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# RESPONSES OF *TRAPA NATANS* AGAINST THE SOARING CONCENTRATIONS OF NITRATE AND PHOSPHATE IN A TROPICAL RIVER GOMTI IN LUCKNOW CITY, INDIA

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## ABSTRACT

The amount of nitrate and phosphate, considered as major inorganic nutrients-cum-pollutants of municipal waste pipes were monitored in the water of a tropical river Gomti in Lucknow city during summer, rainy and winter seasons during 2009. All the samples from the 6 selected sites of Gomti river in the vicinity of this mega city showed the levels of nitrate and phosphate ranged between 14.02-49.13 and 0.16-4.32 mg $L^{-1}$ respectively, which were beyond the permissible limits (10 mg $L^{-1}$ $NO_3^-$ and 0.1 mg $L^{-1}$ $PO_4^{3-}$) in all the seasons. The maximum values of nitrate and phosphate were recorded during rainy season possibly due to excess runoff of the effluent mixed water through waste pipe lines. *Trapa natans* (Water chestnut) commonly cultivated aquatic crop in the region was cultured in the 20 L plastic tubs containing Gomti river water, under simulated net house conditions, for 3 weeks. *Trapa natans* removed nitrate and phosphate upto 71.34 and 74.64% respectively which was significant. Increase of 8.29, 14.59, 70.44 and 24.07% was recorded in the fresh wt., lamina length, protein in fruit and chlorophyll in leaves of *Trapa natans* respectively.

**KEY WORDS** Gomti river, Nitrate, Phosphate, *Trapa natans*

## INTRODUCTION

Water is one of the most important natural resources and clean water supply is very important for the survival of humans. Introduction of chemicals and nutrients at high concentration contributed to poor water quality. Increasing population, expand of industrialization, urbanization and disposing of the pollutants and waste material in the water bodies adversely affect the aquatic ecosystem and result in eutrophication, hypoxia etc [1]. Critical plant nutrients such as nitrate and phosphate have been frequently observed at high levels within aquatic systems [2]. Impact of high nitrate polluted water can include toxicity to humans and animals via ingestion, intestinal disorder, cancer etc [3]. Phosphate is generally considered as the limiting nutrient ion and this may also lead to excessive aquatic plant growth in the water bodies, resulting in accelerated eutrophication [4]. Sources of these nutrients are municipal sewage, livestock waste, chemical fertilizers, effluent discharge, industrial, urban and agricultural run-off, as well as airborne depositions etc [5].

For the supply of water for domestic use, activated sludge or chemical precipitations are required consistently. However, these processes are expensive in terms of requirement of energy and skilled operators. This approach is considered technically and financially inappropriate at small scale now and hence often not in practise in most of the potable water supply systems of Indian cities and towns [6]. The cost per gram of nitrate and phosphate removed is much higher for domestic waste water treatment plants serving small communities [7].

Phytoremediation is assumed to be very useful, and it is an innovative, eco-friendly and efficient technology in which natural potential of plants can be utilized in water treatment systems to remediate inorganic pollutants from sewage or domestic waste water supply [8]. It is cost effective and useful for developing countries [2]. *Trapa natans* is a common aquatic macrophyte cultivated in surface water bodies for its fruit commonly known as water chestnut [9]. This aquatic plant is important in water purification as it reduces current velocity and allows deposition of sediment and inorganic pollutants (nitrate, phosphate etc) removal. Hoseinizadeh et al. [10] reported that among 3 aquatic plants viz. *Typha latifolia, Trapa natans* and *Hydrocotyle vulgaris*, highest inorganic pollutants removal was attained by *Trapa natans* and *Hydrocotyle vulgaris*.

In this perspective, the present study was planned with multiple objectives 1) to determine the levels of nitrate and phosphate in Gomti river during various seasons, 2) role of *Trapa natans* in removal of nitrate and phosphate from the river water in simulated net house condition and 3) effect of Gomti water on growth; protein and chlorophyll content of *Trapa natans*.

## MATERIAL AND METHODS

### Water Samples

Water samples were collected from 6 different sites of Gomti river in the vicinity of Lucknow viz. Sitapur Over Bridge (Inlet), Kudiyaa Ghat, Saheed Park, Hanuman Setu, Laxman Mela Park and Dilkusha Railway Bridge (Outlet). Six samples were collected from each site during summer, rainy and winter seasons, 2009. Samples were analyzed for nitrate and phosphate concentrations within 24h of sampling.

