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TREATMENT OF WASTEWATER USING LOW COST NATURAL ADSORBENT – A REVIEW

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ABSTRACT

The brilliant performance of Pharma sector in India on one side has established it as a trustworthy destination for manufacturers but at the same time has raised concerns over the catastrophic depletion of safe environmental conditions in the country. Whilst they have brought prosperity, employment and a global recognition, in the hind sight they have also given very large side-effects. Chemicals that are discharged from these industries have been found to be in volumes that are manifolds higher than the safe guidelines. Many companies strictly adhere to the safe discharge norms but majority of them have facilities which have tremendous scope for improvement. In such cases financials dictate the extent to which the treatment plants are deployed. Cost effective techniques, smaller treatment plants and alternative treatment methods have been introduced. However the use of nature's own creation in cleaning the contaminants from water is not a new practice. Since ancient times many trees and herbs have been used for this purpose, prominent of which are Drumstick (*Moringa oleifera*), Peepal (*Ficus religiosa*) and Neem (*Azhadirachta indica*). They have the ability to bring down the pH, TDS & TSS thereby increasing the usability of water. The exact feasibility of Drumstick trees is being evaluated.

INTRODUCTION

The progress of mankind has been a story of a species that strived hard to gain control over their origin. No other life form has been able to adapt or create products, processes, ideas and tools to address the various conditions – physical, climatic or derived that nature created and manifested as a result of the tremendous exploitation it has gone through. Pharmaceuticals in many ways are the synonyms of medical advancement achieved. From mildest of headaches to cancer, pharmaceuticals serve immensely in controlling or reducing the ailments. Man is probably the only species that has developed the artificial ways of contraception. Levonorgestrel is a synthetic hormone that is produced in a laboratory setting. It mimics the action of a natural hormone called progesterone.

Endocrine disrupting chemicals (EDCs) and potential EDCs are mostly man-made, found in various materials such as pesticides, metals, additives or contaminants in food, and personal care products. EDCs have been suspected to be associated with altered reproductive function in males and females; increased incidence of breast cancer, abnormal growth

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patterns and neurodevelopmental delays in children, as well as changes in immune function.

Human exposure to EDCs occurs via ingestion of food, dust and water, via inhalation of gases and particles in the air and through the skin. EDCs can also be transferred from the pregnant woman to the developing fetus or child through the placenta and breast milk. Pregnant mothers and children are the most vulnerable populations to be affected by developmental exposures, and the effect of exposures to EDCs may not become evident until later in life. Research also shows that it may increase the susceptibility to non-communicable diseases.

In response to these concerns, WHO published several publications, including the latest information on the subject in the State of the Science of Endocrine Disrupting Chemicals 2012, which was done in collaboration with UNEP and key scientific experts. A resolution to include EDCs as an emerging issue under Strategic Approach to International Chemicals Management (SAICM) was also adopted in September 2012 by the third International Conference on Chemicals Management (ICCM3) in Nairobi during which WHO and UNEP jointly raised public awareness on EDC issues during a ise-event and technical briefing session (partially supported by the National Institute of Environmental Health Sciences) (http://www.who.int/ceh/risks/cehemerging 2/en/).

Water Treatment through Drumstick Seeds

The use of natural material of plant origin to clarify turbid surface waters is not a new idea. Sanskrit writings in India dating from several centuries BC make references to seeds of the tree Stynchrnos Potatorium as a clarifier. Peruvian text from the 16th & 17th centuries detail the use by sailors of powdered, roasted grains of Zea as a means of settling impurities. More recently Chilean folkoretexts from the 19th century refer to water clarification using the sap from "tuna" cactus. However of all these plants that have been investigated for water treatment *Moringa olifera* is the most effective primary coagulant for water treatment (Malusare, 2011).

Introduction

M. oleifera tree is a native of Northern India, which now grows widely throughout the tropics. English vernacular names include drumstick (shape of the pods) and horseradish (taste of the roots). It may be propagated from seeds or cuttings, grows well even in poor soils requiring minimal horticultural attention and is able to survive long periods of drought. It grows rapidly -growth of up to 4 metres in height, flowering and fruiting were all observed within one year during trials near Nsanje in Southern Malawi Extended and multiple harvests in a single year are evident in many parts of the world (Folkard Dr Geoff, 2001). The many products and numerous uses of the tree are given as under:

- **VEGETABLE**

Green pods, Leaves, flowers and roasted seeds are Highly nutritious (Folkard Dr Geoff, 2001)

- **OIL**

Seeds contain 40% vegetable oil by weight – may be used for cooking, soap manufacture, cosmetics base and as lamp fuel (Folkard Dr Geoff, 2001).

- **COAGULANT**

Crushed seed used traditionally to clarify turbid waters at individual/household treatment level in the Sudan & Kenya. Successfully used at pilot & full scale in conventional water treatment works in Malawi. Applicable to the contact flocculation-filtration process for relatively low turbidity water. Presscake remaining after oil extraction also effective as a coalgulant. Potential for use as an aid to primary sedimentation of wastewaters.

