Nitrate Removal from Synthetic Wastewater by using Bio-adsorbent

Sumiya U. and Anu N.

Abstract—Environmental pollution is the most terrible ecological crisis to which we are subjected today. Today the environment has become foul, contaminated, undesirable, and therefore harmful for the health of living organisms, including man. The most common contaminant identified in ground water is dissolved nitrogen in the form of Nitrate (NO_3).Decomposition of organic matter present in soils leaching, of soluble fertilizers, human and animal excreta are the source of nitrate in subsurface waters. This research work is for to find preventive measures to avoid the nitrate pollution. This paper explains suitability of bio adsorbent i.e. 'green algal powder' for removal of nitrates from water has been studied. The work is for the use of bioadsorbent in the different dosages to achieve the task.

Index Terms—Nitrates, Biosorption, Water pollution, Green algal powder

1. INTRODUCTION

Nitrate (NO3 −) water pollution is one of the most prevailing and relevant ecological issues. For instance, the wide presence of this pollutant in the environment is dramatically altering the quality of superficial and underground waters. Nitrate is a chemical, like salt. We get nitrate in food and in water. Usually, water is a fairly minor source of nitrate. However, sometimes water has high levels of nitrate, then it is a significant source. Nitrates are naturally present in many foods like carrots and spinach. Nitrate (NO_3) is a water-soluble molecule made up of nitrogen and oxygen. It is formed when nitrogen from ammonia or other sources combines with oxygenated water. Nitrate is a natural constituent of plants and is found in vegetables at varying levels depending on the amount of fertilizer applied and on other growing conditions.

According to the World Health Organization, most adults ingest 20-70 milligrams of nitrate- nitrogen per day with most of this coming from foods like lettuce, celery, beets, and spinach. When foods containing nitrate are eaten as part of a balanced diet the nitrate exposure is not thought to be harmful. Nitrate is formed when nitrogen from ammonia or other sources combines with oxygenated water. Nitrate is a natural constituent of plants and is found in vegetables at varying levels depending on the amount of fertilizer applied and on other growing conditions.

1.1 Sources of Nitrates Pollution in Groundwater:

Cultivation in areas where the soil layer is relatively thin, or has poor nutrient buffering capacity, or where there are changes in land use;

Over fertilization of crop for intensification of agricultural activity;

- Spread cultivation of crops which require high fertilizes doses and which leave the soil bare over long periods (maize, tobacco and vegetables);
- Drainage systems which lead to drainage of fertilizers;
- Intensive agricultural rotation cycles involving frequent plugging and extensive areas of bare soils during winters;
- Organic fertilizers form animal husbandry;
- Increased urbanization.

1.2 Problems Associated With High Nitrate Levels:

If the level is 10 mg/l or higher do not use the water to feed your baby. Infants who are fed water that is high in nitrate can develop a condition that doctors call methamoglobinemia. The condition is also called "blue baby syndrome" because the skin appears blue-gray or lavender in color. Although many studies have been performed attempting to link stomach and gastrointestinal cancer due to nitrate intake

Literature survey reveals that the marine macroalgae Caulerpa taxifolia (biosorpent) was screened for its nutrients and heavy metal absorption capacities at various initial concentrations and contact period in laboratory conditions. Likewise, the red alga Kappaphycus alvarezii was tested for nutrient utilization besides its growth in waste water. The experiment on nutrient absorption by seaweed C. taxifolia inferred that all time intervals (6, 12, 18 and 24 hrs) maintained at different pH (4-10) the study showed significant amount of nutrients absorption. Of these, 24 hours biosorption at pH 7 showed the utmost removal of all the tested nutrients. The maximum absorption of zinc was recorded in pH 7 and at 24 hours with 0.5 g concentration of the seaweed being optimum under laboratory conditions. The experimental study using K.alvarezii in shrimp waste water confirmed excellent potentials of the seaweed in absorbing nutrients and thereby aiding its growth [1]. A potentially feasible method is the biological treatment of effluents, using macroalgae for nutrient removal [2][3]. Heavy metals like Fe, Zn, Ca and Mg have been reported to be of bioimportance to man and their daily medicinal and dietary allowances [4]. Even for those having bioimportance, dietary intake have to be maintained at regulatory limits, as excesses will result in poisoning or

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toxicity, which is evident by certain reported medicinal symptoms that are clinically diagnosable [5][6][7]. The process of biosorption, which utilizes various certain natural materials of biological origin, including bacteria, fungi, yeast, algae, etc. it is an ideal candidate for the treatment of high volume and low concentration complex wastewaters [8]. A floating bed vegetated with a terrestrial herbaceous species (Italian ryegrass) with the aim to remediate hydroponic solutions polluted with NO3− [9]. NO3− contamination of groundwater has become a relevant problem and an environmental priority [9]. Agriculture practices are constantly contributing to this kind of contamination. Excessive fertilization in intensive agricultural areas has caused some serious environmental problems because of water and soil enrichment with NO3−of agricultural origin [11]. Nitrate accumulation alters the quality of water bodies and causes the eutrophication of aquatic environments. Furthermore, high concentrations of NO3 − in water can be very hazardous for human and animal health [12]. Among the techniques available for contaminants removal from soils and water bodies, phytoremediation and/or phytoextraction is very promising, cost-effective and non-invasive. This technology takes advantage of the capacity of certain plants to remove various pollutants from contaminated matrices [13]. To this regard, macrophytes have been widely investigated They have been selected for their capacity to take up substances from polluted solutions. In addition, they can stimulate microbial communities, which can further trigger the degradation of the contaminants. Some authors [14] reported that constructed wetlands are effective in the removal of various pollutants, including organic and inorganic nitrogen forms, in water bodies [15].

