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Devising an economical water purification unit using bio-adsorbent

Shivprasad H. Majumdar[1]*, Nayana V. Pimpodkar[2], Tejashree A. Ghadge[1]

[1]Satara College of Pharmacy, Satara
[2]College of Pharmacy (D. Pharm.), Degaon, Satara

*corresponding author: majumdarshiv@gmail.com

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Abstract: Number of techniques are available to purify water, it include reduction, precipitation, ion exchange, electrochemical reduction and reverse osmosis. Most of them involve high capital costs with recurring expenses, which are not suitable for small-scale industries. Bio-technique has attracted the attention due to its effectiveness and environmentally benign nature. In bio techniques, agro wastes may be the potential sources for producing bio-adsorbents, which can be used for improving the quality of west water. Banana peel and Orange peel are also used as adsorbents for purification of water. Using natural resources upto it's extend and making water palatable and is the need of the hour specially in developing and underdeveloped counties. Present work emphasizes use of banana peel as bio adsorbent in water purification unit. The designed water purification unit shows remarkable result in limits of purification of water.

INTRODUCTION

The polluted water does not remain suitable for drinking purpose and causes diseases in human being along with affecting the flora and fauna adversely. Water of high quality is essential to healthy human life. Therefore, sustainable removal of these unwanted contaminants and heavy metals has become a major challenge for scientists. Water purification is one of the best ways to help the generations out to overcome the problem. A number of techniques are available to purify water but treatment facility for all polluting sources is difficult and also expensive. The conventional methods for metal removal from water include reduction, precipitation, ion exchange, electrochemical reduction, and reverse osmosis. Most of them involve high capital costs with recurring expenses, which are not suitable for small-scale industries. Adsorption with activated carbon is widely applied for removal of heavy metals at trace levels (Huang and Blankenship, 1984). Despite the versatility of carbon adsorbents in water treatment, it remains costly. In bio technique may be potential sources for producing bio adsorbents. The process of bio adsorbents is very simple. Additionally, it is cheap, readily available and simple to use. Different bio adsorbents have been developed used for removal of heavy metals. Some of them include rice straw, sea weed, bark and wood, tea waste maize corn cob, jatropha oil cake, saw dust, rice husk, sunflower stem etc. Peels of some vegetables and fruits can also be used as bio adsorbents. In fruit peel banana peels shows high adsorption capacity. (Singhal et al 2014 and Annadurai et al 2002).

This work reports the potential of banana peel as adsorbents for removal of impurities including heavy metals from water and to make it potable. The residues of banana peel can be processed and converted to be adsorbent because they have large surface areas, high swelling capacities, excellent mechanical strengths, and are convenient to use and have great potential to adsorb harmful contaminants such as heavy metals. Banana peel contain atoms of nitrogen, organic compound such as carboxylic acids these are negative charged so they bind with positive charge heavy metals which are present in polluted water. Banana peels could be used repeatedly to purify water contaminated by industrial plants and farms up to 11 times. Peels can purify water if immersed in it for 24 hr. making it drinkable. (Pandharipande and Deshpande 2013)

METHODS OF WATER PURIFICATION:- (Anhwange et al 2009)

CHEMICALS-

CHLORINE-

This is common, cheap, but extremely toxic. It does not decrease physical or chemical contamination; it does increase cholesterol formations, is a carcinogen, and causes heart disease.

BROMINE-

Used in pools and spas, doesn't smell or taste as bad and doesn't kill bacteria very well.

IODINE-

Is not practical, and is mostly used by campers.
HYDROGEN PEROXIDE-
Kills bacteria with oxygen, is chemically made and is very toxic. It is used in emergencies.
SILVER-
Is an effective bactericide but a cumulative poison which concentrates and doesn't evaporate.
NONTOXIC ORGANIC ACIDS-
Should be used with caution in large water plants only.
LIME AND MILD ALKALINE AGENTS-
Should also be used with caution only by large water plants, or only for laundry.
NEUTRALIZING CHEMICALS –
React with the unwanted chemicals and produce outgases and a sediment, but levels of need vary.
COAGULATION-FLOCCULATION-
Adds chemicals which lump together suspended particles for filtration or separation.

ION EXCHANGE-
Exchanges sodium from salt for calcium or magnesium, using either glauconite (greensand), precipitated synthetic organic resins, or gel zeolite, thus softening the water. Minerals, metals, chemicals or odors are not affected, and the water is salty to drink.