### Plant Materials

Plants of *Trapa natans* (Water Chestnut) were obtained from the Gomti river and cultivated in the 20 litre plastic tubs (5 replicates) containing polluted Gomti river water. The culture was monitored for 3 weeks in the simulated net house condition, during the month of February, 2010. On every $7^{th}$ day, water samples were collected from the treatment tubs and analyzed for nitrate and phosphate levels. Simultaneously, biomass and length measurement of the plant; protein and chlorophyll estimation in the plant was also carried out.

### Samples Analysis

Nitrate was estimated by the method of [11] and phosphate was determined by the Stannous Chloride method [12]. Protein was analyzed by the method as described by [13] whereas chlorophyll was assayed using the method of [14]. All samples were analyzed via Varian, Carry 100 Bio, Uv-visible Spectrophotometer by preparing standard curves.

### Data Analysis

The data was analyzed using one way ANOVA (Analysis of Variance). The difference between treatments was considered significant at $P \leq 0.05$.

## RESULTS AND DISCUSSION

### Nitrate and Phosphate

All the sites have nitrate concentration level which was 1-4 folds higher over the [15] prescribed limit of 10 mg $L^{-1}$ for surface water, in all the three seasons. However, nitrate concentration in the water of Gomti river during the rainy season was higher than in summer and winter seasons (table 1). For instance, a site which is Laxman Mela Park had very high nitrate concentrations of 49.13 mg $L^{-1}$ in rainy season, whereas lowest value of nitrate i.e. 14.02 mg $L^{-1}$ was detected at Sitapur Over Bridge (Inlet) in summer season (table 1). On the other hand, phosphate content in Gomti river water was found between 0.16 to 4.32 mg $L^{-1}$ during all the 3 seasons, which was 1-40 folds above over the permissible limit i.e. 0.1 mg $L^{-1}$ [16]. Some sites such as Saheed Park and Hanuman Setu revealed consistent high content of phosphate during all the 3 seasons however, maximum phosphate level (4.32 mg $L^{-1}$) was detected during rainy season at Hanuman Setu (table 2). Srivastava et al. [17] in his study of Gomti river water characteristics reported the level of nitrate and phosphate beyond the permissible limit in all the months [18]. High level of nitrate and phosphate during rainy season in the river water could be attributed to urban farming runoff, street wash and dumping of city sewage in excess [19,20].

Although, reduction in the concentrations of these ions (nitrate and phosphate) was observed in all the treatment tubs containing *Trapa natans*. The percent of nitrate and phosphate removed by the plant at $7^{th}$, $14^{th}$, and $21^{st}$ day were in between 22-28, 48-56 and 71-74% respectively. However, *Trapa natans* removed 71.34 of nitrate and 74.64% of phosphate from the polluted water of Gomti river within 3 weeks of its cultivation (fig. 1). Rawat et al. [21] demonstrated that *Pistia stratiotes, Trapa natans, Mimulus glabratus and Polygonum persicaria* have high aptitude to improve water quality by removing heavy loads of nutrients and other inorganic pollutants. Researchers have made it clear that these macrophytes can reduce the concentrations of nutrient ions such as nitrate and phosphate significantly under controlled environmental conditions (22,23).

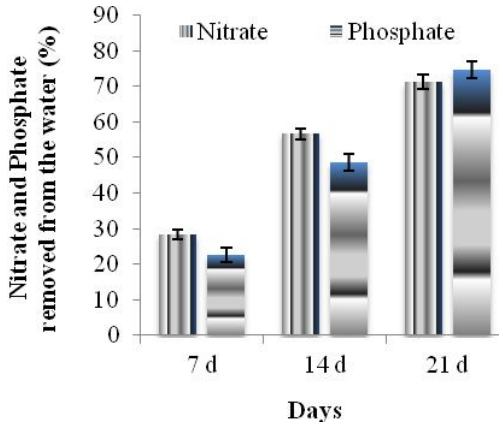


**Fig. 1** Nitrate and phosphate removed from the water by *Trapa natans* at $7^{th}$, $14^{th}$ and $21^{st}$ day

### Fresh Weight and Lamina Length

*Trapa natans* have its roots and shoot completely under water and take up the ions with help of rootlet. *Trapa natans* survived appreciably and showed remarkable growth in the physiological parameters (fresh wt. and lamina length) within 3 weeks. Increment in the fresh wt. of the plant was 10.86 g i.e. 8.29% and lamina length was increased by 2.7 cm i.e. 14.59% during the treatment tenure (table 3). Almost similar results were reported by [24] when

*Trapa natans* was exposed to high manganese concentration for the period of one month.

