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Phytoremediation of the Endocrine Disruptor Bisphenol A using *Pistia stratiotes.*

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ABSTRACT

In the present study we evaluated the ability of *Pistia stratiotes* to remediate Bisphenol A (BPA) from water samples. The plants were grown in beakers containing 500 ml of water into which different known concentrations of BPA was added. The initial and latter concentration of BPA was analyzed by measuring the optical density (OD) using a UV spectrophotometer. The OD was measured for a period of three days and it was noticed that there was a gradual decrease in the OD of the water sample on each day. The morphological changes of the plant such as chlorosis and shriveling of the leaves over a period of three days was also observed. These experimental findings proved that the plant has the ability to phytoremediate BPA from water.

Keywords: Bisphenol A, Phytoremediation, Endocrine disruptor, *Pistia stratiotes*

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INTRODUCTION

The world today is on a fast moving lane, industrialization and commercialization and demand for more luxurious development has led to the increased use of natural resources and chemical compounds. Plastics are one such chemical component which has been stabilized on planet earth due to their tremendous usage in the field of packaging and manufacture of household and industrial goods. Bisphenol A is one of the important chemical components used in the manufacturing of plastic materials. Bisphenol A (BPA) commonly referred to as 2, 2- (4, 4-dihydroxydiphenol) propane, it is commonly used in the production of polycarbonate plastics and epoxy resins. The use of plastics and resins is increasing day by day for large scale production of PET bottles, plastic hand covers, and automated bill receipts, carbonless papers, in dental sealants and also in the field of food and beverage industries. Globally more than 5 metric tons of BPA is used by the plastic and food beverage industries. Plastics find their applications in every field but the degradation of plastic materials takes a very long time. BPA can migrate from the coating of the cans into the food especially at elevated temperature and favorable alkaline conditions. BPA in high levels in the body increases the risk of coronary heart diseases. Due to its capability of mimicking oestrogen it influences the uterus and the prostate organs which then start gaining weight (Krishnan 1993). The BPA released from the dental sealant formulations is either unabsorbed by the system or is found in negligible quantity in the systemic circulation (Fung 2000). It posses complex Immuno modulating effect which leads to neuro pshychiatric disorders by disrupting the dopaminergic system. BPA induces endocrine manifestation, malformation in growth, chromosomal damage, and biochemical changes. BPA influences biochemical pathways related to obesity (Takeuchi et al 2004). BPA acts as an Obesogen **(**Blumberg). Warming plastic in microwave increases the leaching of BPA into liquids when this food is consumed the BPA acts as endocrine disruptor, polycarbonated plastic vessels enhance the leaching of BPA and also repeated washing which can mimic estrogen and has been shown to cause ill health affects in the biological entity hence BPA is also called as environmental estrogen (Frederick 2005). BPA causes alterations in brain sexual differentiations (Rubin 2006) and causes defects in the male and female reproductive tracts in adult stages (Richter 2007). Endocrine disruptors are a class of man-made chemicals that act as both agonist and antagonist to estrogen, androgen and thyroid hormone receptors (Vandenberg 2008; Patricia 2009). Exposures during prenatal and neonatal development have been linked to a wide variety of effects like asthma, diminished lung functions and increased chances of wheezing as young children (Adam 2014). These studies indicate that BPA is carcinogenic and when released into the environment leads to serious ill effects, thereby BPA must be remediated from the environment and phytoremediation would be the best possible solution on a large scale.

MATERIALS AND METHODS

Collection of plant material

Young healthy plants approximately of the same size were collected from the ponds of FRLHT (Foundation for Revitalization of Local Health Tradition), the plants were brought to the laboratory and grown in plastic trays of width 15*15*5cms (Length*Breadth*Depth).

