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Experimental and modelling studies for the percentage conversion of nitrate from biomass derived from rotten fruits under aerobic conditions

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ABSTRACT

Nitrate salts are used widely in many areas as fertilizers, explosives, oxidizing agents in the chemical industries, and as food preservatives especially to cure meats. If the range of nitrates increases in environment shows many dangerous and ill effects. Conversion of nitrate was needed. In this study the highest percentage conversion of nitrate was found to be 83 % from the optimized conditions. The final form of the proposed model equation for the percentage conversion of nitrate was $Y_s=0.83(1-e^{-0.2039t})$. Where Y_s = percentage conversion of nitrate and t= conversion time (days). The model showed good agreement with experimental data by generating average absolute relative deviation (AARD) of about 0.5225± 44.49% conversion of nitrate from biomass derived from rotten fruits under aerobic conditions for sewage water.

KEYWORDS

Nitrate;
Denitrification;
Conversion;
Model equation;
Average absolute relative deviation;
Rotten fruits;
Sewage water.

INTRODUCTION

Nitrates[1] are naturally present in soil, water, and food. In the natural nitrogen cycle, bacteria convert nitrogen to nitrate, which is taken up by plants and incorporated into tissues. Animals that eat plants use the nitrate to produce proteins. Nitrate is returned to the environment in animal feces, as well as through microbial degradation of plants and animals after they die. By the aerobic action of the nitrosomonas bacteria[2] in nitrogen cycle the nitrates converts to nitrogen. Nitrate salts are used widely as inorganic fertilizers[3], explosives, oxidizing agents in the chemical industries, and as food preservatives especially to cure meats. Natural process the is no contamination of nitrate by the extensive utilization of synthetic fertilizers and Industries, human excreta, sewage disposal, cattle seepage, fertilizer industries, explosives industries, municipal waste and industrial effluents, particularly from food processing, release of improperly treated wastewater from industrial or municipal facilities are the causes of nitrate contamination in natural water, ground water systems as well as atmosphere also. Nitrate contamination causes health hazards[4] like methemoglobinemia which losses the oxygen carrying capacity of hemoglobin, blue baby syndrome, headache, dizziness, vomiting, diarrhea, labored breathing Pregnant women are more sensitive to the effects of nitrate due to a natural increase in methemoglobin levels in blood during the later stage of pregnancy beginning around the 30th week. Nitrates are entering into the atmosphere and can be converted to nitrous oxide (N2O), which a greenhouse gas is contributing to global warming, acidic deposition and the formation of other secondary pollutants. Nitrate is one of the main contributors to eutrophication[5] of surface water. The U.S. Environmental Protection Agency[6]

Short Communication

(EPA) sets Maximum Contaminant Levels (MCLs) for nitrogen in public drinking water systems as 10 milligrams per liter (NO3 –N mg/l) and nitrites as one milligram per liter (NO2 –N mg/l). The World Health Organization (WHO)[7] has prescribed the maximum permissible limit of nitrate in drinking water as 50 mg per liter, while IS-10500 prescribes 45 mg per liter as the maximum permissible limit in drinking water.

MATERIALS AND METHODS

Conversion of nitrate was more important to remove contamination in sewage water contain more amount of nitrates. The sewage was collected in and around the region of Vizag. The sewage contains waste from hotels, domestic waste, animal excreta and rain water runoff. To convert nitrates into nitrogen micro organisms are developed from rotten fruit waste.

Development of biomass from rotten fruits

10 g per 1000 ml of fruit mixture is taken in distilled water and kept for days 40 harvesting under aerobic conditions. The developed culture is used as biomass for denitrification process.

Estimation of nitrate concentration

The concentration of nitrate was estimated by using spectrophotometer[8]. The reagents used for this process are salfanilic acid, hydrochloric acid, methyl anthranilate and sodium hydroxide. Take 10 ml of sewage water and add 1 ml of salfanilic acid to diazotized[9] to form nitrates. Then 1ml of 2mol/ L HCl was added to make the reaction faster and the contents are kept under shaking for 5 min to complete the diazotization reaction. After the diazotization 1 ml of 0.5% methyl anthranilate was added to indicate the color. Methyl anthranilate reacts with nitrates present in sample and forms brown red color. For this 2 ml of 2mole/L NaOH was added to neutralize the acidic nature and 10 ml of distilled water was added for this, and the color of the sample was estimated under 490 nm spectrophotometrically to get the concentration of nitrate.

Modeling of conversion of nitrate

In order to describe the nitrate conversion from sewage water the following hypothesis were used. The mass transfer coefficient is constant. The conversion of nitrate diffusion phenomenon by biomass derived from rotten fruits under aerobic conditions. The final form of modeling equation[10] was obtained from the conversion of nitrate

$$Y_s = B\,(1-e^{-Dt})$$

Where Y_s = percentage conversion of nitrate; T= conversion time (days) and B and D are equation constants.

RESULTS AND DISCUSSION

Percentage conversion of nitrate

As the reaction proceed the micro organisms denitrifying the sewage and converts the nitrates into nitrogen and releases to atmosphere. The concentration of nitrates is decrease as the time proceeds and the conversion increases. From the optimized conditions the percentage conversion is found to be 83% and it remains constant from day 8 to day 12. The results are shown in TABLE 1 and figure 1.

TABLE 1 : Percentage conversion of nitrate with time

Conversion Time, days	Nitrate Conversion
1	0.00
2	0.26
3	0.4
4	0.5
5	0.66
6	0.73
7	0.8
8	0.83
9	0.83
10	0.83
11	0.83
12	0.83

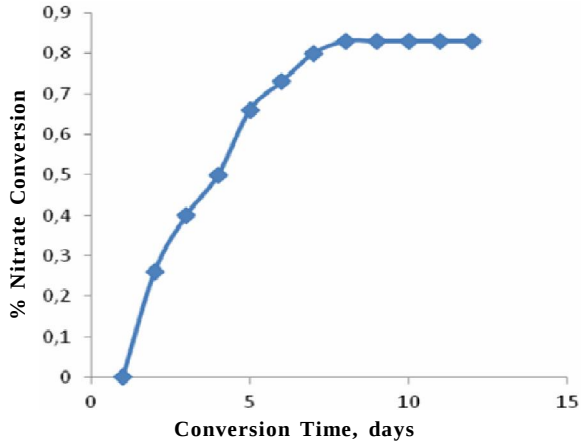

Figure 1 : Percentage conversion of nitrate

Short Communication

Modeling of conversion of nitrate by using micro organisms

To describe the conversion of nitrate in sewage water using the micro organisms, the highest percentage conversion of nitrate was found to be 83 % from the optimized conditions. The final form of the proposed model equation for the percentage conversion of nitrate was

$$\mathbf{Y_s=0.83(1-e^{-0.2039t})}.$$

Where Y_s = percentage conversion of nitrate; t= conversion time (days).

The model showed good agreement with experimental data by generating average absolute relative deviation (AARD)[11] of about 0.5225± 44.49% conversion of nitrate from biomass derived from rotten fruits under aerobic conditions for sewage water.

CONCLUSION

In this study the conversion of nitrate was estimated while it is harm and dangerous to the water sources, environment and humans health. The highest percentage conversion of nitrate was found to be 83 % from the optimized conditions. The final form of the proposed model equation for the percentage conversion of nitrate was Ys=0.83(1-e-0.2039t). Where Y_s = percentage conversion of nitrate and t= conversion time (days). The model showed good agreement with experimental data by generating average absolute relative deviation (AARD) of about 0.5225± 44.49% conversion of nitrate from biomass derived from rotten fruits under aerobic conditions for sewage water.

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