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# Study of the Efficiencies of Algal Species in Removing Pollutants from Sewage Waters

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Three algal species were exploited for the removal of pollutants from sewage water. These algal forms utilised sewage pollutants as nutrients for their growth and development. The algal biomass could be used as food and fodder since it contained high quantity of carbohydrates, fats and proteins. The algal growth indicates the extraction of useful nutrients present in drain water and thus makes it comparatively pure. The increase in DO indicates the release of oxygen by photosynthetic process. All the remaining parameters, *i.e.*, BOD, COD, different forms of nitrogen, hardness etc. were found decreased. Hence, it can be inferred that algal species may be used as a source for sewage purification and also as a method for the recovery of valuable food materials from the sewage.

## INTRODUCTION

There are several processes which have been developed for the treatment of domestic sewage. Two methods of sewage treatment, *i.e.*, physical and biological, are in use. Commonly used biological methods are trickling filters, activated sludge and oxidation pond system. The first two are not suitable for developing countries due to their high operation costs.

The use of algae in wastewater treatment by Gotaas[1] gained momentum in the late 1960's. A good deal of work on the treatment of wash waste by algal species has been done by Fallowfield and Garrett[2] and Sengar *et al.*[3] In the present study, the emphasis has been laid down on knowing the efficiency of individual algal species in removing the pollutants from sewage water.

## EXPERIMENTAL

Studies were conducted in triplicate in the glass vessels. The raw water was collected from the drains in previously washed plastic containers. The quantitative analysis of various pollutants was made following standard methods[4]. The three algal species, *i.e.*, *Gloeocapsa gelatinosa*, *Spirulina laxissima* and *Scenedesmus quadricauda* and naturally present algal population were exploited for the treatment of waste water.

Studies were conducted in batch culture in $6'' \times 6'' \times 6''$ glass vessels. The vessels were set up in triplicate for each alga and incubated at $30 \pm 1$°C temperature under uninterrupted fluorescent (2400 lux) light. Similar experiments were conducted simultaneously with mixed algae of drain water. For this, the raw water collected from the drains was filtered through Buchner funnel to remove the algae. The filtered water was taken into clean glass vessels and inoculation was done by individual algae. The analysis of various pollutants was done at 10 days interval up to 30 days in all the sets. The algal biomass was calculated .

## RESULTS AND DISCUSSION

The results of the quantitative changes in algal biomass and different pollutants of sewage water during the treatment period are recorded in Tables 1–4.

TABLE 1
TREATMENT OF SEWAGE WATER BY MIXED ALGAL POPULATION (SET I)

| Parameters | Pretreated sewage water | Post-treated sewage water | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10th day | | 20th day | | 30th day | |
| | | mg/L | %Change | mg/L | %Change | mg/L | %Change |
| Algal biomass | 1.1 | 17.6 | – | 104.7 | – | 136.4 | – |
| pH | 8.1 | 8.1 | –0.0 | 7.4 | –8.6 | 7.1 | –12.3 |
| DO | 0.8 | 0.7 | –12.5 | 5.5 | +587.5 | 7.8 | +87.5 |
| BOD | 390 | 456 | +16.9 | 94 | –75.9 | 15 | –96.2 |
| COD | 378 | 348 | –7.9 | 138 | –63.5 | 68 | –82.0 |
| $NH_3$-N | 16.42 | 14.94 | –9.0 | 3.44 | –79.0 | 1.36 | –91.7 |
| Organic-N | 14.45 | 13.53 | –6.6 | 2.32 | –84.0 | 0.15 | –98.9 |
| $NO_3$-N | 0.96 | 0.75 | –21.9 | 0.0 | –100 | 0.0 | –100 |
| $NO_2$-N | 0.49 | 0.33 | –32.7 | 0.0 | –100 | 0.0 | –100 |
| Phosphate | 0.12 | 0.10 | –16.7 | 0.0 | –100 | 0.0 | –100 |
| Hardness | 426 | 344 | –19.2 | 56 | –86.8 | 13 | –96.9 |

TABLE -2
TREATMENT OF SEWAGE WATER BY *SPIRULINA LAXISSIMA* (SET II)

| Parameters | Pretreated sewage water | Post-treated sewage water | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10th day | | 20th day | | 30th day | |
| | | mg/L | % Change | mg/L | % Change | mg/L | % Change |
| Algal biomass | 0.80 | 30.60 | – | 124.70 | – | 163.7 | – |
| pH | 8.10 | 8.10 | –0.0 | 7.40 | –8.60 | 7.1 | –11.1 |
| DO | 0.80 | 0.60 | –25.0 | 5.30 | +5.62 | 7.7 | +862 |
| BOD | 360 | 381 | +5.8 | 136 | –62.20 | 61 | –83.1 |
| COD | 366 | 340 | –7.1 | 157 | –57.10 | 76.0 | –79.2 |
| $NH_3$-N | 16.30 | 15.30 | –6.0 | 6.15 | –62.20 | 3.4 | –79.2 |
| Organic-N | 14.40 | 13.20 | –9.0 | 4.18 | –71.00 | 1.88 | –87.0 |
| $NO_3$-N | 0.94 | 0.74 | –21.3 | 0.26 | –72.30 | 0.05 | –94.7 |
| $NO_2$-N | 0.44 | 0.34 | –22.7 | 0.07 | –84.10 | 0.0 | –100 |
| Phosphate | 0.12 | 0.10 | –16.7 | 0.00 | –100 | 0.0 | –100 |
| Hardness | 410 | 348 | –15.0 | 114 | –72.20 | 24 | –94.0 |

