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PLANTS AS BIOFILTER

Privya M.*[1] and Varuna P. Panicker[2]

[1]MSc. Biochemistry and Molecular Biology Student, College of Veterinary and Animal Sciences, Mannuthy, Thrissur.

[2]Assistant Professor, Department of Veterinary Biochemistry, College of Veterinary and Animal Sciences, Mannuthy, Thrissur.

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***Corresponding Author**
Privya M.
MSc. Biochemistry and Molecular Biology Student., College of Veterinary and Animal Sciences, Mannuthy., Thrissur.

ABSTRACT

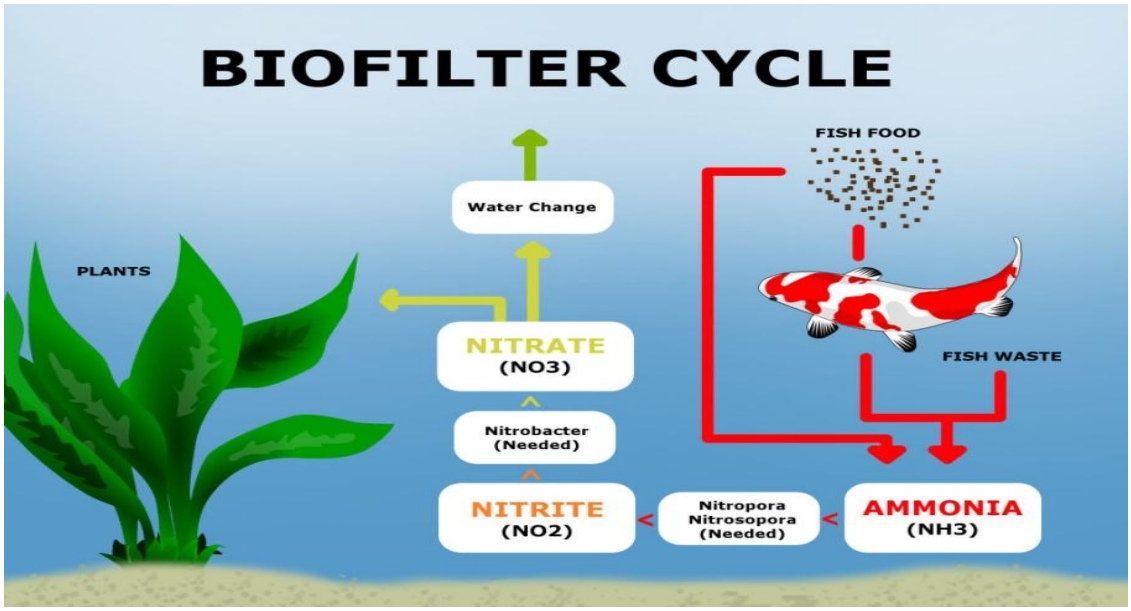
Plants are best to filter the pollution from environment, and they are also eco-friendly. Plants root, bark, seed, leaves are the main components to act as a coagulant, which have the capacity to purify the water to a great extent and it can also have anti-bacterial and anti-fungal properties. They can absorb heavy metals and toxic substances in the waste water. When there is a good impact, absolutely there is also a bad impact – here also there are some disadvantages are there. Then also we can prefer this method that is it's a natural method and the scarcity of water is increased.

KEYWORDS: Plants, Biofilter, Heavy Metals, Plant Roots.

1. INTRODUCTION

Biofilter, which is used to control the pollution from the environment by the help of a bioreactor and the bioreactor which included living materials, which can hook and reduce the pollutants. Although in water treatment the naturally occurring microorganisms helps to improve the water quality. Plants acts as a good biofilter and they have the capacity to absorb heavy metals and other toxic substances from the water and they also helps to purify the waste water. The water quality is reduced day by day by the action of humans (cutting of trees, dumping of toxic waste material from factories etc.) and also the level of pure drinking water is decreased although that is negatively affect to living organisms. Plants roots, leafs and the whole plant is the main part to absorb the toxic substances. And reduce a large extent of impurities in the waste water using plants.