FILTRATION:-
SLOW SAND- Slow sand of 1 cubic meter passes about 2 liters/min, and does a limited bacteria removal.
PRESSURE SAND - Pressure sandof 1 cubic meter passes about 40gpm and must be backwashed daily.
DIATOMACEOUS EARTH- removes small suspended particles at high flow rates, must be daily backwashed and is expensive.
POROUS STONE/CERAMIC -filters are small but expensive, and do not effect chemicals, bacteria or odors.
PAPER or CLOTH- filters are disposable and filter to one micron, but do not have much capacity.
CHARCOAL-
COMPRESSED CHARCOAL/CARBON BLOCK is the best type of charcoal filter, can remove chemicals and lead, but is easily clogged, so should be used with sediment prefilter.
GRANULAR CHARCOAL is cheaper, but water can flow around the granules without being treated.
POWDERED CHARCOAL is a very fine dust useful for spot cleaning larger bodies of water, but is messy and can pass through some filters and be consumed.
REVERSE OSMOSIS, uses a membrane with microscopic holes that require 4 to 8 times the volume of water processed to wash it in order to remove minerals and salt, but not necessarily chemicals and bacteria.
ENZYMES & BACTERIA combined can remove contaminants and reduce sludge. See recent article on enzymes & bacteria.
OXYDATION:-
AERATION- sprays water into the air to raise the oxygen content, to break down odors, and to balance the dissolved gases. However, it takes space, is expensive, and picks up contaminants from the air.
OZONE- is a very good bactericide, using highly charged oxygen molecules to kill microorganisms on contact, and to oxidize and flocculate iron, manganese and other dissolved minerals for post-filtration and backwashing.
ELECTRONIC PURIFICATION and DISSOLVED OXYGEN GENERATION- creates super oxygenated water in a dissolved state that lowers the surface tension of the water and effectively treats all three types of contamination: physical, chemical and biological.

EXPERIMENTAL:-
Materials:-
Profile of banana:-
Family-Musaceae
Scientific name: Musa sp.
Origin: Asian tropics
Banana (*Musa paradaisica*), is grown worldwide and consumed as ripe fruit or used for culinary purposes. Peels form about 18-33% of the whole fruit and are a waste product. With a view to exploiting banana peel as a source of valuable components, the nutritional composition, and antioxidant components. *Musa sapientum* which is commonly called banana is an herbaceous plant of the family Musaceae. It is known to have originated from the tropical region of Southern Asia. The *Musa sapientum* grows up to a height of about 2-8m with leaves of about 3.5m in length. The fruit grows in hanging cluster, with twenty fruits to a tier and 3 – 20 tiers to a bunch. The fruit is protected by its peel. Bananas are packed with nutrients, and that includes their peels. Nitrogen, phosphorus and potassium are required in the highest amounts, and nutrients such as calcium, manganese, sodium and sulphur are necessary in lower amounts. (Nagarajaiah and Prakash 2011)

Other uses of banana peel:-

1. Teeth Whitener – Cut off a piece of the peel and rub the inner part gently over your teeth for a few minutes, then rinse off. Repeat 1-2x daily for whiter looking teeth.
2. Skin Brightener – The same way they whiten teeth, peels can brighten skin. You gently rub the inner peel over your skin then rinse off afterward.

3. Wrinkle Reducer – Rub the inner portion of the peel over your target areas. Leave on for 30 minutes before rinsing. Some say they also leave on overnight and rinse it off in the morning, letting the banana work its magic while they sleep.
4. Acne Treatment – There's been some success for treating blemishes and acne by rubbing the affected area (gently is key!) for a few minutes then rinsing, repeating three times daily. The antioxidants and nutrients in the peels help pesky breakouts.
5. Moisturizer – Soften and hydrate dry skin with banana peels as you would to fight wrinkles and acne.
6. Combat Puffy Eyes – While cucumbers are the popular way to fight tired, puffy eyes, banana peels can do the trick as well – just use them the same way, over your eyes, to give you a bright, freshened look.

Physical characteristics of the peels:-
The physical characteristics of peels -Fresh banana peels were yellow in color, but a significant darkening was observed on drying. Water absorption capacity was high ranging from 600 to 690 ml. This could be due to high fibre content of peels which consist of a large number of hydrophilic groups that absorb water. (Kamsonlia S et al 2012) (Memon et al 2008)

Method:-

1. Banana peel was cut into small pieces, dried, and crushed by using suitable mixer.
2. Fine powdered washed thoroughly with double distilled water to remove the adhering dirt.
3. Washed material was then dried in an air oven at 100°C for 24 h.
4. After drying, the adsorbents were sieved. The particle sizes were 1 to 5 mm.

Designing water purification unit:

1) Banana peel- small pieces:-

Fig.1 Small pieces of banana peel

2) Fine powder:-

Fig: 2-Fine powder of banana peel

3) Filter unit:-

Fig: 3- Filter unit containing banana peel powder.

