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Efficiency of Moringa Olifera Seed Powder for Quarry Water Treatment

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Abstract: ***Storm water stored in the excavations in stone quarries are used for domestic purposes. This water may contains chemicals which are leached out from the explosives used for blasting granites. Main chemicals are Ammonium Nitrate, Potassium Nitrate and Ammonium Sulphate. This research is carried out to find out whether there is any presence of chemicals in quarry water and to test the effectiveness of naturally available ecofriendly Moringa olifera seed powder for its removal. The samples collected were analyzed before and after treatment for various parameters. This showed a reduction in chemical parameters such as Ammonia, Nitrate, and Chloride, Turbidity, Total Dissolved Solids (TDS) in the samples. It also act as an antimicrobial agent. Thus the application of Moringa olifera seed powder can be used as a treatment method for removing physico chemical and biological contaminants from surface water near quarries***

Keywords: Quarry, explosives, Moringa olifera seed powder, mosp, batch study, column study

1. Introduction

1.1 Environmental Impacts of Granite Quarries

Granite rock quarries affect the environment in various ways such as dust and noise pollution. And also contaminating nearly water bodies by leaching chemicals used for blasting etc these chemicals in water bodies leads to algal bloom, turbidity, contamination and health problems to humans due to the unwanted toxic chemicals. This contaminated water is used for various domestic purposes by the workers and the local people. These chemicals have health effects like allergies, skin disease etc.[29]

Quarrying can generate a number of on-site and off-site environmental effects through the blasting, excavation, crushing, screening, stockpiling and transport of aggregate. The degree and nature of effects caused by quarrying varies according to the type of quarry, the scale of operation, methods used to excavate aggregate, the geology of the area, the receiving environment and the surrounding land uses. The effects of quarries also vary by their nature (rock or sand) and whether they are in short- or long-term use, in continuous use or used irregularly or seasonally.[33]

It is the high time to develop a locally available low cost material to treat the water before consumption. At present eighty quarries are functioning legally in the 2,132 square kilometers area of Wayanad district in Kerala with state government consent. Of the 80 quarries, 64 extract stones, 15 are engaged in sand mining and one mines black sand. But none of these have requisite sanction from the Ministry of Forests and Environment. Ambalavayal is a village within the Wayanad district in Kerala state which is known for the extensive quarrying for many years in the past.[28]

In all forms of mining, granite rock is broken by drilling and blasting. In controlled blasting process a calculated amount of explosive is used so that a pre-determined volume of material is broken. But now a day's large quantity of explosives are used to remove large volume of granite rocks with in minimum time.[31]

Ammonium Nitrate

Explosives commonly used in the quarrying industry are predominantly Ammonium Nitrate based. The main one is a simple Ammonium Nitrate Fuel Oil mixture (ANFO), slurries, and emulsions. Most granite rocks require blasting to disintegrate it in to pieces prior to excavation in surface mines. Selection of explosives depends on many factors, which primarily includes critical diameter, hydrostatic pressure, temperature, minimum primer weight, density weight strength, bulk strength, gap sensitivity, water resistance, loading procedures, shelf life, reliability for bulk operations and overall drilling and blasting economics.

There are two classifications of explosives and blasting agents. High explosives include permissible and other high explosives. Permissible are explosives that the mine safety and health administration approved. Blasting agents and oxidizers include ammonium nitrate-fuel oil (ANFO) mixtures, regardless of density; slurries, water gels, or emulsions; ANFO blends containing slurries, (Slurry is generic term for both water gels and emulsions. They are water-resistant explosive mixtures of ammonium nitrate and fuel sensitizer); and ammonium nitrate in prilled, grained, or liquor form. The principle distinction between high explosives and blasting agents is their sensitivity to initiation. Flash powder is a chemical mixture that is extremely sensitive to heat and sparks. It burns very rapidly, causing a flash of light. It should be handled with extreme caution. Since it contains aluminum and magnesium, it is silver in color. High explosives are cap sensitive, whereas blasting agents are not. Ammonium nitrate is one of the least sensitive and most readily available main charge high explosives. When fuel oil is added to the prills, the mixture then becomes ANFO (ammonium nitrate and fuel oil). ANFO has found wide use in coal mining, quarrying, metal mining, and civil construction in undemanding applications where the advantages of ANFO's low cost and ease of use matter more than the benefits offered by conventional industrial explosives, such as water resistance, oxygen balance, high detonation velocity, and performance in small diameters

ANFO is an explosive material consisting of 94% prilled ammonium nitrate and 6% fuel oil. it is insensitive, and a detonator alone will not cause ANFO to detonate. in order to initiate ANFO, it will require an initiating system and a booster. It comes in either bulk form (mixed on site and pumped directly into boreholes) or 50-pound bags (premixed). Unmixed ammonium nitrate can decompose explosively and has been responsible for several industrial disasters, including the 1947 Texas City disaster in Texas City, Texas, the 2004 Ryongchon disaster in North Korea, and the 2013 West Fertilizer Company explosion in West, Texas. Environmental hazards include eutrophication in confined waters and nitrate/gas oil contamination of ground or surface water.

A blasting agent is any booster-sensitive mixture or material that contains an oxidizer and fuel that is intended for blasting, is not otherwise defined as an explosive, and the finished product--as mixed for use or shipment-- cannot be detonated by means of a no. 8 test detonator when confined. Since blasting agents do not contain nitroglycerin but consist largely of ammonium nitrate, they are relatively insensitive to heat, friction, and shock. Ammonium nitrate is one of the least sensitive and most readily available main charge high explosives. it is widely used as a blasting agent, an ingredient in certain dynamites, and as a fertilizer. Depending on its purity, it will range in color from white to buff-brown and will have a saline or salty taste. To facilitate identification, colored dyes may be also added to the product. Ammonium nitrate is usually found in the form of small compressed pellets, commonly known as prills. When fuel oil is added to the prills, the mixture then becomes ANFO (ammonium nitrate and fuel oil).

In order to detonate ammonium nitrate, the use of a booster is required. Commercially, pentolite and RDX are used as a booster, while the military will often use TNT as the booster. Some degree of caution should be used when handling ammonium nitrate. It is a strong oxidizing agent and has the ability to increase the combustibility of other flammable materials with which it comes in contact. for example, brass or bronze non-sparking tools should not be used because of the reaction with ammonium nitrate, which will form an explosive that is as sensitive to impact as lead azide. TNT is most commonly used in boosters and demolition charges. tnt is yellowish crystalline compound that comes in cast or flake form. TNT is mostly found in cast form. When TNT is exposed to sunlight for prolonged periods of time, it will turn brown. It is a moderately toxic explosive that is relatively insensitive, stable, and compatible with other explosives. When stored properly, TNT has a shelf life of at least 40 years. TNT is the most common military explosive. It is used as a demolition charge, as part of a composition, and as main charge in filler for hand grenades, mines, bombs, projectiles, rockets, and depth charges. Dynamite is one of the most widely used high explosives in blasting operations. It differ widely in their explosive content, strength, and sensitivity. Dynamite usually will be found in sticks or cylindrical form and wrapped in buff, white, or colored waxed paper. it comes in a variety of diameters and lengths. Gelatin dynamite is insoluble in water and varies from a thick liquid to a tough rubbery gelatinous substance. it contains nitrocellulose. it is used in wet blasting operations and for blasting hard rock. Ammonia gelatin dynamites have most of the characteristics and qualities of gelatin dynamite but they contain ammonium nitrate.[31]