**Protein and Chlorophyll**

Content of protein in the fruits ranged from 2.03-3.46 mg $g^{-1}$ fr. wt. that was comparatively more than the leaf and root (table 3). There was spontaneous increment in the protein content at 7th, 14th and 21st day in the leaf, root and fruit of the plant. However, at 21st day of the experiment, 45.91, 37.50 and 70.44% increase was recorded in the protein content of leaf, root and fruit of the plant over the 1st day (table 3). It is clear that maximum increment in the protein i.e.

70.44% was detected in the fruit of the plant. Similarly, chlorophyll content in the leaves was found in between 1.08-1.34 mg $g^{-1}$ fr. wt. from 1st to 21st day respectively. Over all increment of 24.07% in the content of chlorophyll (leaf) was noticed at 21st day. However, [24] noticed the increase of 11.79% in the chlorophyll content of the leaves of *Trapa natans* which was cultivated for 30 days under high manganese concentration.

**Table 1.** Nitrate ion concentration (mg $L^{-1}$) in the water samples collected from the different sites of Gomti river in vicinity of Lucknow during the year 2009

| Sites | Summer | Rainy | Winter |
|---|---|---|---|
| Sitapur Over Bridge (Inlet) | 14.02±0.42 | 18.23±0.63 | 15.03±0.41 |
| Kudiyaa Ghat | 16.82±0.33 | 22.32±0.49 | 19.08±0.23 |
| Saheed Park | 17.79±0.35 | 25.0±0.37* | 21.43±0.53 |
| Hanuman Setu | 23.91±0.78 | 32.09±0.21* | 28.32±0.32 |
| Laxman Mela Park | 41.78±2.92 | 49.13±0.85* | 44.12±0.17 |
| Dilkusha Railway Bridge (Outlet) | 29.84±0.53 | 38.21±0.32* | 32.59±0.59* |

Values are mean with standard deviation (n=6). Permissible limit for $NO_3^-$ in the surface water is 10 mg $L^{-1}$ [15]. *Significant values

**Table 2.** Phosphate ions concentration (mg $L^{-1}$) in the water samples collected from the different sites of Gomti river in vicinity of Lucknow during the year 2009

| Sites | Summer | Rainy | Winter |
|---|---|---|---|
| Sitapur Over Bridge (Inlet) | 0.16±0.14 | 0.58±0.06 | 0.23±0.23 |
| Kudiyaa Ghat | 1.89±0.22 | 2.06±0.73 | 1.94±0.29 |
| Saheed Park | 3.18±0.04 | 3.95±0.21 | 3.87±0.64 |
| Hanuman Setu | 3.01±0.06 | 4.32±0.11 | 3.32±0.22 |
| Laxman Mela Park | 1.08±0.06 | 3.97±0.51* | 3.97±0.10 |
| Dilkusha Railway Bridge (Outlet) | 0.84±0.03 | 1.98±0.12 | 1.59±0.73 |

Values are mean with standard deviation (n=6). Permissible limit for $PO_4^{3-}$ in the surface water is 0.10 mg $L^{-1}$ [16]. *Significant values

**Table 3.** Effect of nitrate and phosphate on some physiological and biochemical parameters in *Trapa natans* cultivated in the 10 L tubs for 3 weeks

| Parameters | | 0d | 7d | 14d | 21d |
|---|---|---|---|---|---|
| **Fresh wt. (g)** | | 130.87±2.34 | 133.02±2.98 | 138.14±1.12* | 141.73±2.01 |
| **Lamina length (cm)** | | 18.5±1.57 | ND | ND | 21.2±1.02 |
| **Protein (mg $g^{-1}$ fr. wt.)** | **Leaf** | 0.98±0.02 | 1.2±0.07 | 1.31±0.6 | 1.43±0.08 |
| | **Root** | 0.08±0.001 | 0.08±0.003 | 0.09±0.04 | 0.11±0.01* |
| | **Fruit** | 2.03±0.8 | 2.60±0.09 | 3.0±0.13 | 3.46±0.10 |
| **Chl- a+b (mg $g^{-1}$ fr. wt.)** | | 1.08±0.7 | 1.12±0.12 | 1.23±0.12 | 1.34±0.11 |

Values are mean with standard deviation (n=5). *Significant values

**CONCLUSION**

High content of nitrate and phosphate were detected at all the 6 sites during the rainy season. *Trapa natans* reflected its efficiency in the removal of nitrate and phosphate and showed the consistent increase in the physiological and biochemical parameters within 3 weeks of its cultivation in plastic tubs containing Gomti water. *Trapa natans* can be used as an efficient filter of polluted river water

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