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NOVEL METHOD FOR THE PURIFICATION OF WATER USING *MOMORDICA CHARANTIA* PEEL EXTRACT

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Abstract

The presence of heavy metal (Cu, Mg, Pd, Zn, Ca), carbonates and bicarbonates impurities increase hardness in water and makes it unfit for drinking. To make water fit for drinking, purification of water is needed. Therefore, *Momordica charantia* extract was found best to improve the quality of water by decreasing the hardness of water. *Momordica charantia* extract was prepared by the Soxhlet extraction using ethanol as solvent. Analysis was done on the basis of hardness, pH, colour and Turbidity present in sample solution. Natural product *Momordica charantia* extract was found to decrease the hardness of water from 120 ppm to 50 ppm when concentration ratio of extract and standard hard water are 2:8 respectively. This can be attributed to the ability of the flavonoids and polysaccharides present in *Momordica charantia* to form complex with divalent metal cation Ca^{2+}. Overall, *Momordica charantia* extract was proved best for decreasing the hardness of water and make it fit for drinking and other household purposes.
Keywords: *Momordica charantia* extract, Standard Hard Water, Metal complexation, removal of Ca^{2+} metal cation impurity.

Introduction

Water is a universal solvent which is essential for all living organism to live on earth. But now a days, world is witnessing the increment in water pollution (Arzoon *et al.,* 2013; Nagaman *et al., 2*015). It is impossible to get 100% purity in water for drinking and household purposes. The presence of heavy metals (Cu, Ca, Pd, Mg, Zn) and other organic pollutant/waste in water above tolerable limits make it unfit for drinking. Presence of these heavy metal in small amount is also necessary for our body but in large quantity, it can cause many serious health problems (Gandhi *et al.,* 2015; Mallampati *et al.,* 2013; Akhtar *et al.,* 2006). There are three types of impurities/contamination present in water which causes pollution and hardness. Physical impurities like colloidal particles such as clay, slit etc. may causes turbidity, coloured organic matter such as humid substances, metal such as iron and magnesium or coloured industrial waste results in change in the colour of water (Matilainen *et al.,* 2010). Chemical impurities include inorganic cation and anions such as Al^{3+}, Mg^{2+}, Ca^{2+}, Cl^-, F^- and organic impurities like dyes, pesticides, insecticide, textile materials and detergents (Sharma *et al.,* 2010). Biological impurities include bacteria, viruses, pathogens, worms, parasites and microbes (Fawell *et al.,* 2003). All of these impurities increase the hardness of water. Hardness of water is defined as the presence of dissolve amount of Ca^{2+}, Mg^{2+} ions content and other heavy metals in water (Ahn *et al.,* 2018, Masamichi *et al.,* 2019). Water hardness is expressed in terms of mg/l $CaCO_3$ (ppm) (Sireesha *et al.,* 2018). Table-1 depicts the classification of water based upon the hardness

Table 1 : Water hardness scale

Grains/gal	Mg/l or ppm	Water Classification
Less than 1	Less than 17.1	Soft
1-3.5	17.1-60	Slightly hard
3.5-7	60-120	Moderately hard
7-10	120-180	Hard
Above 10	Above 180	Very hard
1 gpg=17ppm or mg/l		

Hardness in water are of two types i.e. Temporary hardness which is due the presence of contamination of Mg $(HCO_3)_2$, $CaCO_3$ and Ca $(HCO_3)_2$ in in water. Permanent hardness is due to the presence of $CaSO_4$ and $MgSO_4$ in solution (Pal *et al.,* 2018). Magnesium is added to water when it moves through dolomite and magnesium rocks and the $CaCO_3$ hardness comes from soil and rocks (Ramya *et al.,* 2015). Hard water can cause a variety of diseases such as increases the chances of forming of calcium oxalate crystal in unitary tract, skin irritation, problems in digestive system and many more. That's why treatment of hardness and the pollution of water is necessary. Many methods and processes are used to decrease the water hardness such as soda lime process (Agostinho *et al.,* 2012), sedimentation, filtering, and electro-dialysis (Sinha *et al.,* 2014). Present study explore the use of natural *Momordica charantia* peel extract (Figure-1) to treat the hardness of water

Fig. 1 : *Momordica charantia*

The active components present in Momordica charantia are charantin, flavonoids and polysaccharides (Patel *et al.,* 2010, Jia *et al.,* 2017, Joseph *et al.,* 2013).

