Research Article
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Studies of effects of various categories of pollutants on the rate of photosynthesis in *Hydrilla*

Abstract

Man has been the harbinger of development in all parts of the world. But anthropogenic activities have affected the environment in unfathomable ways. The use of different chemicals in our daily lives has shown some surprising and alarming results affecting the plants. In our experiment, we worked with different parameters and it was sought to find out whether they had any bearing on the rate of photosynthesis of an aquatic plant, Hydrilla, using a Wilmott's Bubbler and by counting the number of oxygen bubbles evolved. Five organic solvents viz., aniline, benzene, 1-butanol, benzaldehyde, and acetic anhydride were used for our study. While aniline, 1-butanol and benzaldehyde showed some rises in rate of photosynthesis by 20.51%, 21.42% and 9.8% respectively, benzene and acetic anhydride dropped the rate by30%and 27.5% respectively. Hydrilla was treated with samples of Indian brands of soaps and detergents viz., Tide, Dove, Clean and Clear face wash, Lifebuoy and Surf Excel bar. Dove shampoo plummeted the rate by 80.6%, followed by Lifebuoy at 80.0%. Clean and Clear face-wash, Surf Excel bar and Tide led to a drop by 62.9%, 55% and 48% respectively. Then, five industrial pollutants viz., strontium chloride, barium chloride, lead nitrate, chromium trioxide and mercurous sulphide were used to find out their effects on the rate of photosynthesis. Only barium chloride showed a rise by 48.8%. Strontium chloride showed a moderate drop by17.8%. Mercurous sulphide, lead nitrate and chromium trioxide dropped the rate of photosynthesis by 90.1%, 28.9% and 54.2% respectively. Lastly, five leading brands of automobile lubricants viz., Servo, 4T, Castro, Max and HP were taken for consideration. Servo showed a nominal increase in the rate of photosynthesis by 27.2%. Max had the highest impact by 458%. In between, 4T, Castrol and HP showed some rises by 70%, 80% and 275% respectively. Although a lot more work is needed to come to the final conclusion, it has become quite clear that the unchecked use of all the above chemical substances has created a serious imbalance in nature. Plants form the basis of nature and are the torch bearers of a clean environment. Neither a major increase, nor a decrease in the rate of photosynthesis is good because it creates havoc in the plant system. So there is an urgent need to implement the judicious use of these substances so that a minimal interference to the environment is allowed in course of our development planning and execution.

Keywords: detergents, lubricants, heavy metal, photosynthesis, solvents

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Introduction

All ecosystem stems on plants due to their capabilities to photosynthesise. As a complex process it has many natural variables. However the anthropogenic led changes have been reported by various scientists (Henry and Heinke, 2005).[1] Dohmen, Loppers and Langebartels, (1990) have reported the profound effects of mist and other pollutants on the health status of Norway spruce. In the industrial areas, on the whole the vegetation seems to be lagging behind in terms of health and productivity. Thus in the light of above, it was found worthwhile to work out the effects of various kinds of materials and chemicals on the rate of photosynthesis. The idea behind is that post industrial revolution and having observed a plethora of chemical discoveries, the use of many new formulations have started and intensified. The prevalent use and throw ethics in larger parts of the country has led the societies to turning a blind eye beyond use. In the name of health, hygiene and sanitation, the bulk use of soaps and detergents of different brands have a say in the market. It was sought to find out which one was the most deleterious and which one the least. Likewise, the populations use organic solvents for multiple uses. Similarly, heavy metals and automobile lubricants have also in much demands and use. In any case, the chemicals make it to confluence with water streams and finally to the water bodies.

Materials and methods

Several healthy *Hydrilla* plants were chosen for the experiment. Since *Hydrilla* remains submerged in water all parts remain in contact with the pollutants. The oxygen release is observable and the plant remains viable right through the year. A Wilmott's Bubbler (an instrument used to measure the rate of photosynthesis) was taken.

a. **The detergents brands used were:** TIDE, DOVE, CLEAN AND CLEAR FACE WASH, LIFEBUOY and SURF EXCEL BAR

b. **The automobile lubricants used were**: Servo, 4T, Castrol, Max and HP

c. **The heavy metal salts used were:** Strontium chloride, barium chloride, Lead nitrate, chromium trioxide and Mercurous sulphide.

d. The organic solvents used were: Aniline, Benzene, 1-butanol, Benzaldehyde and Acetic anhydride

The stem of the *Hydrilla* plant was fixed in the tube through the cork on the mouth of the Wilmott's Bubbler which was then filled with water. The whole experimental set-up was placed in sunlight. Firstly, the rate of photosynthesis in pure water was measured, wherein the number of oxygen bubbles evolved per minute were counted. Then, the parameters used for the experiment i.e., organic solvents, heavy metal compounds, automobile lubricants and detergents and soaps, were applied to the setup. Each chemical compound was added to the water in the Wilmott's Bubbler drop wise, one by one. The number of oxygen bubbles that evolved per minute in presence of impurities in water were noted. It was also noted how fast or how slow the bubbles evolved. The evolution of oxygen bubbles in one minute gave us the rate of photosynthesis in the presence of impurities in water. The water was changed after every experiment. Also, a new *Hydrilla* plant was used for every experiment.[2]

