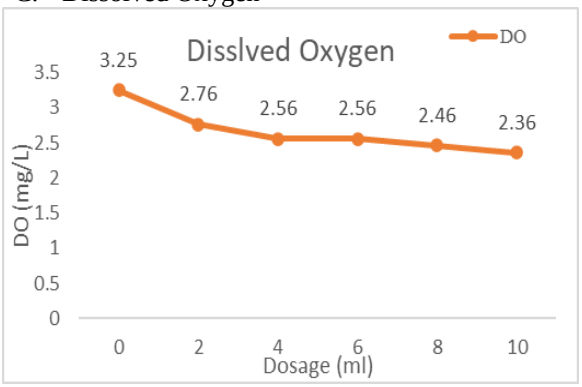

Fig. 6. Graph showing the effect of coagulant dosage on dissolved oxygen

This graph shows the result of coagulant dosage on Dissolved Oxygen. The initial reading was 3.25mg/L for raw water sample. Then it decreases to 2.76 mg/L at 2ml dosage. And we add 4ml it reduces to 2.56 mg/L and it is constant in 6 ml also. Then it decreases to 2.46 mg/L at 8ml and at the final reading it decreases to 2.36 mg/L at 10ml.

D. Total dissolved solids

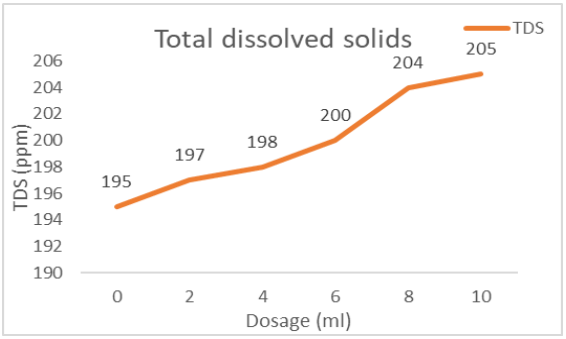

Fig. 7. Graph showing the effect of coagulant dosage on total dissolved solids

The above graph shows the result of coagulant dosage on TDS (ppm). The initial reading was 195 ppm for raw water sample. Then we add 2 ml dosage of sapodilla seed coagulation it increases to 197 ppm. Then it reaches to 198 ppm at 4ml, at 6ml it increases to 200 ppm. Then it increases to 204 ppm at 8ml. And at the final reading it increases to 205 ppm for 10ml dosage.

Table 2: Other Characteristics of synthetic Water after adding natural coagulant

s/No	Dosage (ml)	Alkalinity (mg/L)	pH	BOD (mg/L)
1	2	96	8.4	0.2
2	4	92	8.4	0
3	6	92	8.4	0.2
4	8	88	8.4	0
5	10	88	8.4	0

3.3 Effect of Alum on water sample

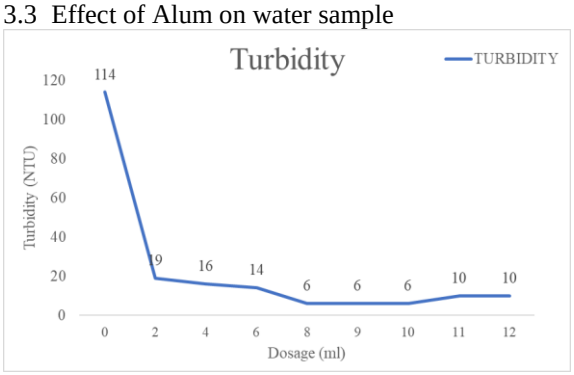

Fig. 6. Graph showing the effect of Alum on water

The above graph showing the effect of Alum dosage on Turbidity removal. Here the initial reading was 114 NTU for raw water sample. And it gradually decreases to 19 NTU for 2ml dosage of alum. For 4ml it reaches to 16 NTU, then it slightly decreases to 14 NTU at 6ml. Then we add 8 ml it reduces to 6NTU and it remains constant for both 9ml and 10ml. for 11ml it slightly increases to 10NTU for 11ml and 12ml of alum dosage.

3.4 Effect of Natural coagulant + Alum aid on water treatment

A. Turbidity

The below Graph shows the effect of coagulant+Alum on Turbidity. In this graph we mentioned the dosage in percentage is equivalent to 2ml. Then we add 100% of coagulant the turbidity is 6NTU. For 90%coagulant + 10%alum it rises to 7 NTU, then at 80%coagulant + 20%alum it decreases to 6 NTU. And we add 60% coagulant + 40%alum again it decreases to 5 NTU. then we add 40%coagulant + 60%alum it reaches to 8 NTU at final reading we add 20%coagulant + 80% alum it is in 8 NTU. The optimum dosage obtained in the combination of 60% coagulant + 40%alum was 5NTU.