Plants as Biofilter



Plants play a great role in removing impurities and toxic substances in the water and in the biofilter cycle, the ammonia which is a toxic substance and the toxic substance is absored by the plants and the naturally occurring bacteria which helps to reduce the toxicity. That is the fish is excreted ammonia from the gills and the ammonia is dissolved in the water then the water become toxic, although ammonia which also came from fish waste and fish food. Then the ammonia is converted to nitrite (NO2) by the presence of naturally occurring bacteria (nitropora and nitrosopora) and this nitrite is also toxic to the organisms then the nitrite is converted to nitrate (NO3), which is less toxic to the environment by the presence of nitrobacter, which is also a naturally occurring bacteria. Now the nitrate can be absorbed by the plant, also it is less toxic and a good fertilizer to the plants.

i. **Water Hyacinth (** ***Eichhornia crassipes)***

Figure 1: Water Hyacinth.[1]

It acts as a natural bio-filter and example for hydrophytes. The roots of hydrophytes has adapted so that it can grow and survive in anaerobic conditions for a very long period and it also classified as floating plant. It reproduces uncontrollably and very quickly as a result it kill the fresh water organisms and also it decrease the dissolved oxygen.[2]

It also reduces the turbidity of water by sediment in lakes. Roots of heavier and taller plants have more capable of binding capacity towards the sediment and reduce the population of hyacinth otherwise it may fluctuate the ecosystem. On the high production of hyacinth, proper sunlight cannot reach to the bottom of the water, that is there are so many photosynthetic organisms are in the water and they didn't get enough sunlight so, the dissolved oxygen level is decrease and it harmful to the organisms living in the water.[2]

Table-1: Advantages and Disadvantages of Water Hyacinth.[2]

Advantages	Disadvantages
• Reduce the turbidity of water by sediment	• Reproduce very quickly and uncontrolled and
• Act as natural biofilter	• It fluctuates the ecosystem
	• Proper sunlight cannot reach to bottom of lake

ii. **Moringa seed (*Moringa oleifera)***

Figure 2: Moringa seed powder.[3]

It acts as a coagulant and an anti-microbial agent. The seeds are highly efficient in remove the suspended particles from water.[4] It has the capacity to kill bacteria and clean the water, by a positively charged protein which is present in this seed called moringa oleifera cationic protein (MOCP). Just crush the seeds and add to the water, which is polluted and the protein

which present in the seed can kill bit more of microbial organisms, they clump together with the protein and they settle down. As a drawback for this treatment is that the dried seed powder is not perfect or ideal for the purification of water because the organic matter on the seed will act as a food for the pathogens, bacteria that not killed by the treatment and so the purified is not kept for long time.[5]

As earlier said that the protein which act as food for the bacteria and they add the biological oxygen demand then also the pathogen is used them as food. The bacteria which are also present in air also fall into the water and they also growing in the water so, we have to keep this water atleast for a day.[5] This treatment can remove up to 90-99% of the impurities in the water. The active components in the seed which helps for the purification is lower on the rainy season so, we must avoid this treatment on winter season and also done this on dry seasons. And there are so many types of moringa is found in our environment and the most effective seed is from the *Moringa stenopetala* than the *Moringa oleifera.* About two moringa trees give proper seeds for the treatment for a family of about four to five members.[4]

Table-2: Advantages and Disadvantages of moringa seed.

Advantages	Disadvantages
• Highly effective in removing suspended particles from water with medium to high levels of turbidity.[4]	• Dissolved oxygen matter which left over in the water contributes to growth of pathogen .[5]
• Ability to kill bacteria and clarify water.[5]	

iii. Neem *(Azadirachta indica)*

Figure 3: Leaves of Neem.[6]

It is a medicinal tree of mahogany family.[6] Quercetin, ß-sitosterol and flavonoids, which is present in the leaf, were help to purify the water and they gave the anti-bacterial and anti-fungal properties. Nimbidin, nimbidol and nimbin which inhibits the fungal growth. It has strong anti- pathogens or bacteria a little bit are also kept in the water after treatment and it harm to our health. The whole plant is a medicinal tree and it is rich in antioxidant.

It has also an anti-feedant property and that is it can kill the bacteria, virus, fungus etc. Plants fruits, seeds, oil, leaves, bark, and roots show an important role in diseases prevention due to the rich source of antioxidant and also prevent the growth of the coliform bacteria. The neem leaf extract have a strong green colour which is extent the presence of chlorophyll, it also reduces the coliform results impossible to interpret.[7][8]

Table 3: Advantages and Disadvantages of Neem.

