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Evaluating the Water Treatment Potential of Desert Date *(Balanite Aegyptiaca)*

Kyari, F. A., Mele Y. B., Muhammad, A. A. and Fanna, A.K.
Department of Civil Engineering Technology, Ramat Polytechnic, Maiduguri, Borno State, Nigeria

Abstract: *The use of plant-based natural coagulants/disinfectants in water purification has triggered several researchers because of their abundance, environment friendly, multifunction and biodegradable nature. This research investigates the potential of desert date (Balanite Aegyptiaca) seed kernel as anti-bacteria in water purification. The processing of the material involved extraction of oil from the plant which yielded about 40.12% oil. Using a jar test, the residual powder after oil extraction was applied in varying dosages of 2, 3,4,5 and 6g in raw water obtained from river Ngadda within Maiduguri metropolis. The water after treatment was analyzed for Total Coliform, E.coli, Salmonella and Shigella. The optimum dose of the processed powder was considered to be 6g/l since 100% reduction was achieved in all of the considered bacteria. Bacteria regrowth was observed after 24hours of treatment, this may be addressed by further filtration of the water immediately after treatment. The significance of this paper is to introduce healthy natural water treatment method to the most disadvantaged communities.*

Key words: *Natural disinfectant, Soxhlet Extraction, Jar test.*

INTRODUCTION

Surface water is a general term describing water body that is found flowing or standing on the earth surface such as streams, rivers, ponds, lakes and reservoirs (Mustapha *et al*, 2012).Surface water serve as a major source of drinking water and other domestic uses to most cities and rural communities (Ichor, 2014). In most urban rural communities in the developing countries especially the sub-saharan Africa, surface waters (rivers, streams and lakes) have been the most available sources of water used for domestic purpose (Igwe *et al,* 2017). Surface water chemistry in river basin is usually impacted by natural factors and anthropogenic activities in which the natural factors include rainfall, temperature, runoff discharge and weathering process (Mustapha *et al*, 2012). There has been significant impairment of rivers with pollutants, as anthropogenic activities

are fast degrading most water bodies (Igwe *et al*, 2017). The quality of water is of vital concern for mankind, since it is directly linked with human well-being and as at present, the menace of water borne diseases and epidemics still loom large on the horizons of developing countries (Majumder *et al*, 2017). Toxic metals, synthetic organic compounds, sediments, animal and human wastes pathogenic organisms top the list of pollution in the non- industrialized nations (Ichor, 2014). The microbiological quality of water is said to be important to consumers, water suppliers, regulators and public health authorities and its health risks are major concerning issue in all over the world (Ichor, 2014 and majumder *et al*, 2017). The potential of water to transfer microbial pathogens to a great number of people and subsequently causing illness have been well documented in countries at all level of economic development (Ichor, 2014). Ichor, (2014) added that the number of outbreaks that have been reported throughout the world demonstrate that transmission of pathogens by water remains a significant cause of illness. The human pathogens that contaminate water include: campylobacter, E.coli, Salmonella typhi, shigella spp, Vibro Cholera, Yersinia, Enterocolitica, pseudomonas Aeruginosa etc. Most of these pathogens account for the serious health risk associated with water predominantly obtained for human and animal enteric origins and causes disease whenever it is present as source of water supply (Ichor, 2014). Pathogenic micro-organisms in drinking water are the major cause of endemic disease including Gastro Enteritis, Dermatitis, Poliomyletis, Typhoid, Cholera, Salmonellosis etc (Doughari, 2007 and Ichor, 2014).

In developing countries, most of which have huge debt burdens, population explosion and rapid urbanization, people have little or no option, but to accept water resources of doubtful quality, due to lack of better alternative sources or due to economical and technology constraints (Mustapha *et al,* 2012). More often, people living in slums and other remote areas have the responsibility of managing their own domestic water needs individually and sometimes in a communal setup (Mumbi *et al,* 2018). The need for good water quality has been a growing concern in Nigeria and worldwide and the growing problem of pollution of river ecosystem has necessitated the monitoring of water quality (Igwe *et al*, 2017). Water treatment should remove existing water contaminants or so reduce their concentration that water becomes fit for its desired end use, which may be safely returning used water to the environment (Oyebode *et al,* 2015).