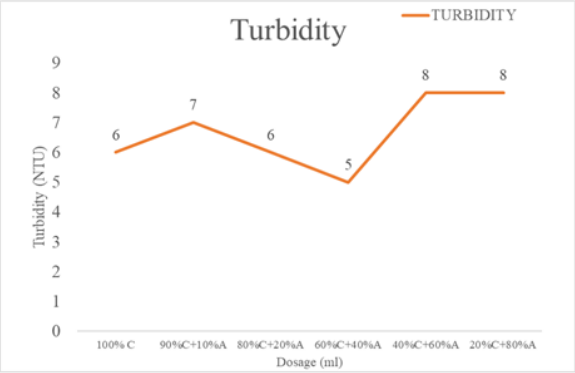

Fig. 7. Graph showing the effect of coagulant+Alum dosage on Turbidity

B. Total Hardness

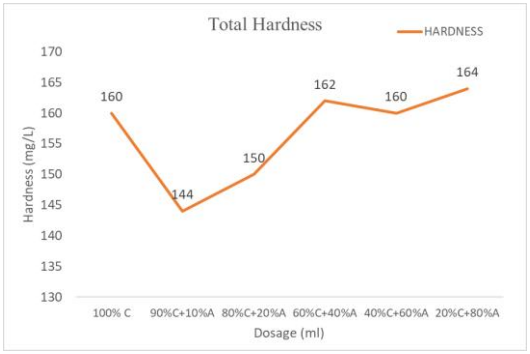

Fig. 8. Graph showing the effect of coagulant + Alum dosage on Turbidity

This graph showing the effect of coagulant+Alum on Total Hardness. Here we add 100% of coagulant than the Total hardness was 160 mg/L. And we add 90%coagulant + 10%alum it is decreases to 144 mg/L, then at 80%coagulant + 20%alum it increases to 150 mg/L. Then we add 60% coagulant + 40%alum again it increases to 162 mg/L, and we add 40%coagulant + 60%alum it decreases to 160 mg/L. Then at the final reading we add 20%coagulant + 80%alum it increases to 164 mg/L. the maximum reduction of hardness observed at 90%coagulant + 10%alum proportion and the reading obtained was 144 mg/L.

Table 3: Effect of Natural coagulant + Alum aid on water treatment

S/No	Natural Coagulant +Alum (Wt. of %) = 2ml	Turbidity (NTU)	pH	Temperature (^{0}C)	Conductivity (µS/cm)	TDS (ppm)	Alkalinity (mg/L)	Hardness (mg/L)	DO (mg/L)
1	100% C	6	8.4	25.8	394	198	96	160	2.76
2	90%C+10%A	7	8.4	26	396	198	100	144	3.35
3	80%C+20%A	6	8.4	26	408	204	116	150	1.87
4	60%C+40%A	5	8.4	26	412	206	76	162	2.5
5	40%C+60%A	8	8.4	26	412	206	96	160	2.36
6	20%C+80%A	8	8.4	26	412	206	92	164	2.86

C. Dissolved Oxygen

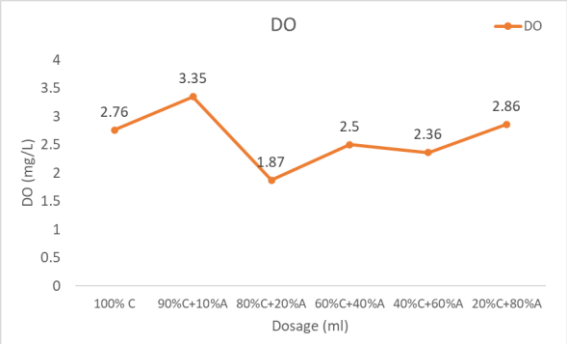

Fig. 9. Graph showing the effect of coagulant + Alum dosage on Dissolved Oxygen

Above graph showing the effect of coagulant+Alum on Dissolved Oxygen. Here we add 100% of coagulant than the Dissolved Oxygen is 2.76 mg/L it is in the initial reading. And we add 90%coagulant + 10%alum it is increases to 3.35 mg/L, then at 80%coagulant + 20%alum it decreases to 1.87 mg/L. And we add 60% coagulant + 40%alum again it increases to 2.5 mg/L, and we add 40%coagulant + 60%alum it decreases to 2.36 mg/L. Then at the final reading we add 20% coagulant + 80% alum it increases to 2.86 mg/L.

