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DEFLUORIDATION POTENTIAL OF SEA SHELL, RICE HUSK, GROUNDNUT SHELL AS A NON CONVENTIONAL ALTERNATIVE FOR FLUORIDE REMOVAL: AN IN-VITRO STUDY

Dental Science

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ABSTRACT

Purpose: To compare the defluoridation potential of Seashell, Rice husk, Groundnut shell

Materials and method: It is an invitro study. The natural absorbents used in the study were sea shell, groundnut husk and rice husk. The absorbents were sun dried for 2 days and grinded to small/ fine particles. 50gms of each material was mixed with approximately 1kg of clay and molded into small pieces. To rule out the effect of clay on defluoridation, pure clay pieces (without any study material) was also molded. The artificial fluoridated water was prepared by keeping the concentration at 3mg/l. 500ml of prepared fluoridated water was collected in 4 containers (A,B,CandD).To these four containers one of the randomly selected study material was added. The post fluoride analysis was done at 8hrs, 16hrs and 24 hrs and finally portability analysis, mud analysis was done

Results: Defluoridation effect was observed in all the 4 groups where the fluoride level reduced from 3mg/L to 0.05mg/L, 0.06mg/L, 0.07mg /L and 0.07mg/L in groundnut husk, Sea shell, Rice husk and Normal mud piece groups. Higher reduction was observed in groundnut husk group.

Conclusion: Excessive fluoride in drinking water has several consequences to person's health. In this study some waste natural absorbents have been used which have revealed significant defluoridation effect. Among those groundnut husk has better defluoridation effect.

KEYWORDS

Defluoridation, Waste bioadsorbents, Groundnut shell, Rice husk, Sea shell.

INTRODUCTION:

Water or Jal is the second element among panchabhuta and it is essential to all forms of life. Water in its pure form is a clear, colorless, odorless and tasteless liquid. The chemical formula for water is H_20 which is interpreted as 2 hydrogen atoms and oxygen in a ratio 2:1. Apart from hydrogen and oxygen it also contains calcium, magnesium, potassium, sodium and phosphorus. Other than this various hazardous contaminants like fluoride, arsenic, nitrate, sulfate, pesticides, other heavy metals are also present.[1]

In India, fluoride is the major inorganic pollutant of natural origin found in groundwater. Fluoride in minute quantity is an essential component for normal mineralization of bones and formation of dental enamel. The safe limit of fluoride in drinking water is 1.0 mg/L. Due to large number of variables, the fluoride concentrations in groundwater range from well under 1.0 mg/L to more than 35.0 mg/L. Fluorine being a highly electronegative element has extraordinary tendency to get attracted by positively charged ions like calcium. Hence the effect of fluoride on mineralized tissues like bone and teeth is large amount of fluoride gets bound in the tissues and only a small amount is excreted through sweat, urine and stool.[1]

Even though it is beneficial in smaller quantity, it is harmful in larger amount. Fluoride related health hazards are considered to be a major environmental problem. In India, 25 million people in 19 states and union territories have already been affected, and another 66 million are at risk including 6 million children below the age of 14 years.[2]It affects both orally and systemically resulting in Dental fluorosis, Skeletal fluorosis and other effects like non-skeletal fluorosis, harmful effects to erythrocytes, ligaments, spermatozoa, thyroid glands and destruction of filaments in the muscle tissues etc.[1]

Skeletal fluorosis occurs when fluoride concentration ranges from 4-10 mg/L.[1] Skeletal fluorosis affects children as well as adults. The symptoms of skeletal fluorosis are similar to spondylitis or arthritis. It causes painful damage to bones and joints, stiffness of joints, outward bending of legs and hands seen in advanced stage which is called as knock knee syndrome. In severest form it causes rigid spine known as crippling fluorosis.[1]

Dental fluorosis occurs when concentration of fluoride in water ranges from1.5 to 4 mg/L.[1]The effect of dental fluorosis may not be apparent if the teeth are already fully grown prior to the fluoride over exposure. It is characterized by white, opaque areas on the tooth surface and in severe form; it is manifested as yellowish brown to black stains and severe pitting of the teeth.[1]

The solution to the problem is removing the excess of fluoride form water. Defluoridation is the process of removing excess, naturally occurring fluorides from drinking water. In India, the work on defluoridation was taken up by NEERI at Nagpur, Maharashtra. Some of the methods used are in defluoridation are synthetic ion exchange, Precipitation processes, activated alumina filters, Reverse osmosis, and Adsorption techniques. Among all the available methods, adsorption is considered to be simple, economical and globally pursued technique.[2]

Adsorption techniques can be carried out using chemical, physical or biological absorbents when fluoride concentration is low. Some of those adsorbents are activated coconut shell carbon, activated fly ash, sunflower plant, coffee husk, bark of babool, pine apple peel powder, orange peel powder, grind Neem and pipal leaves, burnt bone powder.[1] The present study aims at producing cost effective and efficient absorbent using natural waste products. Hence objective of this thesis is to investigate the removal efficiency of fluoride using Sea shell, Rice husk and Groundnut shell by applying absorbent technique.