Water purifier:-

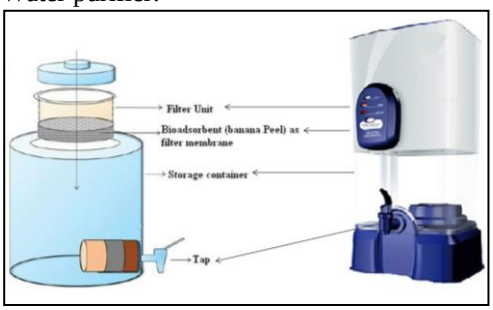

Fig.4: Water Purification Unit

Water purification unit:-
In fig.4 shows water purifier devise, Construction and assembly of the device are simple and can be done locally. The banana peel powder is used as bio adsorbent and kept in the membrane filter. Carbon block is replaced by peel fine powder. Below membrane filter unit storage container is assembled to store purified water or filtered water. (Yirka 2013)

Testing parameters: - (Khedkar and Pande 2012)
Color, odour, turbidity, taste, total dissolved solids, pH, conductivity, alkalinity, fluoride content and hardness

1. Hardness:-

Water that has high mineral content is known as hard water. Hard water contains bicarbonate, chlorides and sulphates of calcium and magnesium. Hardness was estimated by complexometric titration using ethylene diaminetetraacetate (EDTA) as standard and Eriochrome Black-T as internal indicator. A water sample is buffered to 10.1 taken in to conical flask. If an indicator dyes like EBT, when added into solution containing calcium and magnesium ion, the color of solution turns to wine red. Hardness of good quality water should not exceed 250mg/l measured as calcium carbonate equivalent.

2. Alkalinity:-

Alkalinity is primarily a way of measuring the acid neutralizing capacity of water. Alkalinity should not exceed 200mg/l for potable water. For fresh water alkalinity ranges between 20-100 mg/l. Alkalinity was determined by titration method using phenolphthalein and methyl orange indicators. Alkalinity is primarily way of measuring the acid neutralizing capacity of water. Ifsulfuric acid is added in to solution, the pink color is disappeared. i.e. OH^- ions are neutralized.

3. Conductivity:-

Conductivity was determined using conductivity meter after its calibration by 0.1N potassium chloride solution. Conductivity is measured with probe and meter. A voltage is applied between two electrodes in probe immersed in sample water. Electrical conductivity can be expressed as mhos or as Siemens. The conductivity of water is measure of ability of water to carry on electric current. In most water, the conductivity is very low, so milisiemens or micro Siemens are used as units of water conductivity.

Water having more number of ionisable salts for example sea water is having high conductivity. The fresh water bodies only have minimum amount of salts and have moderate conductivity.

Table 1:

Solution	µs/cm
Totally pure water	0.055
Typical DI water	0.1
Distilled water	0.5
RO water	50-100
Domestic tap water	500-800
Sea water	56000

4. P^H:-

-pH measurements were made with digital pH meter equipped with a calibrated combined pH glass electrode.
Total dissolved solids were estimated by absolute drying method. Fluoride was determined by standard method (APHA, 1995) using UV-VIS spectrophotometer. Chloride content was quantified by argentometric titration method using potassium chromate as indicator.

RESULT AND DISCUSSION:-

Water sample is filtered through purifier containing bio adsorbent filter and various parameter were tested to conform purity of water. Result was compared with standards.
The observations and results obtained for water sample before filtration and after filtration with respect to various parameters are summarized in Table-1

CONCLUSION:

The present work explores a new approach of development in the field of purification of water through a cheaper, environmentally benign and economic adsorbent as an alternative to the costly adsorbents. The result is an extremely inexpensive portable water purification device the system cost is comparable to other portable filtration systems, but the processing itself comes to less than Rs. 150 per year. Filtration can be run more than once per day if needed. The researchers believe their device is capable of providing all the drinking water a family of four would need. Fruit peel wastes are cheap material and thus it would be convenient to use it in industrial wastewater treatment plants.

Table 2: Evaluation parameter of water filtration

Sr. No.	PARAMETER	OBSERVATION	
		BEFORE FILTRATION	AFTER FILTRATION
1	Color	Muddy	Clear
2	Odor	Disagreeable	Agreeable
3	Turbidity	Turbid	Clear
4	Taste	Disagreeable	Agreeable
5	p^H	6.3	6.9
6	Total Dissolved solids (ppm)	15000	100
7	Alkalinity (ppm)	4000	155
8	Hardness	700	200mg/l
9	Conductivity (mS/cm)	0.70	0.4

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