Potential for use in Upflow anerobic Sludge blanket reactor for wastewater treatment (Folkard Dr Geoff, 2001).

- **OTHER USES**

All parts of the plant are used in variety of traditional medicines.

Presscake as a solid conditioner/Fertiliser and potentially as animal/ poultry feed supplement. Green leaves as a fertilizer-mulch. Leaf extract used as a Foliar spray to stimulate plant growth. Powdered seed used in ointment to treat common bacterial skin infections. Trees grown as live fence posts and windbreaks. Source of fuel wood following coppicing. Provider of semi-shade within as intercropping system. Wood pulp for Paper making industry. Planted for specific protective and soil melioration functions (Folkard Geoff, 2001).

Working Principle

The presence of water soluble Cationic Coagulant Proteins that have the ability to reduce the turbidity of treated water. The seed kernels contain significant quantities of series of low molecular weight and water soluble proteins that carry positive charge to the solution. On addition to raw water, it binds with the negatively charged particulate making the water turbid. These particulates can grow in size to form flocks given proper agitation. Once they form flocks the same can be removed by gravity separation or sedimentation. The seeds can be converted in three forms (A) Shelled Blended, (B) Deoiled & (C) Protein Powder and can be used as coagulants. The Protein Powder has the highest removal efficiency with the least quantitative requirement. The price of all is comparable with alum (Malusare, 2011).

Process

Pod shells need to be removed manually and Kernels need grinding in a domestic blender after sieving through 600μm stainless steel sieves. In 95% of ethanol added in 1:10 ratio (w/v) to form a suspension. After mixing with a magnetic stirrer for 10 minutes the separation is done by centrifugation at optimum speed and the settled powder is dried at room temperature for 24 hours. This Dried and deoiled powder is then added in 3% Sodium Chloride solution and the suspension is continuously agitated for 12 hours and is subsenquently filered by Whatman Paper No 44. The extract is finally collected in the process heating is done in such a manner that there is no white precipitation at the bottom. This heated extract solution is poured into the dialysis tube to complete a 12 hour long dialysis in cold water kept in ice bath. After the completion of the process the protein is separated and homogenized with cold acetone for delipidization. It is then dried at room temperature. To ascertain the ability of the powder turbid water samples with varying turbidities of 50NTU, 150 NTU and 450 NTU are mixed with powder in various Jars. The mixing is in itself a three stage process where the samples are first stirred for 1 min at higher RPM, followed by 15 min of slow mixing and 15 min of settling (Moravec, 2008).

Costing and Storage

Each tree produces 15000-25000 seeds per year. For a village population of 1000 people 40000 L/day of water is required. The plantation of trees is 1100 Trees/ Hectare and per tree around 9 sq. mt. is required. Interest in seed propagation of drumstick tree (Moringa oleifera) has created a need for information about the water relationships of its seeds. Studies were conducted for the imbibitions and desiccation kinetics and adsorption/ desorption isotherms of drumstick tree seeds. Seeds absorbed water readily when imbibed at 23°C. After 17 h of exposure to an atmosphere of 100% relative humidity (RH), seed moisture content increased from 10 to 150% on a dry weight basis (dwb). Seeds lost water rapidly in a 1% RH still-air environment, and returned to their original seed moisture content in 24 h, indicating seed covering tissues are highly permeable to water (Moravec, 2008).

Adsorption and desorption equilibrium moisture content curves at 25°C were determined using the dynamic gravimetric method. Drumstick tree seeds equilibrated at relatively low moisture contents over all humidities, remaining below 10% (dwb) at RH levels below 80%. Five equations that are used to model seed moisture content as a function of RH were fit to the data using a non-linear regression method (modified Henderson, modified Chung-Pfost, modified Guggenheim-Anderson-de Boer, modified Halsey, and D'Arcy-Watt). The D'Arcy-Watt model resulted in the best fit for predicting the seed moisture content of drumstick tree seeds. In humid environments, drying seeds before long-term storage may increase the longevity of stored drumstick tree seeds (Moravec, 2008).