Charantin (Figure-2) contains an aglycone and steroidal parts which are soluble in non-polar solvents. The glucosides which are attached to its molecules are slightly responsible for its solubility in organic solvents like ethanol.

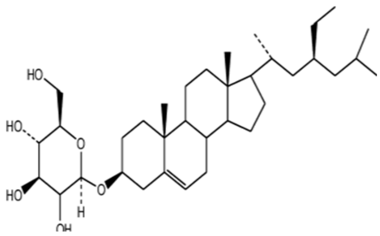


Fig. 2 : Structure of charantin

Flavonoid glycosides (**figure-3**) are polar in nature which is highly soluble in ethanol and water but insoluble in non-polar solvents such as chloroform.

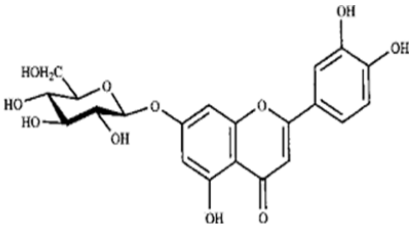


Fig. 3 : Structure of flavonoid (luteolin-O-glycoside)

Polysaccharide (Figure-4) chains contain a COOH functional group which has the capability to form stable complex with Ca^{2+} metal cation (Pellerin *et al.,* 1998). *Momordica charantia* extract decreases the hardness of water because the component flavonoid and polysaccharide are able to form a complex with divalent metal cations which are responsible for the hardness of water

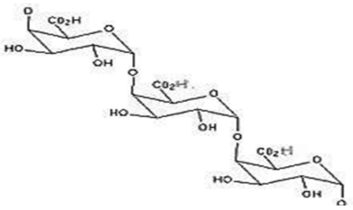


Fig. 4 : Structure of polysaccharides

Materials and Methods

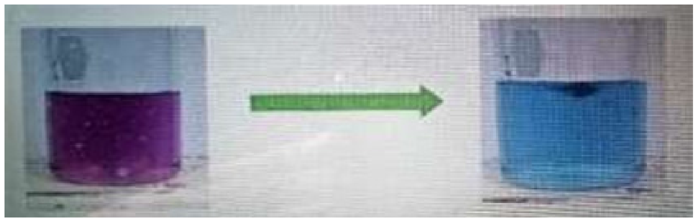
Stock solution of $CaCO_3$ (standard hard water) as 1000ppm of $CaCO_3$ (mg/L) and 0.02N EDTA solution were prepared in a volumetric flask taking known quantities as per the volumes.

Preparation of Momordica charantia extract: *Momordica charantia* were bought from the local market and washed with distilled water properly. It was sun dried for 4-5 hours and was then peeled off into small pieces. 10 gm of peel of *Momordica charantia* was taken in 50 ml of ethanol in soxhlet apparatus (Figure-5) and the mixture was heated at 60^0C for 28 hours. The resultant solution was filtered and filterate was kept in refrigerator at 15-17^0C.

Fig. 5 : Soxhlet extraction of *Momordica charantia* peel

Determination of hardness: Water hardness was determined by complexometric titration method (Kumari, 2016). 0%, 20%, 40%, 60% and 80% sample solutions of *Momordica charantia* peels extracts in standard calcium carbonate solution were made by taking 0 ml, 2 ml, 4 ml and 8 ml of *Momordica charantia* peels extracts and making the total volume to 10 ml by using standard calcium carbonate solution.

2-3 drops of ammonia buffer solution and EBT indicator were added to each sample solutions and the resulting solutions were titrated by using 0.02N EDTA solution until the red wine colour changes into blue.



(red wine) (blue)

The hardness of the sample solutions was determined by using the following equation:

N1V1 = N2V2 (EDTA) ($CaCO_3$)

Where:

N1 = Normality of EDTA solution N2 is the normality

After find the normality of calcium carbonate solution, then apply:

Hardness in mg/l of $CaCO_3$ equivalent = Normality(N_2) × 50000

1mg/l = 1ppm

Determination of pH and colour: Prepared the sample solution ($CaCO_3$ + extract) of different concentrations and the $CaCO_3$ solution and the extract concentration ratio were 10:0, 8:2, 6:4, 4:6, 2:8 respectively. Then noted down the `change in pH of each sample solution by using pH meter and also noted the change in the colour of each sample as the addition of the volume of extract was increased in standard hard water.

