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Research

Bio-Remediation: Water Purification Through Herbs And Microbes

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Abstract

Water is vital for all living organisms, comprising approximately 60% of the human body. Water quality is influenced by physical, chemical, biological, and aesthetic factors, with pollution arising from both point and non-point sources, leading to the presence of harmful contaminants. This qualitative review examines the role of various plants and microbial sources in the purification of contaminated water, focusing on their ability to remove heavy metals and pollutants. This integration of natural methods presents a promising approach to improving water quality in both rural and urban areas, contributing to better health outcomes and environmental sustainability. About twenty-five plants are used for the removal of contaminants, five plants for clearance of turbidity, twenty four microbial species for removal of heavy metals.

Keywords: Water pollution, microbes, heavy metal removal, contaminants removal

INTRODUCTION

Water indeed is the elixir of life, essential for survival and growth of all living organisms Approximately 60% of the human body is composed of water, with variations depending on age, sex, and body composition.Water plays a crucial role in maintaining bodily functions such as regulating body temperature, facilitating digestion, and transporting nutrients and oxygen to cells.Some sources of drinking water are rivers, lakes, storage dams, wells and bore wells, other sources include rainwater harvesting, groundwater, and desalination. In rural areas, most people rely on private water supplies such as wells and dugouts.[1]

METHODOLOGY

This qualitative review systemically explores the use of various plants in removal of contaminants and heavy metals from water purification.Non experimental literature survey was conducted from 1/9/2024 to 30/9/2024 using online data bases to compile data on herbal and microbial contributions to water treatment. An systemic approach was employed to integrate the diveristy of herbs and microbes in water purification.This qualtitative review aims to provide rich and nuanced understanding of mulitfaceted roles of herbs in removal of water contaminants.

Water Pollution

Water quality is commonly defined by its physical, chemical, biological characteristics.[2]

Physical characteristics	Chemical characteristics	Biological characteristics
Temperature	Colour	Protista (enterococci, Fungi, Algae, BGA)
Turbidity	Turbidity	Plants (Ferns, mosses)
	Salinity	Animals(worms, rotifers)
	Suspended solids	
	Biological oxygen demand	
	Dissolved oxygen	
	Nitrogen	
	Phosphorus	
	Silicon/toxic/persistent organic compounds	

Water quality can be impacted by various sources of pollution, categorized into point and non-point sources, affecting both rural and urban areas.

- ✓ Pollution originating from a single, identifiable source, such as a discharge pipe from a factory or sewage plant, is called point-source pollution.
- ✓ Pollution that does not originate from a single source, or point, is called nonpoint-source pollution[3].

Point Sources

- Sewage discharge: Untreated or partially treated wastewater from households, industries, and institutions.
- Industrial discharge: Chemicals, heavy metals, and other pollutants from factories, power plants, and mining operations.

Non-Point Sources

- Agricultural run-off: Fertilizers, pesticides, and manure from farms.
- Urban run-off: Stormwater carrying pollutants from streets, construction sites, and landscaping[4].

Water can also contain substances like heavy metals such as mercury, lead, cadmium, zinc, copper, cobalt, nickel, chromium, manganese etc.

The types of impurities present in water are

- ➢ Dissolved impurities include inorganic salts (Ca, Mg, Cl, NO3, SO4)
- ➢ Organic matter (Humic and Fulvic acids, Pesticides, Detergents etc.)
- ➢ Suspended impurities include Colloidal (Clay, Pests, Acids)
- ➢ Inorganic (Sand Particles), Organic (Industrial, Domestic)
- ➢ Micro-organisms (Bacteria, Algae, Virus)
- ➢ Macro-organisms (Fish, Shrimps, Worms, Larvae) [5].

Purification of water

In rural and undeveloped countries, people living in extreme poverty are presently drinking highly turbid and microbiologically contaminated water, because they lack knowledge of proper drinking water treatment and they cannot afford costly chemical coagulants. Hence, as a result of this and to overcome chemical coagulant problems, there is a need to develop alternative, cost effective and also environmental friendly coagulants.

Currently, treatment of wastewater is done by,

- ➢ Microbial degradation
- ➢ Chemical oxidation
- ➢ Photolysis
- ➢ Adsorption .
- ➢ Chlorination
- ➢ Boiling

- Microfiltration

Treatment of hardwater includes,

- Reverse osmosis
- Ion exchange resin
- Physical treatment such as UV irradiation and chlorine treatment will remove the biological contaminants in it.

Natural plant extracts have been used for water purification for many centuries and Egyptians inscription afforded the earliest recorded knowledge of plant materials used for water treatment, dating back perhaps to 2000BC in addition to boiling and filtration[2].Some plants used for water purification and turbidity clearance are enlisted in table 1 and 2 respectively.

Accumulation of heavy metals can be done by using microbes. Instead of the term accumulation, it is referred as biosorption which includes metal ion binding on extracellular as well as intracellular ligands. The microbes used for heavy metal removal are enumerated in table 3[6][7].