Sampling method

Water was collected in 500ml beakers, different known concentrations of Bisphenol A was prepared ranging from 0.002 gram to 0.01gram and added into the beakers, a control setup was maintained without addition of BPA. The initial concentration of BPA was analyzed by measuring the optical density (OD) using a UV spectrophotometer at a wavelength of 285nm, one plant was transferred to each beaker, the color of the leaf and the number of leaves in each plant was recorded to visualize the morphological changes, the setup was kept at suitable conditions with good light and aeration, the OD of the water samples were analyzed after every 24 hours over a span of three days to monitor BPA concentration and also the morphological changes were recorded.

RESULT AND DISCUSSION

The plant *Pistia stratiotes* was made to grow in beakers which had different known concentrations of BPA, UV spectrophotometer was used to analyze the concentration of BPA. The initial concentration was analyzed by measuring the OD at a wavelength of 285nm, optimum conditions like aeration and light was

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maintained. The plant was allowed to grow in the water sample; the remediation of BPA brought about by the plant was analyzed by measuring the OD. Ying and Kookana who detected greater than 90% BPA degradation both in seawater and in marine sediment referred to differences such as a more active and diverse microbial community, as well as a richer nutrient environment in the sediment samples that might explain the lack of an acclimation period in the marine sediment. In the seawater, a lag period of 35 days had been observed. Kang and Kondo hypothesized that BPA was degraded chemically by reactive oxygen species present in seawater and that bacteria and flagellates might have an important effect on the degradation process.

Table: Indicating the concentration of BPA in milligram and the Optical Density measured at 285 nm over a span of three days.

Sl no.	Concentration of Bisphenol A in g	Initial Optical Density at 285 nm	Day 1 Optical Density at 285 nm	Day2 Optical Density at 285 nm	Day 3 Optical Density at 285 nm
1	0.002	0.149	0.0136	0.0130	0.010
2	0.004	0.251	0.04	0.039	0.039
3	0.006	0.414	0.04	0.037	0.036
4	0.008	0.650	0.024	0.023	0.020
5	0.01	0.483	0.07	0.06	0.06

A frequency polygon representing the initial and the latter concentration of BPA was plotted using the Optical Density recorded over a span of three days. The data for the same is as follows.