TABLE 3
TREATMENT OF SEWAGE WATER BY *GLOEOCAPSA GELATINOSA* (SET III)

| Parameters | Pretreated sewage water | Post-treated sewage water | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10th day | | 20th day | | 30th day | |
| | | mg/L | % Change | mg/L | % Change | mg/L | % Change |
| Algal biomass | 0.40 | 15.7 | – | 82.30 | – | 102.70 | – |
| pH | 8.20 | 8.2 | –0.0 | 7.70 | –6.1 | 7.40 | –9.8 |
| DO | 0.90 | 0.8 | –11.1 | 4.90 | +444.4 | 7.20 | +700 |
| BOD | 490 | 524 | +6.9 | 116 | –76.3 | 29 | –94.1 |
| COD | 414 | 393 | –5.1 | 180 | –56.5 | 121 | –70.8 |
| $NH_3$-N | 13.40 | 12.9 | –3.1 | 6.32 | –52.6 | 4.27 | –68.0 |
| Organic-N | 14.40 | 13.5 | –6.7 | 5.24 | –63.7 | 2.74 | –81.0 |
| $NO_3$ -N | 1.54 | 1.3 | –18.8 | 0.30 | –81.2 | 0.12 | –92.2 |
| $NO_2$-N | 0.24 | 0.18 | –25.0 | 0.03 | –79.2 | 0.00 | –100 |
| Phosphate | 0.68 | 0.64 | –5.9 | 0.07 | –89.7 | 0.00 | –100 |
| Hardness | 520 | 472 | –9.2 | 150 | –71.2 | 83 | –83.0 |

TABLE 4
TREATMENT OF SEWAGE WATER BY *SCENEDESMUS QUADRICAUDA* (SET IV)

| Parameters | Pretreated sewage water | Post-treated sewage water | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10th day | | 20th day | | 30th day | |
| | | mg/L | % Change | mg/L | % Change | mg/L | % Change |
| Algal biomass | 0.6 | 20.70 | – | 94.6 | – | 123.40 | – |
| pH | 8.2 | 8.20 | –0.0 | 7.6 | –7.3 | 7.20 | –12.2 |
| DO | 0.9 | 0.80 | –11.1 | 5.5 | +511.1 | 8.30 | +822.2 |
| BOD | 490 | 548 | +11.8 | 157 | –68.9 | 68 | –86.1 |
| COD | 414 | 401 | –3.1 | 198 | –52.2 | 114 | –72.5 |
| $NH_3$-N | 3.34 | 12.50 | –11.0 | 4.26 | –68.1 | 2.13 | –84.0 |
| Organic-N | 13.30 | 12.50 | –13.0 | 3.80 | –73.8 | 0.88 | –94.0 |
| $NO_3$-N | 1.54 | 1.18 | –24.0 | 0.09 | –94.2 | 0.00 | –100 |
| $NO_2$-N | 0.24 | 0.15 | –33.3 | 0.02 | –91.7 | 0.00 | –100 |
| Phosphate | 0.68 | 0.60 | –10.3 | 0.00 | –100 | 0.00 | –100 |
| Hardness | 520 | 462 | –11.2 | 135 | –74.0 | 86 | –83.5 |

Production of algal biomass (dry wt.) of *Spirulina laxissima* was maximum on 30th day of the experiment followed by mixed algae, *Scenedesmus quadri-*

*cauda* and *Gloeocapsa gelatinosa*. After 10th day of experiment, mixed algae multiplied faster and showed more biomass production than others. It showed that nutrients required for the growth of the plants are always present in sewage water in the form of complex organic compounds. These are oxidised into assimilable inorganic forms before being utilised by algae.

No change in pH was observed on 10th day in each set. But after this the pH decreased in all the sets gradually. It was due to the removal of salts.

The DO contents decreased in all the four sets on the 10th day. Later on, it increased in all the sets. On the 30th day, the maximum DO increased was observed in mixed algae (set I) while minimum in set III (*i.e.* 700%). The BOD reduction ranged from 96.2–83.1% in different sets. It was also observed that mixed algal population was more efficient in reducing BOD load. The reduction of COD ranged from 70.8–80.0%. A similar reduction in COD removal from sewage effluents by algal flocculation was observed by John and Bokil[5]. Nambiar[6] observed 92% COD removal by flocculation in algal bacterial system.

In the present investigation, the removal of all the four types of nitrogen was maximum with mixed algae. Nitrate and nitrite-nitrogen were removed completely on 20th day while organic and ammonical nitrogen was reduced to 91.7 and 98.9% respectively on 30th day. Nitrate and nitrite-nitrogen was the best source of available nitrogen for algae and it is the only reason for manifold increase in algal population and thus the removal of various pollutants from the sewage water.

Phosphorus is one of the important macronutrients required for algal growth. In the present observations, *Scenedesmus quadricauda* and mixed algae achieved complete removal of phosphate on 20th day, while *Spirulina laxissima* removed it completely on 30th day.

Algal species take up the salts from the sewage water and therefore a gradual reduction in hardness was observed. In the present investigation, the reduction of hardness was observed to be 96.9% and 94.1% in sets I and II respectively while 83% in sets III and IV. The reduction in hardness indicates the uptake of calcium and magnesium.

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