Ammonium Sulphate

Ammonium sulphate $(NH_4)_2SO_4$, is an inorganic salt with a number of commercial uses. The most common use is as a soil fertilizer. It contains 21% nitrogen and 24% sulfur. Ammonium sulfate has also been used in flame retardant compositions acting much like di-ammonium phosphate. As a flame retardant, it increases the combustion temperature of the material, decreases maximum weight loss rates, and causes an increase in the production of residue or char. In November 2009, a ban on ammonium sulfate, ammonium nitrate and calcium ammonium nitrate fertilizers was imposed, by the North West Frontier Province (NWFP) of Pakistan government, following reports that they were used by militants to make explosives. In January 2010, these substances were also banned in Afghanistan for the same reason.[32]

Potassium Nitrate

There are two forms of energy released when high explosives are detonated, shock and gas. An unconfined charge works by shock energy, whereas a confined charge has a high gas energy output. There are many types of explosives and methods for using them. However, the use of a locally made explosive known as gunpowder has attracted interests due to its ability to burn at high speed and build up high energy prior to explosion releasing shock and gas energy. Gunpowder is a local product of potassium nitrate, charcoal, and sulfur and combustible organic products like ethanol and baked at high temperature.[32]

1.2. Health Effects Chemicals Used in Explosives

Under normal handling conditions, ammonium nitrate is not harmful. However, inhalation of high concentrations of ammonium nitrate dust can cause respiratory tract irritation. Ammonium nitrate forms a mild acid when mixed with water. This acid can cause irritation to the eyes, nose, and skin[35]. A rapid increase in ammonium ions in blood can cause damaging the central nervous system without microscopic change. Skin contact with irritant substances, leading to dermatitis etc; Inhalation of respiratory sensitizers, triggering immune responses such as asthma. High levels of potassium nitrate can interfere with the ability of the blood to carry Oxygen causing headache, fatigue, dizziness, and a blue color to the skin and lips (methemoglobinemia). Higher levels can cause trouble breathing, collapse and even death. Potassium Nitrate may affect the kidneys and cause anemia.[33]

The toxic elements and contaminants pollute the water stored in the quarry pits. Water accumulated in the pits of quarries is used for domestic purpose. Various conventional treatment processes are available for the removal of chemical contaminants from water. In this study, the efficiency of Moringa olifera seed powder, a natural adsorbent is tested for the removal of ammonium nitrate, potassium nitrate and ammonium sulphate from the quarry water. In various parts of Sudan, they use Moringa olifera seed powder for treating river water for drinking purpose. [2]

1.3. Moringa Olifera

Various types of natural adsorbents such as rice straw, rice bran, rice husk, banana peel , hyacinth roots, Neem bark, saw dust of teakwood origin, Neem leaves, coconut shell , bagasse, paddy husk, corn cob, wheat bran, peanut skin are used for the water purification. Moringa olifera is one of the natural adsorbent which is locally available and cost effective. it typically grows in semi-dry, desert or tropical soil which is why it grows well in many countries that normally have dry soils. There are about thirteen different known species of Moringa, of which Moringa oleifera is the most studied and used. Native of Moringa oleifera is India and they are now widely distributed to many other tropical parts of the world such as Egypt, the Philippines, Kenya, Ghana, sierra Leone, Uganda, Haiti, Nicaragua, Ethiopia and many other countries with the type of soil in which Moringa thrives. Moringa can grow with very little moisture because its roots can store moisture for prolonged periods of time.

Drumstick tree, also known as horseradish tree and Ben tree in English, is a small to medium-sized, evergreen or deciduous tree native to northern India, Pakistan and Nepal. It is cultivated and has become naturalized well beyond its native range, including throughout south Asia, and in many countries of Southeast Asia, the Arabian peninsula, tropical Africa, central America, the Caribbean and tropical south America. The tree usually grows to 10 or 12 m in height, with a spreading, open crown of drooping, brittle branches, feathery foliage of trip innate leaves, and thick, corky, deeply fissured whitish bark. it is valued mainly for its edible fruits, leaves, flowers, roots, and seed oil, and is used extensively in traditional medicine throughout its native and introduced ranges [1].

Moringa, derived from the vernacular south Indian (Tamil) name, is the sole genus in the family Moringaceae, with 12 deciduous tree species native to semi-arid habitats from north Africa to southeast Asia. in addition to Moringa oleifera, which is a diploid species with 28 chromosomes, several other species of Moringa have proven to be useful sources of food, fiber, medicinal, and other products. these include m. concanensis nimmo, m. drouhardii jumelle, m. longituba engl., m. ovalifolia dinter et a. Berger, m. peregrina (forsk.) fiori, and m. stenopetala cuford [36]

The seeds contain 19 to 47 percent oil known commercially as Ben oil, it is similar to olive oil and is rich in palmetic, stearic, behmic, and oleic acids, and is used for human consumption, and in cosmetics and soaps. the oil is highly valued by perfumers for its power of absorbing and retaining odors, and by watchmakers as a lubricant. the oilcake is used as a fertilizer . the dried, powdered, seeds have been used, both in crude form and following extraction of their active principle in petroleum ether through a hot percolation process as an effective and low-cost coagulant for removing turbidity and reducing bacterial and viral contamination from drinking water in rural communities in the Sudan, Malawi, India, Myanmar, and Indonesia. Leaf extracts have been found to increase rhizobium root nodulation, nodule weight, and nitrogenous activity in mung bean (vigna mungo hepper) when applied to seeds or as a root dressing. drumstick tree has numerous traditional medicinal uses in many parts of its native and introduced ranges and the tree continues to have an important role, in traditional Asian and west African medicine in traditional Indian medicine various parts of the tree are used therapeutically, including for treatment[1]

Seeds of m. oleifera contain water-soluble substances that are undoubtedly the most studied natural coagulants. The specific denomination oleifera is due to 35-45% oil content in the seeds. Moringa tree can produce about 2000 seeds per year. This number of seeds could handle about 6,000 liters of water using a dose of 50 mg/l. the trees, however, can be cultivated to produce about five to ten times this yield (i.e. 10,000-20,000 seeds). This would produce up to 60,000 liters of water treated per year. When fully mature, the dry seeds are round or triangular in shape and the kernel is surrounded by a shell with three wings.[17]

The present study is an attempt to look in to the effectiveness of Moringa olifera seed powder for the removal of chemical contaminants from the quarry water. The uses of chemical adsorbents will heavily pollute the environment and also are costlier than the natural. So the main objective of the study is to check the efficiency of Moringa olifera seed powder in the removal of contaminants mainly ammonium nitrate potassium nitrate and ammonium sulfate from the quarry water and its practical application in domestic use.

2. Materials and Methods

2.1. Material Used for Study as an Adsorbent

Moringa Oleifera seed powder(MOSP) is the material used as an adsorbent in this study. The dry drumsticks were collected. The seeds were removed from those drumsticks. They are the kernels. These kernels were grounded to obtain the MOSP.This powder is used as the adsorbent for study

2.2. Study Area and Sampling Site

The study area selected were Aayiramkolly quarry, Manjappara quarry, Mattapara quarry of Ambalavayal Panchayath in Wayanad district in Kerala state. These quarries are located in rural areas. The local people use this water for their domestic purposes. The water is turbid and also consists of algal blooms.

2.3 Methodology

Drumstick seed powder was collected from local market. This raw powder without any treatment was used for the research work. Surface water samples from 3 different quarry excavations were collected. The various physico chemical and biological parameters such as pH, turbidity, hardness, Chloride, TDS, Ammonia, Nitrate, MPN were tested before the treatment processes.