Because of its ability to grow productively in semiarid environments, agronomists, nutritionists, and development professionals are increasingly using drumstick tree in rural tropical and sub-tropical areas where growers often store seeds in structures open to the ambient air. Open-air storage conditions do not protect seeds from large fluctuations in temperature and RH levels, which in turn lead to losses of seed viability. By developing effective seed storage protocols, growers can maintain viable seed populations from season to season. Seed moisture content is one of the most important factors affecting seed longevity in storage. When exposed to air containing water vapor, seed moisture content equilibrates in relation to the relative humidity (RH) of the air surrounding the seeds. In general, as RH of the storage environment increases, seed moisture content correspondingly increases. This process, in turn, decreases seed longevity. Maintenance of seed viability is particularly challenging in tropical environments where stored seeds are often exposed to hot, humid air (Ellis, 1988). Suboptimal seed storage practices can lead to poor germination and stand establishment of a crop. Because orthodox oilseeds store best at low seed moisture content (typically 4-6% moisture), lowering the RH of the storage air, which thereby reduces the seed moisture content, is an effective method to prolong seed viability in conjunction with temperature management (Ellis, 1988);(Hartmann, 2002). However, the relationship between seed moisture content and RH of the surrounding air is species- and tissue-specific. This relationship is thought to be influenced by the carbohydrate, lipid and protein composition of the seed as well as the biochemical structure of the surfaces within the seed (Sun, 2002). One of the first steps in developing recommendations regarding seed storage practices for a species is to describe how seed moisture content changes in relation to varying RH, known as a moisture content isotherm (Brooker, 1992). Once this relationship is described for a species, further studies can be performed to determine seed longevity at specific RH/temperature combinations. Describing this relationship for drumstick tree may help explain why such different estimates of seed longevity have been reported in the literature. The reported lengths of time that drumstick tree seeds can be stored without significant loss in viability vary from three months (Sharma,1982) to one year (Vijayakumar, 1999); (Sivasubramanian, 1997) or even several years (Jahn, 1986). Despite the widespread use of drumstick tree throughout Africa, Asia, India, and the Caribbean, little has been recorded about water uptake and loss kinetics of its seeds. One of the first steps in understanding the permeability of seed tissues to water, germination, and dormancy in a species is determining the volume and rate of water uptake and loss (Baskin, 2001). In general, when dry seeds come into contact with free soil water, they take up water through a passive process that can eventually initiate germination under proper environmental conditions. Imbibed seeds can also lose water when soil conditions become dry. The rate at which seeds take up and lose water varies by species, and is predominantly determined by differences in seed tissue permeability (Vertucci, 1989). The aim of this study was to describe water relations in drumstick tree seed (*M. oleifera*). First, the time courses during which seeds take up and lose water were determined. Second, how the RH of the surrounding air affected seed moisture content were determined. Because drumstick tree seeds contain 30-40% oil, they were expected to observe low equilibrium moisture contents at any given humidity relative to seeds (Folkard Dr Geoff, 2001).

DRUMSTICK TREE WATER RELATIONS

Predictions about the rate of water uptake based on the ratio of lipid, protein, and carbohydrate are not likely to be valid since water uptake rates are not primarily controlled by the seed's chemical composition (Vertucci, 1989).Materials and methods Imbibitions tests were conducted by researchers who kept five sets of ten M. oleifera seeds were weighed and placed in a porous ceramic funnel lined with filter paper moistened with distilled water under laboratory conditions at 23°C. This container was used to provide enough moisture to allow water uptake by the seeds, but to prevent the seeds from being immersed in water. Each set was weighed every 8-10 min for the first two hours, every 15 min for the next nine hours, then periodically for the next ten hours until seeds stopped gaining water weight. Distilled water was added to the filter paper between weighing events and was allowed to drain before the seeds were returned to each funnel. After 24 h, the seeds were placed in a 103°C oven for 24 h then weighed. Seed moisture content at each imbibitions time was calculated on a dry weight basis (dwb) as (seed weight – oven dry weight) oven dry weight (Folkard Dr Geoff, 2001).

CONCLUSION

The turbidity removal in all cases is in excess of 70%. As it is obvious the removal is far more pronounced in higher turbidity solutions. Of the three the shelled blended are the least effective on account of oil content in the seeds forming a film on the surface of flock thereby inhibiting the further action. The powder requirement is the least for protein powder given the same turbidity followed by De-oiled and shelled blended.

In a nutshell, the Moringa-based water treatment technique can produce a 90 to 99.99 per cent reduction in bacteria in previously untreated water. *Moringa oeifera* is a vegetable tree which is grown in Africa, Central and South America, the Indian subcontinent, and South East Asia. It could be considered to be one of the world's most useful trees. Not only is it drought resistant, it also yields cooking and lighting oil, soil fertilizer, as well as highly nutritious food in the form of its pods, leaves, seeds and flowers. Perhaps most importantly, its seeds can be used to purify drinking water at virtually no cost. When crushed into a powder, Moringa seeds can be used to remove pathogens from turbid surface water. The treatment technique also reduces cloudiness, making water not only more fit for drinking but more aesthetically appealing as well.

Despite its life-saving potential, the technique is still not widely known, even in areas where the Moringa is routinely cultivated. By making the technique in a freely available protocol format, it will become easier to disseminate the procedure to communities that need it. This technique does not represent a total solution to the threat of waterborne disease. However, given that the cultivation and use of the Moringa tree can bring benefits in the shape of nutrition and income as well as of far purer water, there is the possibility that thousands of 21st century families could find themselves liberated from what should now be universally seen as19th century causes of death and disease. This is an amazing prospect, and one in which a huge amount of human potential could be released. The same can be employed in treating the Effluent released from Pharmaceutical Industries thereby reducing the pathogens, turbidity and Bacteria present rendering it less harmful for the environment.

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