Determination of turbidity: Prepared the sample solution ($CaCO_3$+ extract) of different concentration such as 10:0, 8:2, 6:4, 4:6, 2:8 respectively. Then put each sample solution one by one in turbidity meter and note down the reading shown on it.

Result and Discussion

The results obtained for hardness, pH, colour and turbidity of sample solution as shown in tables 2 and 3 given below.

Table 2 : Hardness of sample solution

S.No.	$CaCO_3$ solution	*Momordica charantia* extract	Hardness
1.	10	0	120
2.	8	2	112
3.	6	4	100
4.	4	6	100
5.	2	8	50

Momordica charantia extract was proved best for decreasing the water hardness. The proposed reason is that the flavonoid and polysaccharide present in *Momordica charantia* extracts are responsible for complexation with divalent metal cation as shown in Fig. 6. and 7.

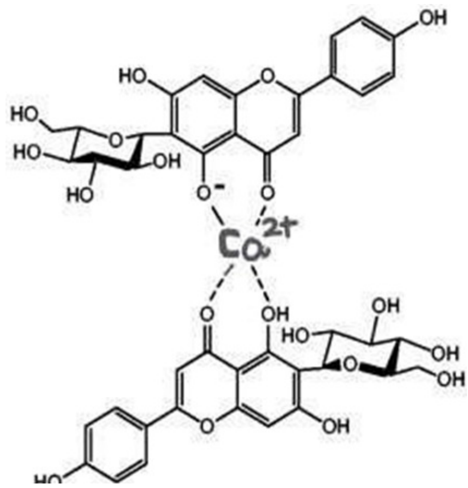


Fig. 6 : Metal complex of flavonoid (luteolin-O-glycoside)

Flavonoid contains hydroxy group which have a tendency to form metal complex with Ca^{2+} metal cation (Davis *et al.,* 2004) after donating H^+ ions and was helpful for decreasing the hardness.

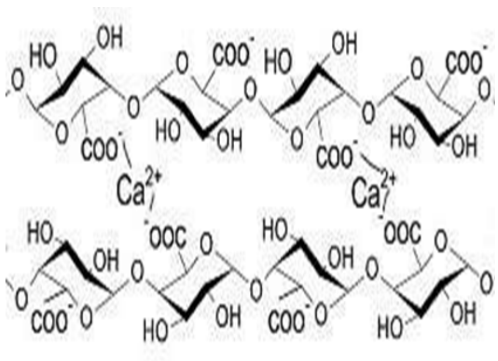


Fig. 7 : metal complexation of polysaccharide

Polysaccharide chain contain a COOH group which form carboxylate ion (COO^-) after donating H^+ ions. The carboxylate ion has a tendency to form stable complex with divalent metal cation Ca^{2+} (Pellerin *et al.,* 1998). Polysaccharide act as a cation exchanger to remove the metal cation impurities in a waste water through ion exchange process.

Table 3 : pH, colour and turbidity of sample solutioN.

S. No	$CaCO_3$ solution	Momordia charantia extract	pH	Colour	Turbidity
1.	10	0	5.6	Trans-parent	24 NTU
2.	8	2	6.4	Light green	22 NTU
3.	6	4	6.7	Dark green	19 NTU
4.	4	6	7.2	Dark green	14 NTU
5.	2	8	7.6	Dark green	14 NTU

As the concentration of *Momordica charantia* extract was increased in $CaCO_3$ solution, pH also increased and approached towards the neutral value from the acidic value with changes the colour of the solution. The pH of water used for drinking and other household purposes should be in range of 6.5-8.5 (Iaslam *et al.,* 2017). As shown in above table 3, the pH range is in between 6.4-7.6 as the extract concentration increases in standard hard water. *Momordica charantia* extract was found to decrease the turbidity in water.

Conclusion

Momordica charantia extract decreases the hardness from 120 up to 50 ppm when the concentration ratio of extract and $CaCO_3$ solution were 2:8 respectively which was determined by complexometric titration method. At the same concentration, it decreased the turbidity up to 14 NTU. This may be due to the presence of polysaccharide which contain COOH and flavonoid contain OH respectively which will donate H^+ ions, in *Momordica charantia* extract. After donating H^+ ions, it became COO^- and O^- ions which have a tendency to bind with divalent metal cation and form metal complex. This method was proved best for the removal of metal cation from aqueous solution and hence can be used for the waste water treatment at low cost.

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