Methodology for testing efficiency of MOSP powder as an adsorbent

Treatment process was conducted as batch and column study. Stock solutions of Ammonium Sulphate, Potassium Nitrate and Ammonium Nitrate were prepared.

2.3.1 Batch Study

For batch study, *Moringa Oleifera* seed powder was added in varying quantity such as 0.5g, 1g, 1.5g, 2 g, and 2.5g in 500 ml of quarry water sample. Then by rapid mixing for 2-3 minute and slow mixing for 15 minute thorough stirring of the solution was conducted. After that 1 hour settling time was given. Supernatant collected after the process was again tested for the above parameters. The variations in the removal of parameters were noted. This was done mainly to test whether the chemical parameters Ammonia, Nitrate and Chloride can be removed by using MOSP.

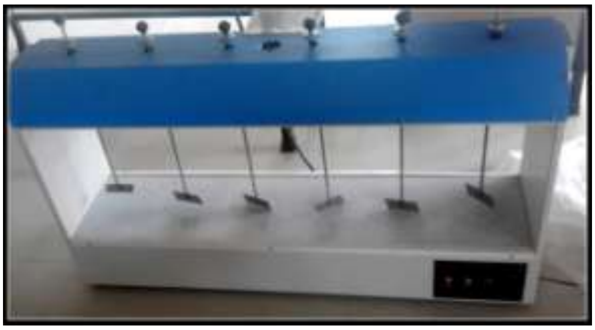

Figure 2.1: Jar test apparatus

2.3.2. Column Study

Column study was conducted in chromatographic column of length 30 cm and dia 1.8 cm. the raw drumstick seed powder was filled by mixing it with distilled water. The distilled water is allowed to drain out through the bottom opening. Again distilled water was added till a colorless effluent was obtained. The rate of flow through the tube was adjusted as 100ml/hr. Then stock solution was passed through the column chromatographic tube. The effluent was collected and tested for various parameters.

Figure 2.2: Column study

2.3.3. Methodology for testing efficiency of MOSP as an antimicrobial agent

MPN test was conducted in the quarry water samples before treatment and in the supernatant from the jar test. Thus the efficiency of MOSP as an antimicrobial agent was tested. As the supernatant was collected after jar test it consist of the residue which may affect the result. Standard methods were followed for testing the physical chemical and bacteriological parameters.

2.3.4. Adsorption isotherm

The general form used to develop adsorption isotherm is

$$q_e = \frac{(C_0 - C_e)V}{m}$$

Where

q_e = adsorbent phase concentration after equilibrium, mg adsorbate/g adsorbent

C_0 = initial concentration of adsorbate in mg/L

C_e =Final equilibrium concentration of adsorbate after absorption has occoured, in mg/L

V = volume of liquid in reactor, L

m = mass of adsorbent, g

2.3.4.1. The Langmuir isotherm

The Langmuir isotherm Equation is represented as:

$$C_e / q_e = 1/ q_m K_L + C_e / q_m$$

Where,

Ce = dye concentration at equilibrium (mg /L);

Qe = equilibrium adsorption capacity (mg /g);

KL = Langmuir adsorption constant (L /mg)

So, y = c + mx

To calculate the parameters, plot Ce / q_e versus C_e

For a good fit the R^2 value should be as close to unity as possible.

So the gradient of the line equals to $1/q_m$

Knowing this value calculate K_L from the intercept "c" = $1/q_m K_L$

2.3.4.2. Freundlich isotherm

The Freundlich equation is purely empirical based on sorption on heterogeneous surface and is given by

qe= k Ce(1/n)

It can be rearranged to obtain a linear form by taking logarithms

log qe = log k + log Ce

The slope and the intercept correspond to (1/n) and k, respectively. K and n indicate the capacity and intensity of adsorption respectively. If a value for n = 1, the adsorption is linear, for n<1, the adsorption is chemisorptions, and for n > 1, the adsorption is a favorable physical process.

3. Results and Discussion

3.1. Granite Quarry Raw Water Sample Analysis

Table 1: Sample -1. Aayiramkolly granite Stone quarry raw water sample analysis

Sample 1-Ayiramkolly Quarry		
S. No	Parameter	Raw Sample
1	pH	8.18

2	Turbidity (NTU)	37.1
3	TDS (mg/l)	116.3
4	Chlorine (mg/l)	67.9
5	Nitrate (mg/l)	1.82
6	Ammonia (mg/l)	1.172
7	MPN/100 ml	1100

Table 2: Sample -2. Manjappara granite stone quarry raw water sample analysis

Sample 2-Manjappara Quarry		
S. No	Parameter	Raw Sample
1	pH	7.85
2	Turbidity (NTU)	19.9
3	TDS (mg/l)	233
4	Chlorine (mg/l)	33.9
5	Nitrate (mg/l)	1.96
6	Ammonia (mg/l)	2
7	MPN/100 ml	460

Table 3: Sample -3. Mattapara granite stone quarry raw water sample analysis

Sample 3-Mattapara Quarry		
S. No	Parameter	Raw Sample
1	pH	7.97
2	Turbidity (NTU)	14.4
3	TDS (mg/l)	40.1
4	Chlorine (mg/l)	20
5	Nitrate (mg/l)	1.18
6	Ammonia (mg/l)	1.497
7	MPN/100 ml	1600

3.2. Batch study results

Granite Stone Quarry Treated Water Sample Analysis

Table 4: Aayiramkolly Granite Stone Quarry Treated Water Sample Analysis

Sample 1			Treated Sample				
S. No	Parameter	Raw Sample	0.5g/ 500ml	1g/ 500ml	1.5g/ 500ml	2g/ 500ml	2.5g/ 500ml
1	pH	8.18	7.15	7.29	7.9	8	8.2
2	Turbidity (NTU)	116.3	119	120.3	121.8	121.8	124
3	TDS (mg/l)	37.1	22.3	18.1	10	10	8
4	Chlorine (mg/l)	67.9	40.8	32.1	13.8	13.8	4
5	Nitrate (mg/l)	1.82	1.14	1.06	0.82	0.82	0.8
6	Ammonia (mg/l)	1.173	1.06	0.384	1.84	1.84	0.65

Analyzing the batch study results of sample 1 it was observed that after treatment with Moringa Oleifera seed powder, the pH was decreased at 0.5g/500 ml and then gradually increased. Turbidity reduced as MOSP concentration increased. 79% of removal efficiency was observed.TDS increased when the concentration of MOSP increased. Chloride, nitrate and ammonia reduction were observed as the concentration of MOSP increased. 95% of chloride was removed from quarry water with the use of MOSP. 57% removal of nitrate was observed. Maximum removal of ammonia was occurred at 1g/500 ml. The rate of ammonia started increasing.