D. Total dissolved solids

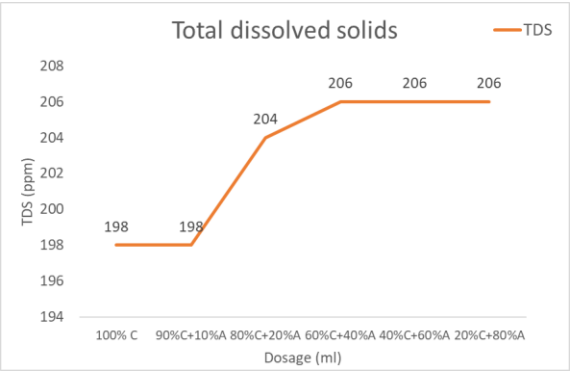

Fig. 10. Graph showing the effect of coagulant + Alum dosage on Total Dissolved Solids

The above Graph shows the effect of coagulant+Alum on Total Dissolved Solids. Here we add 100% of coagulant for that the total dissolved solids is 198ppm it is the initial reading. And we add 90%coagulant + 10%alum it is also in 198 ppm, then at 80%coagulant + 20%alum it increases to 204 ppm. And we add 60% coagulant + 40%alum again it increases to 206 ppm. Then at the final reading we add 20%coagulant + 80%alum for that TDS reading was 206 ppm.

IV. CONCLUSION

Using Sapodilla seed powder as a natural coagulant, it has been observed that optimum dosage was observed to be *2ml* for a reduction in turbidity from 114 NTU to 6 NTU with a reduction efficiency being 95%. By conventional coagulant i.e., Alum it has been observed that optimum dosage was observed to be *8ml* for a reduction in turbidity from 114 NTU to 6 NTU with a reduction efficiency being 95%. For the proportion *40:60 of* Alum and natural coagulant it has been observed there is a reduction in turbidity from 114 NTU to 5NTU with an reduction efficiency of 96%. From the above observation it is evident that the coagulation was more effective when coagulants were considered in proportion of 40 : 60.

REFERENCES

[1]. Roopika Nautiyal, Shivangi Uliana, Ishant Raj, Brij Shah, Kavish Rathore, Anantha Singh, "Decentralized Treatment of Grey Water by Natural Coagulants in the Presence of Coagulation Aid," Proceedings of the 2nd World Congress on Civil, Structural, and Environmental Engineering (CSEE'17), 2017.

[2]. Shivangi Uliana, Brij Shah, Ishant Raj, Kavish Rathore, Roopika Nautiyal, Anantha Singh (2017) "Comparative Study of Different Natural Coagulants for the Treatment of Grey Water with Conventional Alum." Proceedings of the 2nd World Congress on Civil, Structural, and Environmental Engineering (CSEE'17).

[3]. Komal R. Asopa, S. R. Korake, "Use of Sapodilla Seed and Dolichos Lablab in Treatment of Grey Water." International Journal of Research in Engineering, Science and Management Volume-2, Issue-5, May-2019.

[4]. Md. Asrafuzzaman, A. N. M. Fakhruddin, and Md. Alamgir Hossain (2011), "Reduction of Turbidity of Water Using Locally Available Natural Coagulants," ISRN Microbiology, Volume 2011.

[5]. R.E. Kukwa, A.A. Odumu, D.T. Kukwa, "Water Melon Seed (Citrullus Lanathus) As Potential Coagulant for Treatment of Surface Water." IOSR Journal of Applied Chemistry (IOSR-JAC) Volume 10, Issue 7 Ver. II (July. 2017),

[6]. Duithy George, Arya Chandrn J, "Coagulation Performance Evaluation of Papaya Seed for Purification of River Water." International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS) Volume VII, Issue I, January 2018.

[7]. Chidanand Patil1, Ms. Manika Hugar, "Treatment of dairy wastewater by natural coagulants." International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 04, July-2015.
[8]. Rajesh K. Kaushal, Hemant Goyal, (2018) "Treatment of Waste Water Using Natural Coagulants" International conference on "Recent Advances in Interdisciplinary Trends in Engineering & Applications.
[9]. Renuka A. Binayke, M.V. Jadhav, "Application Of Natural Coagulants In Water Purification." International Journal of Advanced Technology in Civil Engineering Volume 2, Issue 1, Article 15, January 2013.
[10]. Qaid M.Saleem, Yousif Algamal, Majed H. Shtaiwi, Mohammad S. Aldahmashi, (2015) "Treatment of Sewer Water Using Alum Salt" International Journal of Sciences: Basic and Applied Research (IJSBAR).
[11]. Musaida Mercy Manyuchi and Tawanda Chikomo "Treatment of water using watermelon (Citrullus lanatus) seeds as organic coagulant and microbial filter" International Conference on Pure and Applied Chemistry, ICPAC 2016, Emerging Trends in Chemical Sciences. Flic en Flac, Mauritius, 18-22 July 2016.
[12]. Birnin-Yauri U. A, Adetunji S. O. and Alhaji, S. M. "Production of Water Treatment Alum Using Ash and Aluminium Scraps" International Journal of Innovative Studies in Sciences and Engineering Technology (IJISSET), www.ijisset.org, Volume:5, Issue:5, (2019).

Kiran H G, et. al. "Treatment of Water Using Sapodilla Seed as Natural Coagulant." *International Journal of Engineering Research and Applications (IJERA*), vol.12 (07), 2022, pp 16-22.