The readings were taken in triplicate and the averages were taken for consideration (Table 1). We found interesting results in the end. While aniline, 1-Butanol and Benzaldehyde showed some rises in the rate, Benzene and Acetic anhydride showed significant drop in the same. Aniline showed a rise of 20.51%, 1-Butanol showed 21.42 and Benzaldehyde a nominal rise of 9.8%. On the other hand, Benzene showed a drop by 30% and Acetic anhydride by 27.5% (Table 2). The results were interesting, as Dove shampoo which is regarded as mild emerged as the most devastating, plummeting the rate by 80.6% closely followed by Lifebuoy at 80.0%. Clean and clear face-wash led to a drop by 62.9%, Surf Excel bar, 55% and the least bothering was the Tide detergent leading to a drop by 48% (Table 3). Using the basic lab techniques of Wilmott's Bubbler and hydrilla plant, some scintillating effects were observed. Only Barium chloride showed a rise in the rate of photosynthesis by 48.8% but the others showed a good beating.

While Strontium chloride showed a moderate drop in the rate by 17.8%, Mercurous sulphide showed a devastating drop in the rate by 90.1%. In between Lead nitrate at 28.9% and Chromium trioxide at 54.2% showed significant drops. Our work is in agreement to the work of Arnon[3] that reflected a marked change in the photosynthetic rate in beet roots under the influence of copper salts (Table 4). The results were startling. Contrary to our expectations, the initial rate of photosynthesis got a rise in all the lubricants. While Servo showed a nominal influence, lifting the rate of photosynthesis by 27.2%, Max brand got the highest impact, pegged at 458%. In between, 4T, Castrol and HP showed some rises at 70%, 80% and 275%.

Table 1 Effect of organic solvents on the primary rate of photosynthesis

S.no	name of organic solvent	Initial number of oxygen bubbles evolved per minute(in pure water)	Final number of oxygen bubbles evolved per minute(after adding the solvent)	Inference(change in rate of photosynthesis)
1	Aniline	40	48	Increase by 20.51%
2	Benzaldehyde	47	52	Increase by 9.8%
3	1-butanol	56	68	Increase by 21.42%
4	Benzene	48	34	Decrease by 30%
5	Acetic anhydride	50	36	Decrease by 27.5%

Table 2 Effect of detergents on the primary rate of photosynthesis

S.no	name of detergent	Initial number of oxygen bubbles evolved per minute(in pure water)	Final number of oxygen bubbles evolved per minute(after adding detergent)	Inference (change in rate of photosynthesis)
1	Tide	23	12	Decrease by 48%
2	Dove	67	13	Decrease by 80.6%
3	Clean and Clear	62	23	Decrease by 62.9%
4	Lifebuoy	10	2	Increase by 80%
5	Surf Excel	69	31	Decrease by 55%

Table 3 Effect of heavy metal pollutants on the primary rate of photosynthesis

S.no	name of heavy metal compounds	Initial number of oxygen bubbles evolved per minute(in pure water)	Final number of oxygen bubbles evolved per minute(after adding metal compounds)	Inference(change in rate of photosynthesis)
1	Strontium chloride	101	83	Decrease by 17.8%
2	Barium chloride	97	144	Increase by 48.8%
3	Lead nitrate	105	75	Decrease by 28.9%
4	Chromium trioxide	135	61	Decrease by 54.2%
5	Mercurous sulphide	94	9	Decrease by 90.1%

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Table 4 Effect of automobile lubricants on the primary rate of photosynthesis

S.no	name of lubricants	Initial number of oxygen bubbles evolved per minute(in pure water)	Final number of oxygen bubbles evolved per minute(after adding lubricants)	Inference(change in rate of photosynthesis)
1	Servo	81	103	Increase by 27.2%
2	4T	80	136	Increase by 70%
3	Castrol	79	142	Increase by 80%
4	Max	75	418	Increase by 458%
5	HP	74	277	Increase by 275%

Conclusion

Although a lot more work is needed to come to a final conclusion, this work certainly throws light on the fact that the environment is hung on a delicate balance and that a minimal interference should be allowed in course of our developmental planning and execution. While the legislation part should be handled with utmost care when a new product is introduced, common man must at least embark on austerity in the uses of such products.

Precautions

The set up were made air tight and the *Hydrilla* twigs were kept in both, control and treated bottles in identical fashions without changing their number or orientation. The readings were taken after half an hour of the treatment to allow stabilization of the set up.

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Conflicts of interest

The authors declared there are no conflicts of interest.

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