MATERIALS AND METHOD :

An invitro experimental study was conducted for analyzing the defluoridation potential of Seashell, Groundnut husk and Rice husk. Ethical clearance was obtained from the Institutional Ethical Review Board of Best Dental Science College, Madurai to conduct the study. The permission was acquired from Head of the Department, Department of chemistry in Gandhigram Rural Institute to conduct the

study and water analysis, by explaining the purpose and protocol of the research.

The study materials, Seashell, Groundnut husk and Rice husk was obtained from local market of Madurai. They were sun dried for 2 days and grinded to small/ fine particles. Each material was mixed in quantity of 50gms to approximately 1kg of clay and molded into small pieces. These were fired at a temperature high enough to mature and hardened the clay pieces. To rule out the effect of clay on defluoridation, pure clay pieces (without any study material) was prepared following the above mentioned procedure.

The fluoridated water sample was prepared at the Gandhigram Rural Institute, from dept of chemistry by adding 2.2mg of sodium fluoride to 5 liters of water. The baseline fluoride concentration was 3 mg/l. 500ml of prepared fluoridated water was collected in 4 containers (A,B,CandD).To these four containers one of the randomly selected study material was added.

A- Normal mud piece
B- Groundnut husk mud piece
C- Seashell mud piece
D-Rice husk mud piece

The defluoridation potential of the study material was assed at 8hrs, 16hrs and 24 hrs using fluoride ion electrode. Fluoride concentrations were determined using a Thermo Scientific Orion Versa Star Advanced Electrochemistry Meter and a Thermo Scientific Orion 9609 BNWP Ion plus Sure-Flow Fluoride ion selective electrode. Finally portability analysis and mud analysis was also done.

RESULTS :

The present study was an attempt to evaluate the defluoridation potential of Seashell, Groundnut husk and Rice husk. The Fluoride removal as a function of various contact time with the absorbent has been studied. In current study the initial concentration of fluoride was 3 mg/l. The fluoride level after absorbent contact at 8hrs, 16hrs and 24hrs was measured. (Table:1 and Graph :1)

Interesting finding that we observed in this study is that, there is remarkable reduction of fluoride level from initial concentration to 24 hrs in all four groups. Among the study materials highest reduction is experimented in Groundnut husk group at all time intervals. The defluoridation ranking is Groundnut > Sea shell > Rice husk > Normal mud pot.

The Water portability analysis was done after 24 hrs in order to assess the impact of these defluoridation absorbent materials on chemical composition and physical properties of water sample. Hardness, pH, Total dissolved solids and chloride was assessed. (Table: 2) The result of portability analysis shows parameter for assessing the water quality are in normal range.

Mud analysis was conducted estimating aluminium, calcium, iron, magnesium, potassium, silica and sodium. The result shows that Calcium and Sodium are at concentration of 6.1 and 866mg/kg (Table:3)

DISCUSSION:

Defluoridation is one of the resolutions to eradicate fluoride from water. There are numerous techniques employed in defluoridation but adsorption is considered to be cost effective. In order to apply adsorption technique successfully, innovation of cheap, non toxic and easily available adsorbents are necessary. Many reviews states that the plant products and waste materials are acting as a promising adsorbents for purification purpose.[6,7,9]

In present study the bioadsorbents selected are seashell, Groundnut husk and Rice husk. It is an invitro experimental study, conducted for analyzing the defluoridation potential of mud piece with Seashell, mud piece with Groundnut husk and mud piece with Rice husk. Many studies had been conducted using these bioadsorbents but this was considered as the first study, as the effectiveness of these bioadsorbents was assessed by adding them to clay mud and making them into mud pieces. Ethical clearance was obtained and permission from higher authorities was acquired from the corresponding department where the study was conducted.

The study material in our study was prepared by adding powdered adsorbents to clay mud. These adsorbents were added in quantity of 50gms to approximately 1kg of clay, as it was the maximum limit that can be added to obtain a proper texture and contour of mud pot. Normal mud piece group was also made to avert the effect of clay. Initially mud pot was tried but due to lack of strength and leakage due to micro porosities, mud pieces were made.