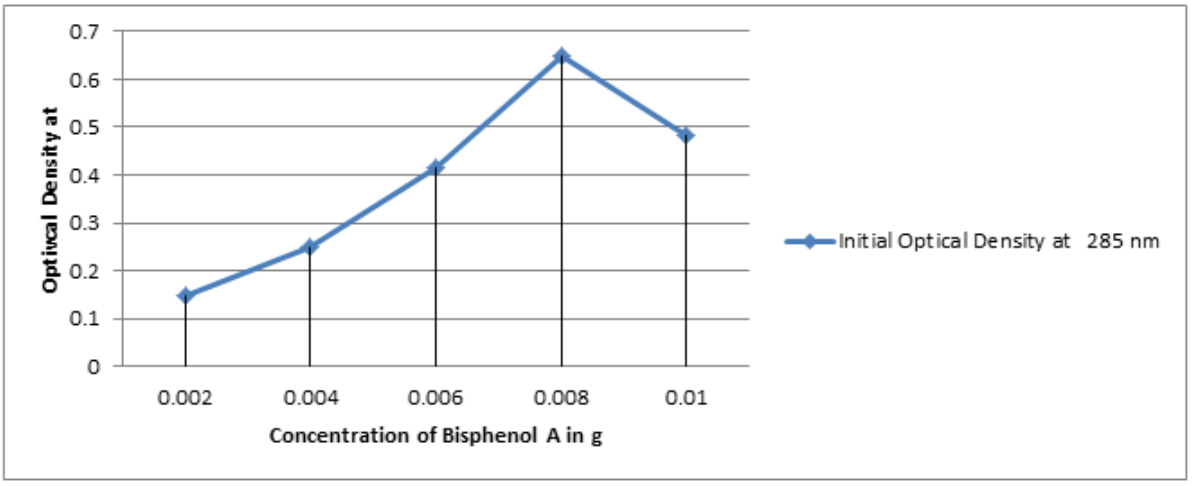

Figure 1: Optical Density values representing the initial concentration of BPA

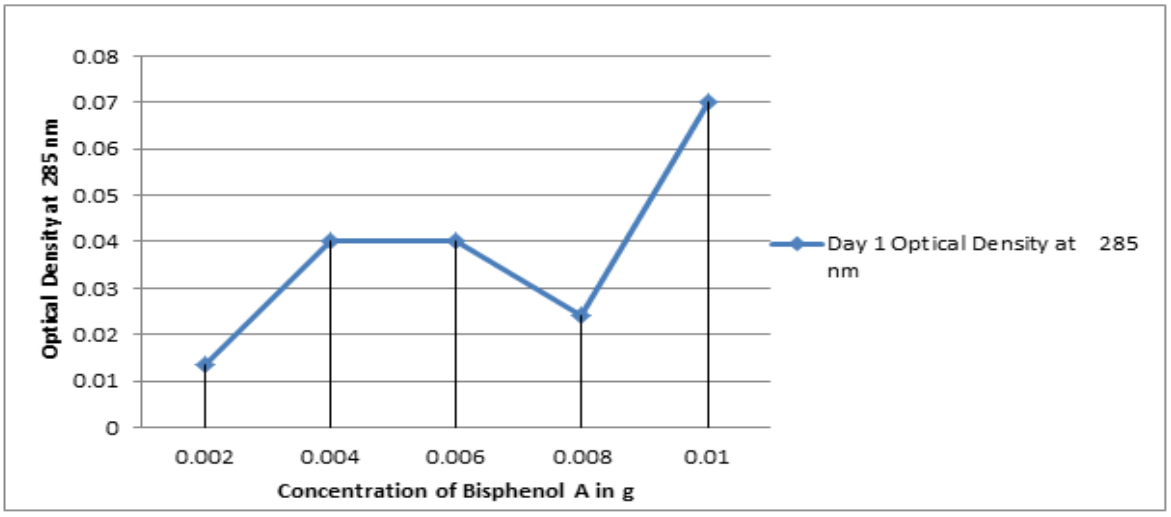

Figure 2: Optical Density values representing the day 1 concentration of BPA

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Optical density values measured at 285 nm showed a drastic decrease on day 1 when compared to the initial concentration of BPA. The OD values changed from 0.149 to 0.0136 for a concentration of 0.002mg, likewise a decrease was observed with respect to the other concentrations too.