Table 5: Manjappara Granite Stone Quarry treated Water Sample Analysis

Sample 2-Manjappara Quarry			Treated Sample				
S. No	Parameter	Raw Sample	0.5g/ 500ml	1g/ 500ml	1.5g/ 500ml	2g/ 500ml	2.5g/ 500ml
1	pH	7.85	75	7.6	7.8	7.8	8
2	Turbidity (NTU)	233	239	242	240	235	226
3	TDS (mg/l)	19.9	17.2	15.3	12.5	9.6	5
4	Chlorine (mg/l)	33.9	30	19	8	0	0
5	Nitrate (mg/l)	1.96	1.84	1.73	1.68	1.23	0.93
6	Ammonia (mg/l)	2	0.9914	0.384	1.659	1	0.735

Analyzing the batch study results of sample 1 it was observed that after treatment with Moringa Oleifera seed powder, the pH was decreased at 0.5g/500 ml and then gradually increased. Turbidity reduced as MOSP concentration increased. 75% of removal efficiency was observed.TDS increased when the concentration of MOSP increased and then showed a reduction Chloride, nitrate and ammonia reduction were observed as the concentration of MOSP increased.100% removal of chloride from quarry water was observed with the use of MOSP. 52% removal of nitrate was observed. Maximum removal of ammonia was occurred at 1g/500 ml. 68% ammonia was removed. Then rate of ammonia started increasing.

Table 6: Mattapara Granite Stone Quarry treated Water Sample Analysis

Sample 3-Mattapara Quarry			Treated Sample				
S. No	Parameter	Raw Sample	0.5g/ 500ml	1g/ 500ml	1.5g/ 500ml	2g/ 500ml	2.5g/ 500ml
1	pH	7.97	7.7	7.65	7.8	7.95	8
2	Turbidity (NTU)	40.1	38.6	41	41.8	38	35.1
3	TDS (mg/l)	14.4	10.8	8	63	3.6	0.8
4	Chlorine (mg/l)	20	11.5	4	0	0	0
5	Nitrate (mg/l)	1.18	0.93	0.91	0.81	0.79	0.72
6	Ammonia (mg/l)	1.497	0.333	0.323	2.357	1.588	0.7688

Analyzing the batch study results of sample 1 it was observed that after treatment with Moringa Oleifera seed powder, the pH was decreased at 0.5g/500 ml and then gradually increased. Turbidity reduced as MOSP concentration increased. 95% of removal efficiency was observed.TDS showed a gradual reduction as concentration of MOSP increased. Chloride, nitrate and ammonia reduction were observed as the concentration of MOSP increased. 95% of chloride was removed from quarry water with the use of MOSP. 40% removal of nitrate was observed. Maximum removal of ammonia was occurred at 1g/500 ml. 79% removal was observed. After that the rate of ammonia started increasing.

3.3. Batch Study Graphical Representation

3.3.1. pH optimization

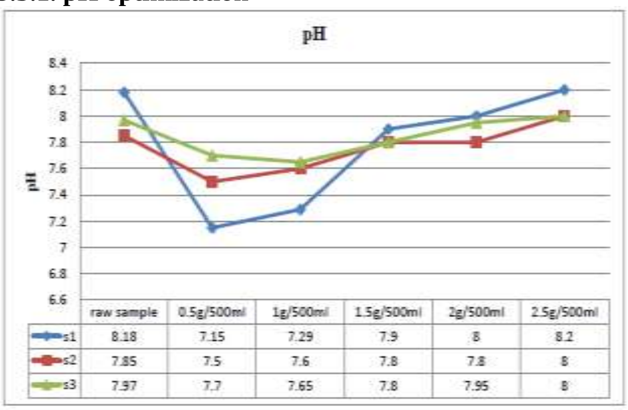

Figure 3.1: Batch study – variation of pH

Based on the results obtained by the three samples collected from Aayiramkolly(S1), Manjappara(S2) and Mattapara(S3) granite quarries , the variation in pH is plotted graphically. During the analysis, it was observed that after treatment with MOSP; pH was decreased at 0.5g, and then it gradually increased. After treatment the range of pH was 7 - 7.7 and it is within the limit AT 0.5g.after the treatment it exceeds the drinking water quality. So the optimization of pH was observed at 0.5g/500 ml

3.3.2. Total Dissolved Solids removal

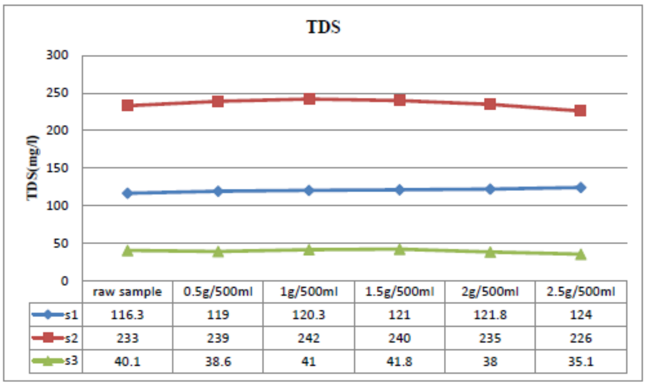

Figure 3.2: Batch study –Total Dissolved Solids removal

The batch study results in 3 samples collected from Aayiramkolly (S1), Manjappara (S2) and Mattapara (S3) granite quarries showed a slight variation in total dissolved solids

3.3.3. Turbidity Removal

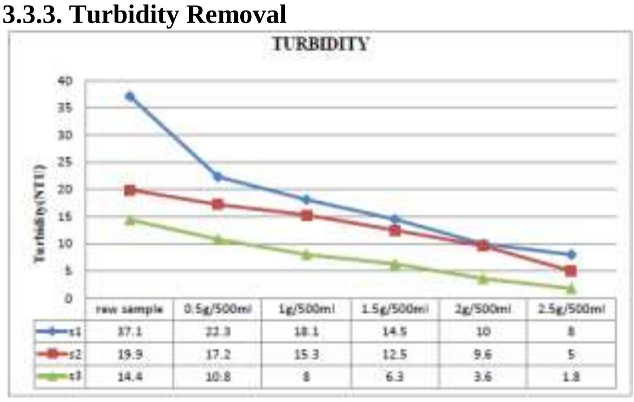

Figure 3.3: Batch study –turbidity removal

The batch study results in 3 samples collected from Aayiramkolly(S1), Manjappara(S2) and Mattapara(S3) granite quarries showed that the use of MOSP showed decreased turbidity with increased dose. Due to this there is an improvement in the flock size and flock was settled rapidly. There was a substantial reduction of 75-95% of turbidity.

3.3.4. Chloride Removal

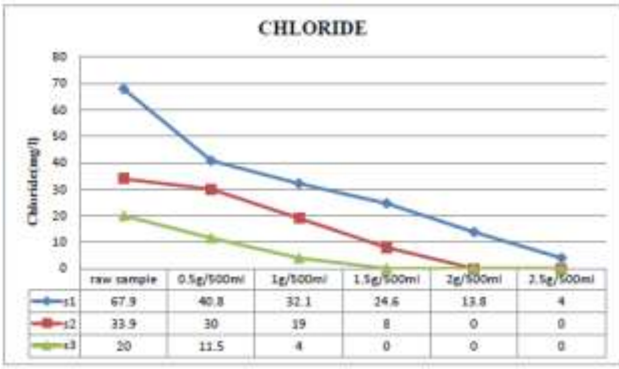

Figure 3.4: Batch Study –Chloride Removal

The batch study results in 3 samples collected from Aayiramkolly(S1), Manjappara(S2) and Mattapara(S3) granite quarries showed that 95-100% reduction of Chloride was obtained. As the concentration of MOSP increased the Chloride gradually reduced three fold.