2. OBJECTIVES

The objectives of this study were

1. To investigate the feasibility of green algal powder for the removal of nitrates from wastewaters.
2. To determine the removal efficiency of the adsorbent for various nitrate concentrations

3. MATERIALS AND METHODS

Adsorption is defined as the change in concentration at the interfacial layer between the two phases of a system due to surface forces. Adsorption is mass transfer operation in that a constituent in the liquid phase is transferred to solid phase. The adsorbate is substance that is being removed from the liquid phase and transferred to the solid phase. The adsorbent is the solid, liquid, or gas phase onto which the adsorbate accumulates. Factors affecting adsorption methods are i) Surface Area ii) Nature of the adsorbate iii) pH iv) Temperature v) Presence of mixed solutes and vi)Nature of adsorbent.

In the present study synthetic sample is prepared and used for experimental purpose of nitrate removal from water.

3.1 Preparation of bio-adsorbent

Healthy and fresh samples of green algae was collected from kollam. The samples after washing were processed as powder by using domestic blender and sieved through 500micro meter stain-less steel sieve.

Fig 1. Green algae powder

3.2. Experiment setup

Nutrient stock solutions were prepared according to standards of Strickland and Parsons 1979. Anhydrous potassium nitrate was dissolved in distilled water, as nitrate stock solution. Working solution was prepared by the dilution of nitrate stock solution.The stock solution (100 ml) were taken in 250 ml conical flasks. Algal powder of various quantities (0.2, 0.4, 0.6, 0.8 and 1.0 g) was added to conical flasks. Then the flasks were maintained at 30°C in shaker at 200 rpm. At the end of the experiment, the fluid was separated from the powder by filtration through whatman (47mm) filter paper.

4. ADSORPTION TEST BY USING SPECTROPHOTOMETER

The nitrate standard sample in the range of 1 mg/lit to 5 mg/lit was prepared by taking appropriate quantities of standard nitrate solution with distilled water. Then add 10 ml sulphuric acid and 0.5ml brucine sulphanilic acid solution and mixed well. Then the samples are placed in boiled water bath for 20minutes at 95^0C. Then the samples were cooled. The spectrophotometer was set to zero absorbance with reference solution and absorbance readings of standard were obtained. Reference solution was used as a blank solution. Spectrophotometer used at 410 nm wavelength was taken as per standard procedure.

Table 1: Standard curve

Std. solution (ml)	ppm Nitratee
blank	0
10	1
20	2
30	3
40	4
50	5

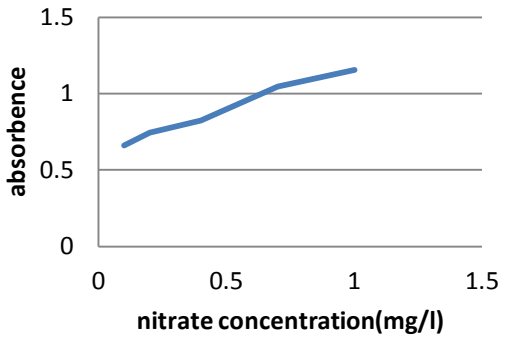

Fig. 2. Standard Curve of Nitrate

After calibration, the samples were checked for nitrate detection in spectrophotometer at wavelength 410nm. Absorbance readings were compared with standard curve and the removal efficiency was found.

5. RESULTS AND DISCUSSION

It was seen that the removal of nitrates increases with an increase in the amount of adsorbent. For all the experiments, initial nitrate ion concentration was fixed at 1 mg/lit. The amount of adsorbent dose was varied from 0.2mg/lit to 1.0 mg/lit in aqueous solutions. Results show that for green algal powder as bio-adsorbent, the maximum removal efficiency of fluoride was 20% at 1 mg/lit.

Table 2: Efficiency after Adsorption

Adsorbent dose (mg/L)	Initial Nitrate Conc. (mg/L)	Final Nitrate Conc. (mg/L)	% Removal Efficiency
0.2	1	0.92	8
0.4	1	0.90	10
0.6	1	0.88	12
0.8	1	0.85	15
1.0	1	0.80	20

6. CONCLUSION

Based on the present study following conclusions are drawn.

1. Use of the green algal powder as bio adsorbent, removal of nitrate is feasible.
2. The removal by adsorption increases with increase in adsorbent dose.

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