The artificial fluoride water sample at concentration of 3 ppm was prepared. The Fluoride analysis was done at 8hrs, 16 hrs and 24 hrs. These timings were chosen as the initial effect of bioadsorbents occurs after 8hrs and usually household storage of water will be for 24 hrs.

The result of the study shows remarkable reduction of fluoride level from initial concentration to 24 hrs in all four groups. This is due to the presence of calcium in all four groups which leads to binding to fluoride at higher affinity level. Among the study materials highest reduction is seen in Groundnut husk group at all time intervals. This was in line with the study conducted by Sharad Sharma et al in which the adsorbents used were Dry Neem Leaves Powder, Dry Peepal Leaves Powder, Neem Bark Powder, Rice Husk Wheat Husk Powdered, Neem Peepal Leaves Mixture, Ground-nut Shells. The result shows that 98.2% and 98% of fluoride removal was achieved in rice husk and ground nut shell group. Among others, these adsorbents rank higher.[8]

Another study conducted by Waheed S et al performed a batch adsorption studies to assess the suitability of inexpensive adsorbent prepared from agricultural waste, rice husk and concluded that it is concluded that the biosorbent prepared from rice husk has shown promising results for the removal of fluoride.[1]

Vivek Ganvir, Kalyan Dasnovel performed a study with an aim of producing cost effective defluoridation method utilizing rice husk ash (RHA) coated with aluminum hydroxide. RHA is obtained by burning rice/paddy husk which is an abundantly available and is an inexpensive raw material. The results showed that rice husk ash (RHA) by coating aluminum hydroxide has excellent fluoride removal efficiency and the adsorption capacity.[4]

N.Gupta et al using bagasse dust, bagasse fly ash, aluminium treated bagasse fly ash, buffalo bone powder and sea shell powder in which the sea shell powder was found to be the best of all the fluoride removing agents studied .[5] Sina Dobaradaran et al experimented a study to determine the efficiency of shrimp shell waste for the removal of fluoride (F) from aqueous solutions by adsorption technique. The adsorbent used in the study was shrimp shell waste and concluded that increasing the contact time of adsorbent did not have a significant effect on the adsorption rate but that the removal efficiency increased with increasing the adsorbent dose. Thus shrimp shell waste was effective in removing F from aqueous solutions.[2]

Many studies had been conducted using bioadsorbents and they have assessed only defluoridation potential of various materials without assessing the impact on quality of water. In current study portability analysis was done to rule out its impact on water quality and the result shows that the parameters assessed are in normal range.

Mud analysis was done since the mud piece container without adsorbents also shows drastic reduction in fluoride concentration. The result shows that calcium and sodium which mainly have higher affinity towards fluoride are at a range of 6.1 and 866mg/kg. A research conducted by Elaine Y. Wong, Michael K. Stenstrom where he investigates calcium carbonate as a cost effective sorbent for an onsite defluoridation drinking water system.The adsorbents used in the study were sea shell, eggshell and calcium pills. He concluded that calcium pills have high adsorption due to its small size and increased surface area.[11] Turner et al states that when fluoride comes in contact with calcium, instant fluoride adsorption occurs and Calcium fluoride is precipitated.[10]

N.Gandhi et al performed experiment on certain low cost adsorbents like concrete, ragi seed powder, Red soil, horse gram seed powder, orange peel powder, chalk powder, pineapple peel powder and multhani matti. The result shows that chalk powder shows 86% of fluoride removal as chalk is the form of calcium carbonate and adsorption takes place due to its affinity and porosities.[3]

The results of the present study revealed adsorbent materials utilized in the study were efficient as defluoridation agents. Employing these materials in day today life will the defluoridation process cost efficient and beneficial. Further studies has to be conducted by adding these adsorbents in candle filters rod preparation so that in can be exploited in our routine.

CONCLUSION:

To conclude, pure water is the world's first and foremost medicine .Excessive fluoride in drinking water makes the water contaminated and causes several complications to person's general and oral health. The outstanding and noteworthy preventive measure of fluoride-free drinking water supply can be executed by defluoridation of potable water.

Bio adsorbent is very dynamic process for Defluoridation and cost efficient too. In this study even though all four groups showed reduction in fluoride highest is seen in groundnut shell group. These adsorbents are available abundantly and have been demonstrated for their outstanding removal capabilities for fluoride removal. This can be exploited commercially, contributing to the sustainability of the environment. Consequently utilizing these absorbents in the areas concerned with high concentration of fluoride will be more constructive and worthy, thereby bestowing accessible and affordable oral care.

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