3.3.5. Nitrate Removal

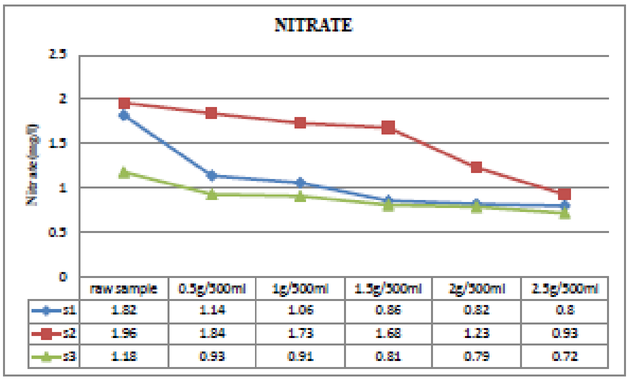

Figure 3.5: Batch Study –Nitrate Removal

The batch study results in 3 samples collected from Aayiramkolly (S1), Manjappara(S2) and Mattapara(S3) granite quarries showed a reduction of 40-57% Nitrate. There was a gradual reduction as the MOSP concentration increases. It shows that concentration of nitrate reduces as adsorbent increases.

3.3.6. Ammonia Removal

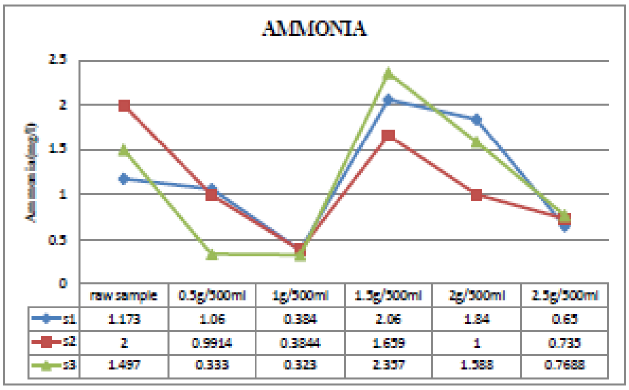

Fig.3.6. Batch study –Ammonia Removal

The treatment of quarry water with MOSP resulted in 67-79% removal of ammonia. It showed a gradual reduction of ammonia after the addition of 0.5g and 1g of MOSP. But after the addition of 1.5g there was a sudden increase in the ammonia concentration. And again shows a reduction. The maximum removal of ammonia was observed during the addition of 1g MOSP.

3.4 Batch Study -Adsorption Isotherm

3.4.1. Adsorption isotherm in the adsorption of chloride by mosp in sample 1

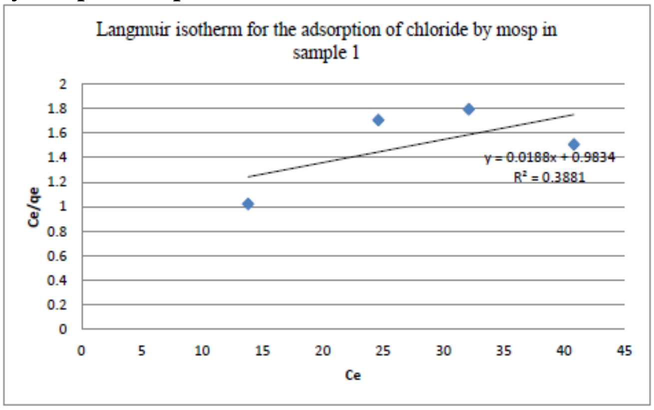

Figure 3.7: Linear Langmuir adsorption isotherm.

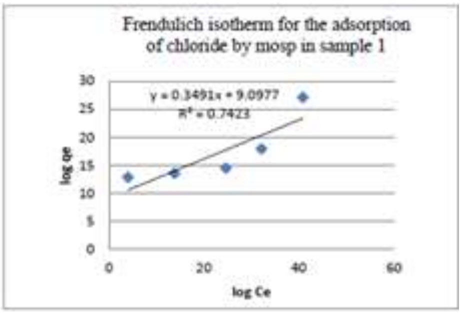

Figure 3.8: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated Here n >1, the adsorption is a favorable.

3.4.2. Adsorption isotherm in the adsorption of nitrate by mosp in sample 1

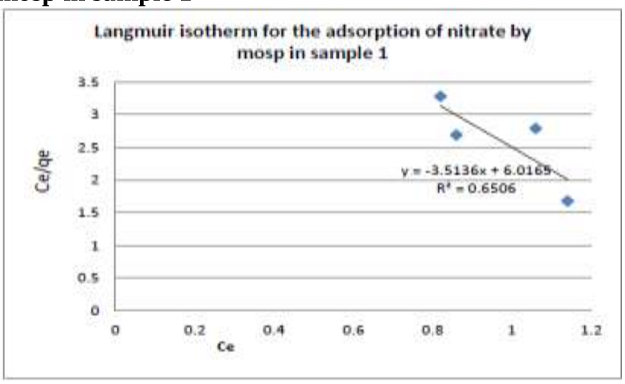

Figure 3.9: Linear Langmuir adsorption isotherm.

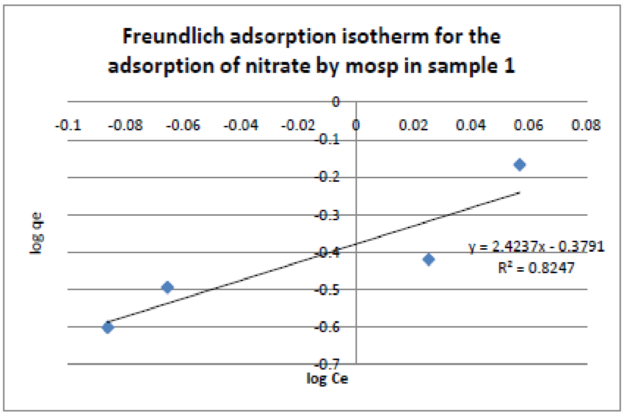

Fig 3.10: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce. The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated. n<1, the adsorption is chemisorptions

3.4.3. Adsorption isotherm in the adsorption of ammonia by mosp in sample 1

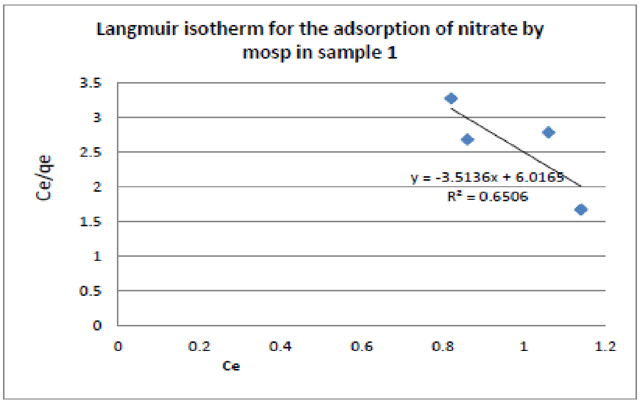

Figure 3.11: Linear Langmuir adsorption isotherm

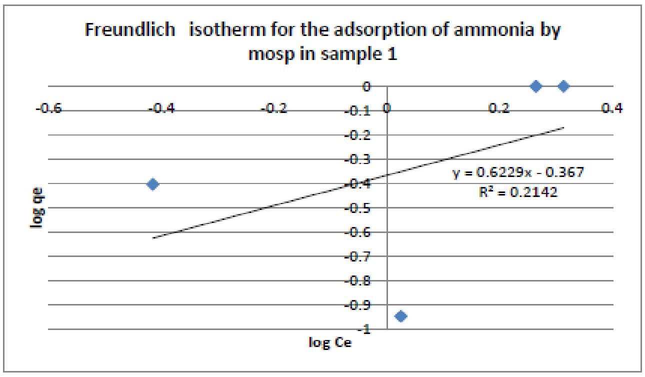

Figure 3.12: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce Since values of n>1, it indicated favorable adsorption. The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated

3.4.4. Adsorption isotherm in the adsorption of chloride by mosp in sample 2

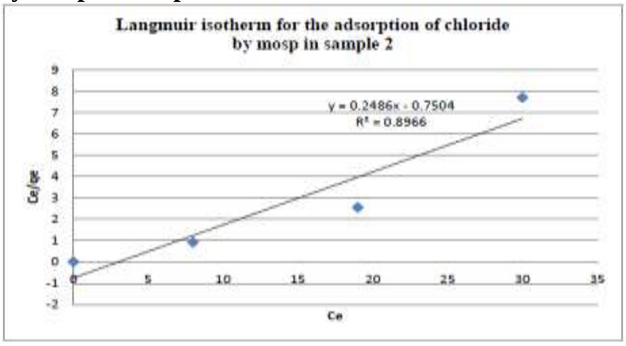

Figure 3.13 : Linear Langmuir adsorption isotherm

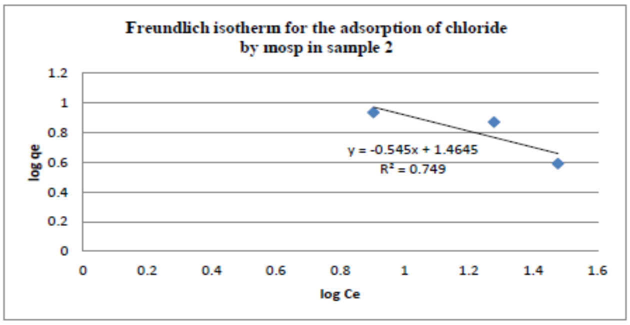

Figure 3.14: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce. The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated. n > 1, the adsorption, is a favorable

3.4.5. Adsorption isotherm in the adsorption of nitrate by mosp in sample 2

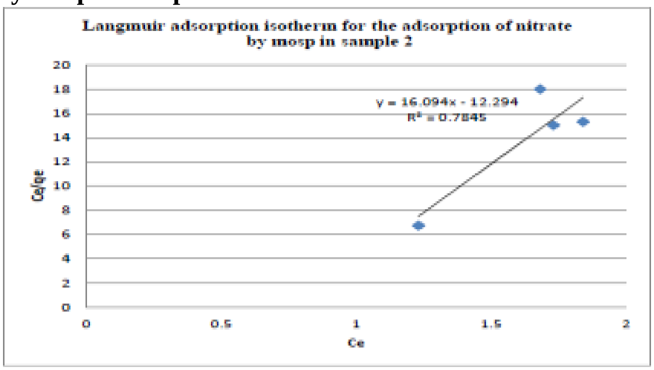

Figure 3.15: Linear Langmuir adsorption isotherm

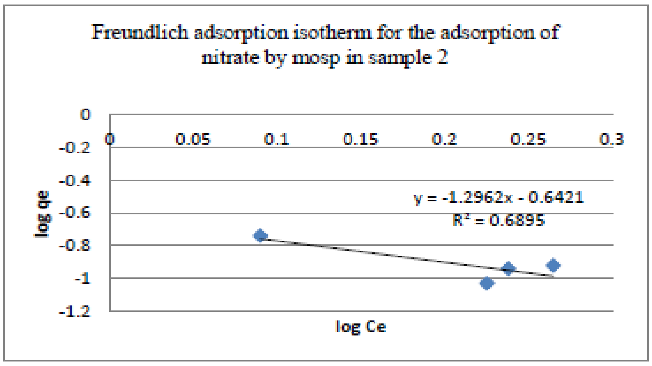

Figure 3.16: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce. The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated

3.4.6. Adsorption isotherm in the adsorption of ammonia by mosp in sample 2

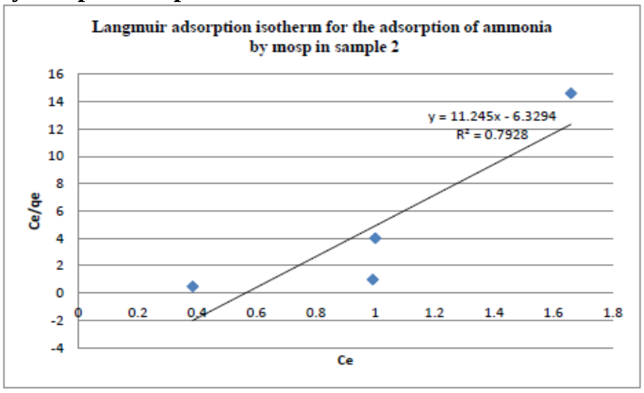

Figure 3.17: Linear Langmuir adsorption isotherm.

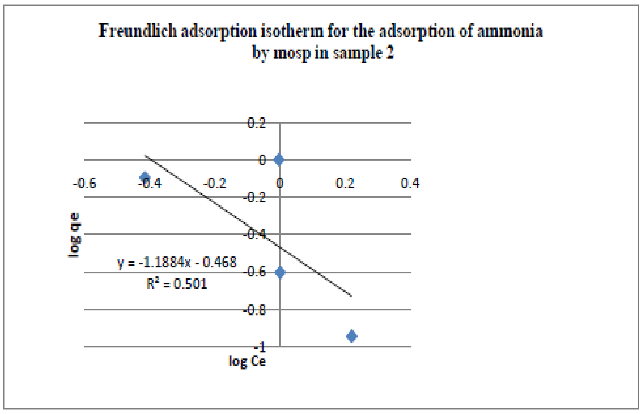

Figure 3.18: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce. The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated

3.4.7. Adsorption isotherm in the adsorption of chloride by mosp in sample 3

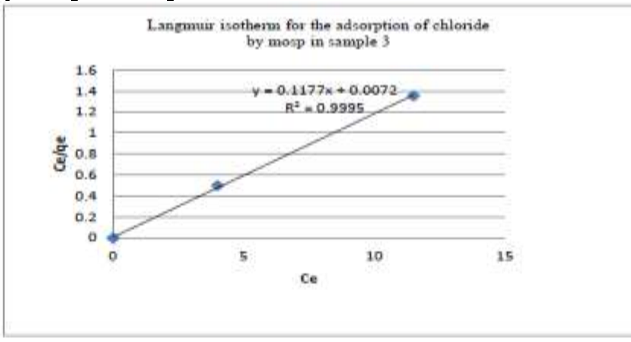

Figure 3.19: Linear Langmuir adsorption isotherm.

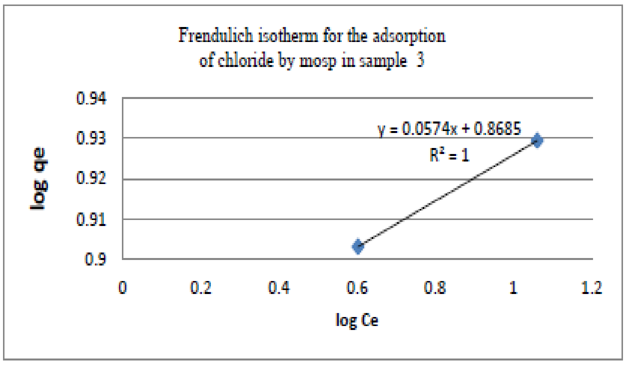

Figure 3.20: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce Since values of n<1, it indicated favorable adsorption. The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated.