Table 1: Plants used for water purification

S.no.	Common name	Biological source	Family	Part used	Reference
1.	Drum stick	*Moringa oleifera*	Moringaceae	Seed	8
2.	Mung bean	*Phaseolus vulgaris*	Fabaceae	Seed	9
3.	Prickly pear	*Opuntis ficus indica*	Cactaceae	Leaves	10
4.	Hyacinth bean	*Dolichos Lablab*	Fabaceae	Fruit	11
5.	Candle plant,bush	*Senna alata*	Fabaceae	Leaves	12
6.	Sweet chestnut	*Castanea sativa*	Fagaceae	Seeds	2
7.	Horse chestnut	*Aesculus hippocastanum*	Sapindaceae	Seeds	13
8.	English oak	*Quercus robur*	Fagaceae	Seeds	
9.	Clearing nut tree	*Strychnous potatorum*	Logoniaceae	Seeds	
10.	Physic nut	*Jatropa curcas*	Euphorbiaceae	Seeds	
11.	Lemon	*Citrus aurantifolia*	Rutaceae	Fruit	
12.	Fenugreek	*Trigonella faenum graecum*	Fabaceae	Seed	
13.	Bitter kola	*Garcinia kola*	Guttiferae	Seeds	
14.	Turkey oak	*Quercus cerris*	Fagaceae	Seeds	14
15.	Neem	*Azardirachta indica*	Meliaceae	Fruit	
16.	Sponge gourd	*Luffa cylinderca*	Cucurbitaceae	Fruit	
17.	Papaya	*Carica papaya*	Caricaceae	Seeds	
18.	Hibiscus	*Hibiscus sabdarifa*	Malvaceae	Calyx	
19.	Date palm	*Phoenix dactylifera*	Areaceae	Seeds	15
20.	Aloevera	*Aloe barbadensis*	Alloaceae	Seed	16
21.	Clay pea	*Vigna unguiculata*	Fabaceae	Seed	17
22.	Chickpea	*Cicer arietinum*	Fabaceae	Seeds	
23.	Mango	*Magnifera Indica*	Anacardaceae	Fruit	18
24.	Ivy gourd	*Coccinia indica*	Cucurbitaceae	Fruit	19
25.	Horse bean	*Parkinsonia aculeata*	Fabaceae	seed	20

Table 2: Plants used to reduce turbidity

S.no	Common name	Biological name	Family name
1.	*Field bean*	Vicia faba	Fabaceae
2.	*Bambarantus*	Voandzeia subterranean	Fabaceae
3.	*Green gram*	Vigna unguiculata	Fabaceae
4.	*Groundnuts*	Arachis hypogaea	Fabaceae
5.	*Jerrybean tree*	Parkinsonia aculeate	Fabaceae

Table 3: Removal of heavy metals using microbes

S.no	Species name	Family	Heavy metal removed	Reference
1	*Anabaena subcylindrica*	Nostocaceae	Cu,Co,Pb,Mn	21
2	*Nostoc muscorum*	Nostocaceae	Cu,Co,Pb,Mn	
3	*Chlorella vulgaris*	Chlorellaceae	Cu,Ni,Cd	22(a,b)

4	*De-alginated seaweed*	Phaeophyceae	Cd	23
5	*Agar-Agar*	Gelidiaceae	Cd	24
6	*Ascophyllum nodosum*	Fucaceae	Cd	
7	*Fucus vesiculosus*	Fucaceae	Cd	
8	*Lamira digitata*	Laminariaceae	Cd	
9	*Saccharomyces cerevisiae*	Saccharomycetaceae	Cd	
10	*Pachmeniopsis*	Halymeniaceae	Cr	25
11	*Phomidium valderianum*	Phormidiaceae	Cd	26
12	*Sargassum sp.*	Sargassaceae	Zn,Cd	27
13	*Scenedesmus abundans*	Scenedesmaceae	Cd,Cu	28
14	*Scenedesmus quadricauda*	Scenedesmaceae	Ni	29
15	*Spirulina platensis*	Phormidiaceae	Cd,Al,Co,Cu,Hg,Ni,Pb.Ni,Zn	30
16	*Spirulina maxima*	Oscillatoriaceae	Pb	31
17	*Tetraselmis suecica*	Chlorodendraceae	Cd	32
18	*Alginate*	Phaeophyceae	Ni,Cu,Cd	22(a,b)
19	*Sphagnum*	Sphagnaceae	Cr	33
20	*Aspergillus terreuss*	Trichocomaceae	Cd	34
21	*Cladosporium cladosporiodes*	Cladosporiaceae	Cd	
22	*Talaromyces helicus*	Trichocomaceae	Cd	
23	*Trichoderma koningii*	Hypocreaceae	Cd	
24	*Escherichia coli*	Enterobacteriaceae	Zn,Pb,Cd	35

CONCLUSION

This review highlights the versatility of plant species in removing heavy metals, and other pollutants offering effective, sustainable, and eco-friendly solutions. The integration of herbs and microbes in water purification systems offers an alternative method contributing to a more sustainable and environmentally conscious approach to water management.

Conflict of interest

The authors and co-authors does not have any conflict of interest.

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