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Name of the Research: Household Application of Chitosan-Based Bioadsorbents for Removal of Metals and Microbes from Surface Water

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Safe, clean and adequate freshwater is vital to continued existence of all living organism and the smooth functioning of ecological unit, communities and economics. Moribund water quality has become a global matter of concern as human population growth, agricultural and industrial activities expand and climate change threatens to cause major alternation to hydrological cycle. The Third World Water Forum 2003 has entitled water as a “Driving force for sustainable development” and a tactical tool to fight against poverty.

Water covers 71 percent of the earth’s surface but only three percent is fresh and utilizable. Most of them are captured in ice caps and the remaining freshwater occurs in rivers, lakes and aquifers which human being, plants and other animal species can use. But these fresh water resources are contaminated by heavy metal, organic pollutants and microbial species (WHO/UNICEF JMP, 2010).

Water scarcity has been causing conflict since the beginning of civilizations. It is predicted that two-thirds of the world’s population will experience water stress condition by 2015 and some countries would experience high water stress condition when water withdrawal against available resources exceeds 40 percent (Jjellen and McGranahan, 1997). It is alarming that, in South Asia, the withdrawal rate against available resources is 48 percent (Ariyabandu, 1999).

Bangladesh, as being a riverine country, has been facing different challenges from water. Both natural process and human activities influence the quality of surface and ground water. The surface water of Dhaka and those of other metro cities has become highly polluted due to unsystematic discharge of raw waste from textiles, tanneries and other industries, municipal wastes into water bodies, poor drainage system, increasing population and urban encroachment. For the pollution and contamination from different sources, water contains dissolved substances, non-dissolved particulate matter and living organism which are harmful for human health and salinity.

Heavy metal contamination in water is an increasing world-wide environmental concern (Ahmed et al. 2005). Water has been used much as a recipient of toxic and solid waste from domestic, industrial and agricultural runoff. Water-borne chemical pollution entering rivers and

streams cause tremendous demolition. Water pollution by heavy metal due to human activities is causing serious ecological problems in many regions of the world. Metals which are discharged into natural waters at increased concentrations in sewage, industrial effluents or from mining operations can have severe toxicological effects on humans and aquatic ecosystems.

Previous investigations showed that industrial effluents and wastes lead to significant pollution of water around Dhaka city and other Metro cities in Bangladesh. Heavy metals like As, Cr, Cd, Pb, Hg, Cu, Zn, and Ni are toxic for plants and human being. These metals, even in trace amounts, interfere with or inactivate enzymes of living cells (Rahman 1992). Therefore, their discharge into the environment must be minimized and carefully controlled.

Often water resources both surface and ground water are contaminated by Microbial species such as bacteria, virus and protozoa etc. In Bangladesh most of the microbial surface water pollution is caused by municipal waste water discharge in rivers and canals. Health sanitation system is poor. Only 56% people of Bangladesh have improved sanitation system (Unicef, 2010) and ultimately these fecal pollutants are dumped into the nearby water body.

One in eight people does not have access to safe drinking water and two of five people do not have adequate sanitation worldwide (Water Aid, 2010). Moreover, lack of access to adequate safe water leads to the spreading of diseases. Children and women bear the greatest health burden associated with poor water and sanitation. World Health Organization (2002) estimated that 1.73 million deaths occur each year due to diarrheal diseases attributed from poor water supply, sanitation and hygiene.

People most affected are those who live near contaminated waterways and those who have no alternative access to safe water or to improve sanitation. In Bangladesh a number of people have no pure water access; only 51% people have the access of pure drinking water. In this regard it is important to treat water.

Available methodologies are flocculation combined with coagulation, reverse osmosis, membrane separation, oxidation or ozonation etc., are either expensive or inadequate in removing metal or microorganism from polluted surface water. For the treatment of surface water some traditional chemicals are used in various steps. Commonly used chemicals are for various treatment units are artificial organic and inorganic substances. In most of the cases these are expensive since it requires higher doses and does not show cost effectiveness, many of the chemicals are also associated with human health and environmental problems (Kaggwa, 2001).

Filtration is a common but effective technology for drinking water treatment and often it is cost effective in comparison with other advanced method. Different filter materials are used such as

sand, gravel, charcoal, straw, stone etc. Chitosan is also used as filter material in assistance with Sand. It is a good absorbent for Metal and Microbes as well (Madhukar et. at., 2012).

Chitosan from prawn shell can be used as adsorbent which can effectively remove contaminant from water. In Bangladesh the abundance of prawns shell is high and have relatively low cost. Bangladesh is rich in natural shrimp resources and nearly 60 species of shrimp (saltwater) and prawn (freshwater) occur in Bangladesh and are contributing in fishing for hundreds of years. Bangladesh is the 7<sup>th</sup> largest exporter of shrimp to the world (DoF, 2002). A lot of shell is wasted during processing operations and these shells being bio waste cause environmental pollution and degradation. The use of prawn shell powder will be helpful to reduce the treatment cost of polluted surface water for drinking purpose. We can adopt such cost effective treatment process instead of conventional or costly methods which is economically feasible and user friendly.

#### Significance of this study

In the present years scarcity of pure drinking water is a great problem in Bangladesh and it is increasing day by day. We have a great chance to utilize natural material to purify drinking water such as chitosan. The significance of the research was:

- The natural waste prawn shell (chitin and chitosan) will be a potential biosorbents for removal of dissolved metal and Microbial organism from polluted surface water.
- It can be a low cost and effective way to provide pure drinking water in hard to reach area.
- It will be beneficial for the improvement of water-sanitation condition of Bangladesh.

#### Objectives of the study

The purpose of this study was to evaluate the effectiveness of chitosan for improving the quality of drinking water. The objectives of this study were:

- To find out alternative natural adsorbant for water purification.
- To Improve and enhance the adsorption rate of conventional filter technology.
- To reduce metal concentration and microbes in surface water using chitosan adsorbent for drinking purpose.

Findings/conclusions from the research: As a polymer chitosan's natural tendency is to form long chains of molecules with positive charges, which act like hooks. So they can reduce the difference physic-chemical parameters in water body. These natural hooks catch metal such as Pb Cr, Zn and Ni etc; remove harmful microorganisms and other contaminants suspended in water. The materials are attached to chitosan and pure water is easily filtered out. Shrimp and Prawn shell is a bio waste and easily found all over the Bangladesh especially in coastal region.

So, the study on the water purification by chitosan has played an important contribution in the field of pure drinking water supply. Following conclusions can be drawn:

- Among all investigated physico-chemical parameters of Buriganga river water pH and turbidity of water is much higher than the acceptable limit. TDS and EC are within the acceptable limit.
- Heavy metal concentration (Pb, Cr, Zn and Ni) and total coliform count of water is much higher than the acceptable limit for drinking purpose.
- Adsorption rate of Chitosan-sand filter is higher than the Charcoal-sand filter. pH, Turbidity, TDS and EC values are reduced after the treatment with Chitosan-sand and the result is satisfactory.
- Removal rate of metal is excellent and up to 99.00% efficient for Pb, Cr, Zn and Ni by Chitosan-sand filter but in Charcoal-sand filter the efficiency is only 3.83 to 26.28%.
- Total coliform count is also reduced with the treatment of Chitosan-sand filter.

Chitosan based adsorbent may offer an alternative to traditional treatment methods. The unique properties of Chitosan together with availability, makes Chitosan an exciting and promising agent for the purification of surface water for household drinking purpose.

*For more information on this research, please contact the National Resource Centre, NGO Forum for Public Health, Email: [nrc@ngof.org](mailto:nrc@ngof.org)*