3.4.8. Adsorption isotherm in the adsorption of nitrate by mosp in sample 3

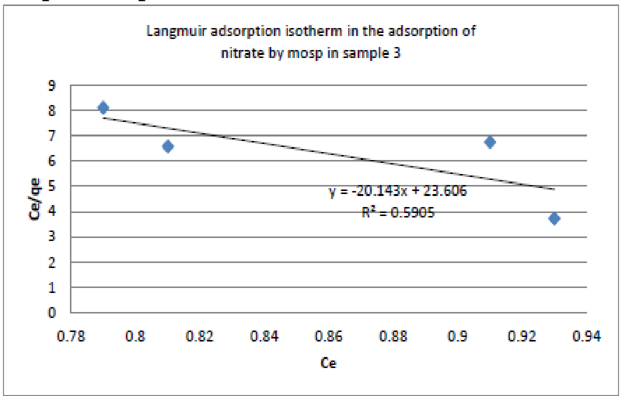

Figure 3.21 : Linear Langmuir adsorption isotherm

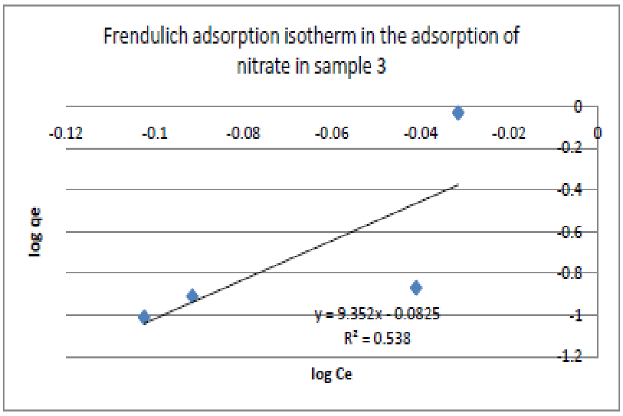

Figure 3.22: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce Since values of n<1, it indicated favorable adsorption. The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated. n<1, the adsorption is chemisorptions

3.4.9. Adsorption isotherm in the adsorption of ammonia by mosp in sample 3

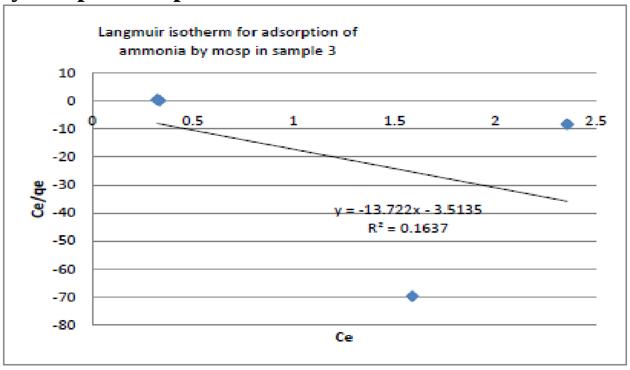

Figure 3.23: Linear Langmuir adsorption isotherm

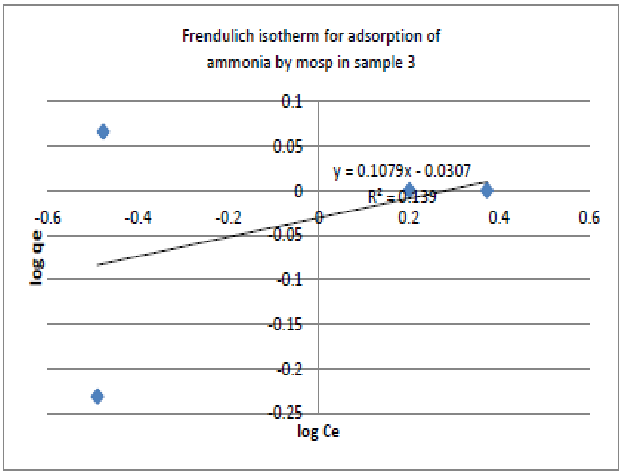

Figure 3.24: Freundlich adsorption isotherm

The values of n and K were obtained for the slope and intercept of a plot of log qe versus log Ce Since values of n<1, it indicated favorable adsorption. The linear Freundlich and Langmuir plots are obtained by plotting log qe vs log Ce and Ce/qe vs. Ce respectively, from which the adsorption coefficients could be evaluated. Here n >1, the adsorption is a favorable

3.5. Column Study Result

Granite Stone Quarry Treated Water Sample Analysis

Table.7. Sample 1- Aayiramkolly Granite Stone Quarry Treated Water Sample Analysis

Sample 1- Aayiramkolly Quarry				
S. No	Parameter	Raw Sample	Treated Sample	Removal Efficiency %
1	pH	7.85	9	
2	Turbidity (NTU)	233	130	45
3	TDS (mg/l)	37.1	5.6	85
4	Chlorine (mg/l)	33.9	0	100
5	Nitrate (mg/l)	1.82	0.73	60
6	Ammonia (mg/l)	1.173	0.72	38.6
7	MPN/100 ml	460	6	98

Sample1collected from Aayiramkolly granite stone quarry was treated by using Moringa Oleifera seed powder by column study. The treated effluent was tested. The test result showed that pH increased and exceeded the standard limit of drinking water. Total dissolved solids showed 45% reduction. 85% turbidity removal was observed. The treatment also showed complete removal of chloride. 60% nitrate removal and 38.6% ammonia reduction was also obtained from the results. 98% bacteria removal was also observed.

Table 8: Sample 2- Manjappara Granite Stone Quarry Treated Water Sample Analysis

Sample 2- Manjappara Quarry				
S. No	Parameter	Raw Sample	Treated Sample	Removal Efficiency %
1	pH	8.18	10	
2	Turbidity (NTU)	116.3	96	20
3	TDS (mg/l)	19.9	2.1	90
4	Chlorine (mg/l)	67.9	0	100
5	Nitrate (mg/l)	1.96	0.96	50
6	Ammonia (mg/l)	2	0.77	62
7	MPN/100 ml	1100	20	98

Sample 2 collected from Manjappara granite stone quarry was treated by using Moringa Oleifera seed powder by column test. The treated effluent was tested. The test result showed that pH increased and exceeded the standard limit of drinking water. Total dissolved solids showed 20% reduction. 90% turbidity removal was observed. The treatment also showed complete removal of chloride. 50% nitrate removal and 62% ammonia reduction was also obtained from the results. 98% bacteria removal was also observed.

Table 9: Sample 3- Mattapara Granite Stone Quarry Treated Water Sample Analysis

Sample 3- Mattapara Quarry				
S. No	Parameter	Raw Sample	Treated Sample	Removal Efficiency %
1	pH	7.97	10.6	
2	Turbidity (NTU)	40.1	10	75
3	TDS (mg/l)	14.4	2	86
4	Chlorine (mg/l)	20	0	100
5	Nitrate (mg/l)	1.18	0.618	48
6	Ammonia (mg/l)	1.497	0.67	55
7	MPN/100 ml	1600	15	99

Sample 3 collected from Mattapara granite stone quarry was treated by using Moringa oleifera seed powder. The treated effluent was tested. The test result showed that pH increased and exceeded the standard limit of drinking water. Total dissolved solids showed 75% reduction. 86% turbidity removal was observed. The treatment also showed complete removal of chloride. 48% nitrate removal and 55% ammonia reduction was also obtained from the results. 99% bacteria removal was also observed.