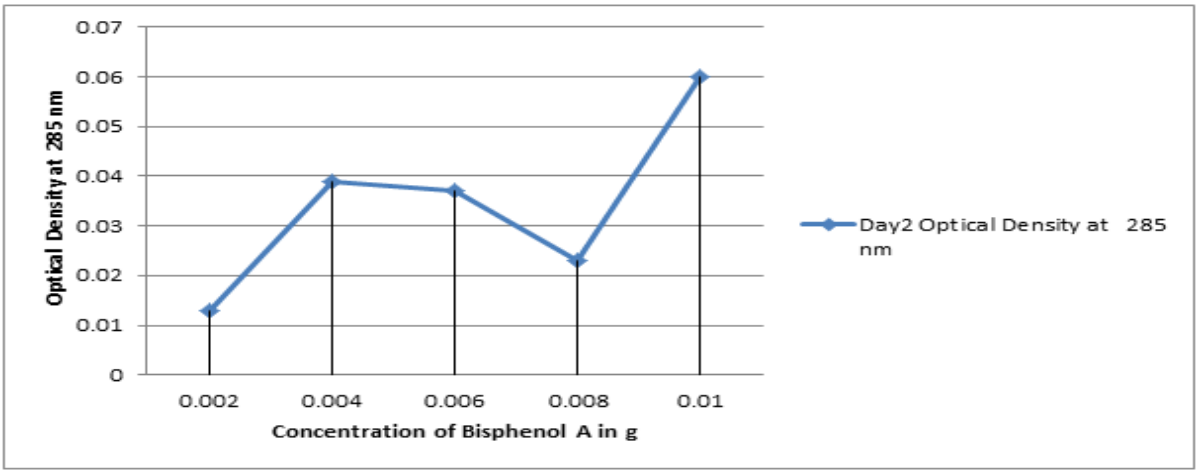

Figure 3: Optical Density values representing the day 2 concentration of BPA

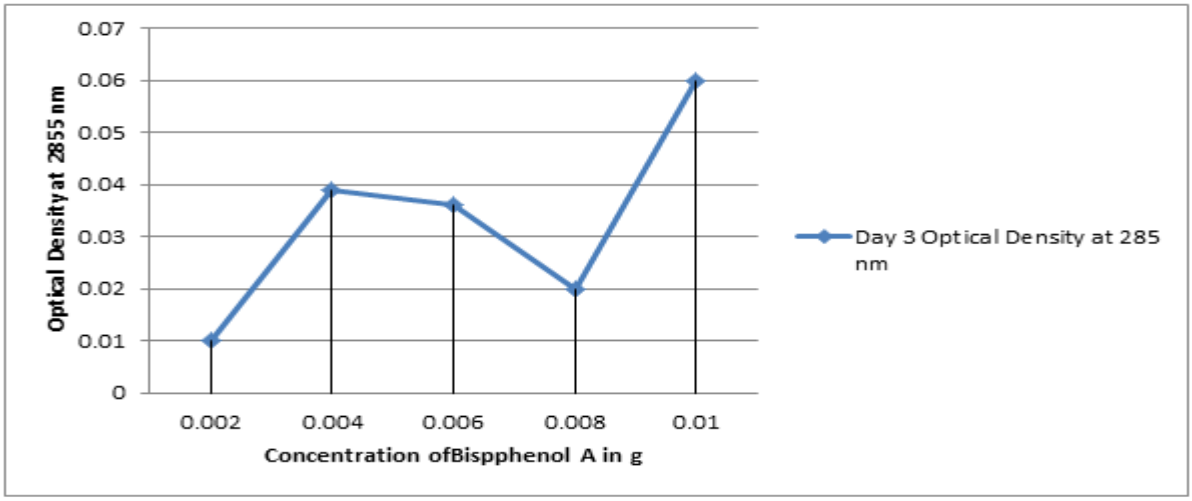

Figure 4: Optical Density values representing the day 3 concentration of BPA

The plant showed many morphological changes such as shriveling of the leaves and chlorosis, the photograph for the same is shown below

CONCLUSION

Pistia stratiotes is an aquatic ornamental plant belonging to the genus *Aracaceae*; it is commonly called the water lettuce or the water cabbage. It has long roots which hang beneath the floating leaves; these plants are commonly found in lakes and other water bodies. This characteristic feature of the plant makes it one of the common plants which can be used for phytoremediation studies.

It was observed through our experimental procedures that *Pistia stratiotes* was found to uptake BPA, this was confirmed through visualizing the morphological changes of the plant such as shriveling of the leaves, discoloration of leaves leading to chlorosis etc and also through the changes between the initial and latter OD

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values of the water sample which was measured at 285nm using a UV spectrophotometer. It was observed that there was a gradual decrease in the OD values on each day when compared with the initial OD values concluding that *Pistia stratiotes* is a moderate plant to remediate Bisphenol A from natural water bodies.

Based on our study we conclude that *Pistia stratiotes* can be used for phytoremediation technology, conservation and maintenance of these plants also becomes very important.

a) ***Pistia stratiotes*** **grown in beaker**

b) **The plant showing symptoms of shriveling, chlorosis and shrinkage**

c) ***Pistia stratiotes*** **grown in a beaker of 0.01g concentration**

d) **The plant *Pistia stratiotes* showing chlorosis, shriveling and shrinkage**

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