Advantages	Disadvantages
• Neem has anti-feedant and growth disrupting effects on insects	• Neem leaves can make the water slight bitter to taste due of the presence of triterpens (limonoids)
• Can kill bacteria, viruses, fungal infections, coliform	

iv. **Tulsi (*Ocimum tenuiflorum)***

Figure 4: Leaves of Tulsi Leaves.[10]

It is also known as “Queen of herbs” and “Mother medicine of nature”.[11] It is a sacred plant and also used for highly effective in respiratory diseases. It has strong anti-bacterial, anti-fungal and anti-viral property and the water after treatment by tulsi has a slight sweet taste. Put some tulsi leaves in the contaminated water and kept it in the sun for six hours, that is the ultraviolet radiation from the sun can kill the pathogens in water and the tulsi can also have

the capacity to remove the fluoride from the water. The water after treatment is also used for medication.[9] Biologically active compounds such as ursolic acid, apigenin and luteolin have been isolated from the leaves. Phytochemical compounds which present in leaf include eugenol, ursolic acid (triterpenoid) and rosmarinic acid (phenylpropanoid).[12]

Table 4: Advantages and Disadvantages of Tulsi Leaves.

Advantages[13]	Disadvantages[14]
• Remove fluoride levels in drinking water	Excess consumption of this water leads to: • Eugenol overdose • Blood thinning • Hypoglycemia • Might impact infertility

v. Rice Husk

Figure 5: Rice husk.[15]

Rice husk are the hard protecting covering of grains of rice and about 20% of the paddy weight is husk. Chemical composition of rice husk is similar to that of many common organic fibers and it contains of cellulose about 40-50%, lignin of 25-30%, ash of 15-20% and moisture about 8-15% and the cellulose which helps to clearing the water and it also have adsorbent property. It is a good material for water purification and also after the burning of rice husk only the silicates are left and the cellulose is removed after the burning so, it cannot use as a biofilter.[16]

Table-5: Advantages and Disadvantages of Rice husk.[16]

Advantages	Disadvantages
• Low value agricultural by rice husk can be made purification of water	• After burning most evaporable components are slowly lost and the silicates are left
	• After burning the cellulose also removed

vi. Sugarcane Bagasse (*saccharum officinurum)*

Figure 6: Sugarcane Bagasse.[17]

Sugarcane Bagasse is the sugarcane fiber waste which left after the juice extraction of the sugarcane. It contains mainly cellulose, hemi-cellulose, pentosans, lignin, which gives the adsorbent property to the bagasse. Sugarcane bagasse, which is an agricultural form from the industrial sugar process by the extraction process. And also utilized in the sugar factories which is used as fuel for certain biofilters. It is a low-cost, eco-friendly and has good adsorbent property. Although it has the capability to take off the malachite which is present in the water.[11]

Table-6: Advantages and Disadvantages of Sugarcane bagasse.[11]

Advantages	Disadvantages
• Used as an good adsorbent	• Biologically degrades in soil in 180 days

vii. Vetiver *(Chrysopogon zizanioides)*

Figure 7: Vetiver.[18]

The Vetiver system was first development by the World Bank for Soil and Water Conservation in India in the 1980's and it has the ability to absorb phosphate, heavy metals and cholera and dysentery causing bacteria (E coli) and use as a flavouring agent because they emit a sweet fragrance and it has a very low cost biofilter and very large and deep penetrating root system that can grow to about 4 meter.[19] Reduce pollutants and act as a primary purifier for sewage effluent under hydroponic condition, also contains monoterpinoids (terpinen-4-ol) has anti-bacterial and anti-fungal property. Although reduces the chemical oxygen demand and prevent the erosion.[20] Although it act as phytoremedial solution and vetiver is highly effective on reducing the toxins and the absorption of manganese is very low and it is very effective in removal of heavy metals by their roots.[19]

Table 7: Advantages and Disadvantages of vetiver.