3.6. Column Study- Graphical Representation

3.6.1. Optimization of pH

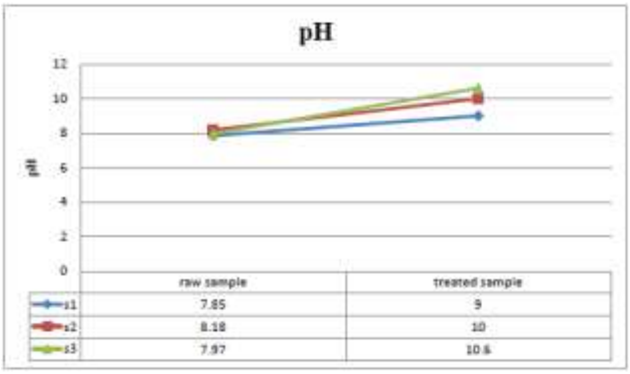

Figure 3.25: column study- variation in pH

Based on the results after column study in the 3 samples collected from Aayiramkolly(S1), Manjappara(S2) and Mattapara(S3) granite quarries the variation in pH is plotted graphically. The results obtained showed an increase in pH. It exceeds the limit of drinking water quality.

3.6.2. Total Dissolved Solids (TDS) removal

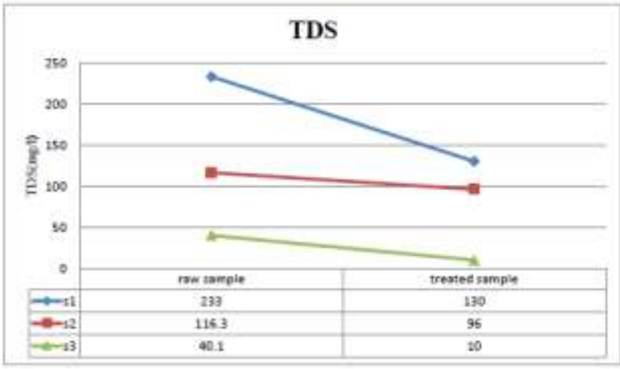

Figure 3.26: column study- total dissolved solids removal

Based on the results after column study in the 3 samples collected from Aayiramkolly(S1), Manjappara(S2) and Mattapara(S3) granite quarries the three samples showed reduction in the total dissolved solids. The three samples showed a reduction of 45-75%.

3.6.3. Chloride Removal

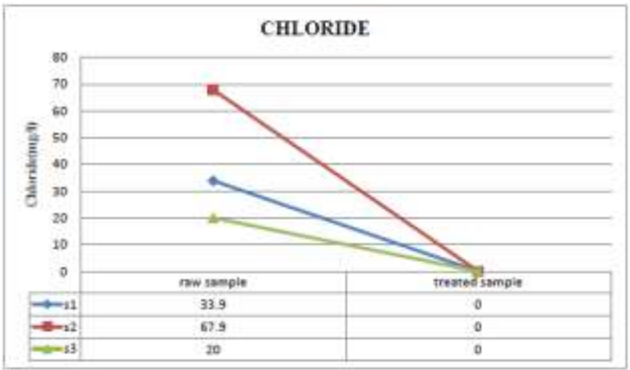

Figure 3.27: column study- Chloride Removal

Based on the results after column study in the 3 samples collected from Aayiramkolly(S1), Manjappara(S2) and Mattapara(S3) granite quarries 100% removal of chloride was obtained. It shows that MOSP is highly efficient adsorbent in the removal of chlorides

3.6.4. Nitrate removal

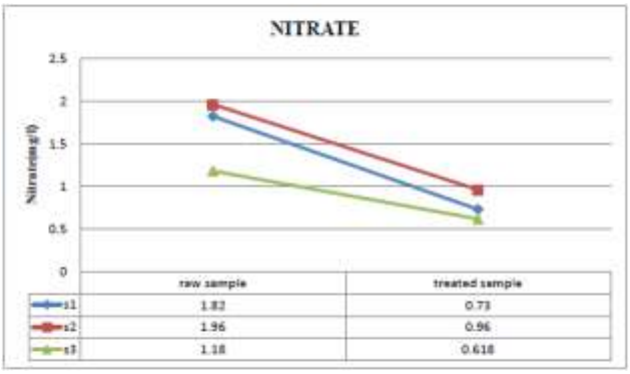

Figure 3.28: column study- Nitrate removal

Based on the results after column study in the 3 samples collected from Aayiramkolly (S1), Manjappara (S2) and Mattapara (S3) granite quarries about 40-60% removal of nitrate were obtained. The three samples showed the reduction of nitrate. The presence of nitrate results in Eutrophication

3.6.5. Ammonia removal

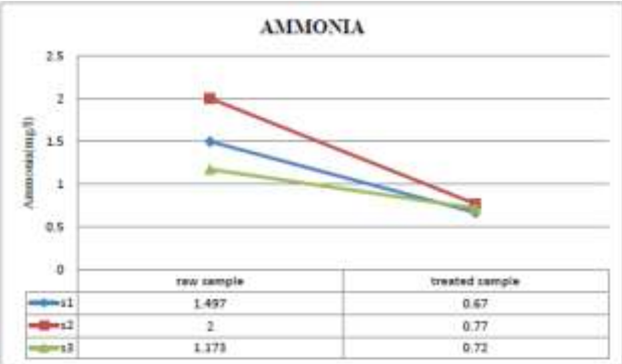

Figure 3.29: Column Study- Ammonia Removal

Based on the results after column study in the 3 samples collected from Aayiramkolly(S1), Manjappara(S2) and Mattapara(S3) granite quarries reduction of ammonia was obtained. There was a reduction of 40-68% of ammonia.

3.6.6. MPN removal

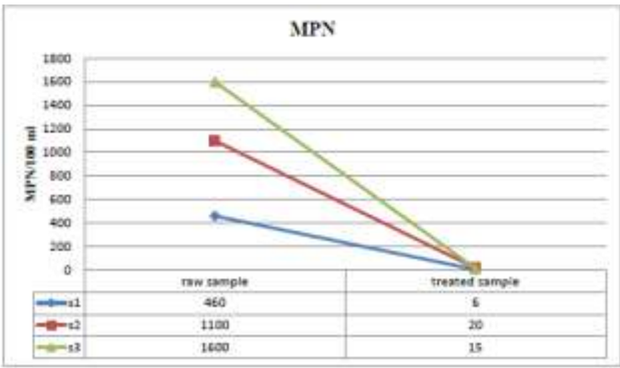

Figure 3.30: Column Study-MPN Removal

Based on the results after column study in the 3 samples collected from Aayiramkolly(S1), Manjappara(S2) and Mattapara(S3) granite quarries reduction of bacteria is observed MOSP acts as an antimicrobial agent. About 99% of bacteria removal was observed after the column study. The samples showed a substantial reduction of bacteria.

4. Conclusion

Moringa Oleifera seed powder is a natural adsorbent which is suitable for the removal of the chemicals such as ammonia and nitrate from the surface water near quarries. It is also a natural coagulant.

By conducting the batch and column studies it observed that it helps to remove the Turbidity, Chloride, Nitrate And Ammonia.

- 75% to 95% turbidity removal was observed.
- It also resulted in 35%to 50% reduction in Nitrate and Ammonia concentration.
- It acted as an antimicrobial agent also. About 99% bacteria were removed by the treatment using Moringa Oleifera seed powder. It helps in decreasing the microbial count in quarry water.

Moringa Oleifera seed powder is a naturally available eco friendly non toxic adsorbent. So this can be used for the treatment of water near quarries, which will be much safer for domestic purpose.

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