Advantages[19]	Disadvantages[21]
• The tensile strength of vetiver grass is about one eighth of mild steel	• It is likely unsafe to take vetiver if you are pregnant. It might cause a miscarriage
• Roots and leaves from a strong barrier that reduces flow velocity and causes deposition of heavier particles	• Also best to avoid vetiver if you are breast feeding

viii. Mangrove *(Rhizophora mangle)*

Figure 8: Mangrove.[22]

It acts as a biofilter for removal of solids and transformation of nutrients for a low cost and significant decrease in dissolved oxygen and pH was observed in the biofilter. Tannic acid produced by mangrove trees and liberated into water through leaf fall could also have been inhibiting phytoplankton growth. Retinoid were found in the roots and bark is a valuable source of tannin, although involve in the suspended solids and nutrient removal by sedimentation and also it absorb the nutrients and uptake ions also. Several factors can be involved in decrease in pH and dissolved oxygen in the biofilter. There is a reduction in the zooplankton density in biofilter and it leads to the less availability of phytoplankton and lesser dissolved oxygen level.[23]

Table 8: Advantages and Disadvantages of mangrove.[23]

Advantages	**Disadvantages**
• Very efficient in reducing the concentration of suspended solids	• No reports
• Keep coastal fish populations stable	
• Slow the flow of water, easing erosion	

ix. Nagachamba *(Mesua ferrea)*

Figure 9: Nagachamba.[24]

It is a herbal medicine and the stem, bark based on its physicochemical and preliminary phyto chemical properties to lay down the pharmacopoeial standards. Bioflavonone called Mesuaferrone A, xanthone and Decussain which gives the anti-fungal and anti-bacterial activity. It is contrast to snake (scorpion) venom, thus it has anti-venom property. Although it has powerful anti-fungal, anti-inflammatory and anti-bacterial properties.[25]

Table 9: Advantages and Disadvantages of Nagachamba.[25]

Advantages	Disadvantages
• Useful for gastritis, nausea, fever, skin disorder	• No reports
• Anti-venom, anti-ulcer and anti-tumour properties	

x. Floating Plants

Figure 10: water lily.[26]

Water lilies (*Nymphaea*) and water poppies (*Hydrocleys nymphoides*) which help to purify the water by absorb the nutrients. Tannic acid, starch and gallic acid were the main component in purification and it also give for adsorbent property. Tropical water lilies grow in 9 to 16 inches of water while hardy water lilies grow in 1 to 4 feet of water. Water poppies grow in 6 to 10 inches of water.[27]

Table 10: Advantages and Disadvantages of Water Lily.

Advantages.[28]	Disadvantages.[29]
• Cures Blood Cough	• When water lilies grow too thickly over the water's surface, they interfere with oxygen exchange
• Prevents Diarrhoea and Nausea	
• Normalizes Blood Pressure	
• As a Stress Relief	

xi. Duckweed (Lemnoideae)

Figure 11: Duckweed.[30]

It is an incredible biofilter, which is highly effective in removing heavy metals. It needs nitrogen and phosphorus for its growth and it given by water. That is, the nitrogen which is converted to ammonia and then the roots can absorb it, phosphorus in water which is in the phosphate form which the plants can absorb directly from the water. It also plays a great role in removing suspended particles in the water very effectively. Although by absorbing the nutrients they get longer roots. It is sensitive to sunlight and temperature. The life period is less due to the high toxic concentration of ammonia in the water and also it takes some time to grow properly. Once it grows it spread all over the pond like water lily. Although in addition they absorb chemical compounds and also lock up the harmful substances such as cadmium, zinc, lead.[31][32]

Table 11: Advantages and Disadvantages of Duckweed.[31][32]

Advantages	Disadvantages
• Highly effective biofilter	• It takes over the algae's role
• Mainly absorb nitrogen, phosphorus and heavy metals	• Locks the sunlight
	• Sensitive to temperature and sunlight

CONCLUSION

Plant-based, biological filters can effectively remove pollutants from household wastewater, polluted water etc. Plants acts as a good biofilters and played a great role in removing phosphates, nitrates, ammonia and heavy metals and have the capacity to kill the pathogens which present in the waste water. Many substances harmful to people and animals are conducive to plant growth. Plants can remove 99% of impurities from the waste water. Plants

cannot reduce 100% impurities from the waste water. Although the sediments from soil, animal waste and grey water are an excellent plant nutrients and plants can absorb it at very extent level.

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