The process and technologies used to remove contaminants, from water to improve and protect water quality are similar all around the world; which is a combination of some or all of coagulation, flocculation and sedimentation, plus filtration and disinfection and has been used routinely for water treatment since the early part of the twentieth century (Mumbi *et al*, 2018). The removal of turbidity and pathogens is an essential step in the water treatment process and generally, this is achieved using coagulation and chlorination process. (Yero *et al,* 2021). In conventional water treatment process, aluminum sulphate (alum) and polyaluminum chloride (PAC) is widely used for turbidity removal while chlorine is used to disinfect pathogens (Yero *et al,* 2021). The sustainability of the treatment with alum slightly have negative view when it is linking to the neurological disease such as Alzheimer, especially when the aluminum residual penetrate into the human body and accumulate in the brain (Saleh *et al*, 2019). As recommended by the world health organization, the amount of aluminum is drinking should not exceed 0.2mg/l. In addition the chlorine used at most water treatment is known to form chlorination by-products, which are believed to be carcinogenic (Mumbi *et al*, 2018 and Mohammed, 2018). Another disadvantage is the high water treatment cost for poor and developing countries making provision for a clean water supply and water treatment difficult (Hoa *et al*, 2018), therefore natural coagulants/disinfectants are offering new possibilities in the quest for sustainable water treatment technologies. Some studies on natural coagulants have been carried out various of which were produced or extracted from plants such as *Moringa Oleifera* (MO), *prosopis juliflora* , *Tamarind Indica*, *cactus latifera* etc.

(Yero *et al*, 2021). Natural organic polymers have been used for more than 2000 years in India, Africa, and China as effective coagulants (Asrafuzzaman *et al*, 2011). In addition, some of these plant based coagulants like the novel *Moringa Oleifera* seeds contain antimicrobial agents and are very effective against several bacteria and fungi (Chaudhary *et al,* 2017).

Al- Thobati, (2018) described (*Balanite Aegyptiaca*) (L.) Delile a drought-tolerant perennial tropical ever green tree belongs to family *Zygophyllaceae* (*Balanitaceae*), is commonly known as "Desert Date" (Heiglige in Arabic), is native to arid and sub arid of Africa and some Middle East especially Arabian peninsula but mostly widely in various parts of Africa and south Asia. The tree is actually valued more for its fruit and seeds. The fruit and kernel are widely used in many countries including Nigeria especially during the dry season and drought periods (Zang *et al,* 2017). The seed kernel consists of the rich oil, protein and mineral (Mariod *et al*, 2017). The chemical content revealed that the oil content range from 20% to 50% while protein varied from 27% to 37%. Mariod, (2017) reported 30-60% oil which is edible and used as cooking oil while Alemayaho, (2020) reported up to 87% oil. The kernel oil extract has physical, Phytochemical and chemical properties (Ogala *et al,* 2018). Zang *et al,* (2018) reported that, the composition of the oil revealed high metal concentration of sodium (5.9178 ± 0.2mg/g) in the seed kernel, magnesium (2.2242 $\pm$ 0.007mg/g) and calcium (1.4643 ± 0.5) in the seed oil. Physiochemical analysis revealed specific density (0.88g/cm^3), moisture content (7.16%), refractive index at 25^{0}c (1.34), iodine value (43.1g/100g), saponification value (136mgKOH/g) and peroxide value (37meg/kg), acid value (12.1mg KOH/g), free fatty acid value (12.2%) (Ogala *et al,* 2018). Phytochemical screening of the oil also showed the presence of alkaloid, steroid, cardiac glycoside and carbohydrate (Zang *et al,* 2017).. Authors like Daya *et al*, (2011) reported that desert date has a long history of traditional uses for wide disease ranges, it possess antioxidant, antimicrobial, anticancer, diuretic, hypercholesterolemia, wound healing, antiviral, antidiabetic, hepatoprotective, mosquito larvicidal, anti-inflammatory and analgesic, antivenin, anthelmintic, cardioprotective coactivity and antinociceptive pproperties. Bark, fruit, seeds, seed oil and leaves of this plant are widely used in folk medicine all parts of the desert date tree plant have medicinal uses (Yero *et al*, 2021). He added, because of the protein content which amounts up to about 37%, it was observed and reported by Muhammad *et al,* (2018) that *Balanitea Aegyptiaca* seed kernel could be a potential natural coagulant and anti-bacteria.

Natural coagulants/disinfectants have triggered several researchers because of their abundance low – cost, environment friendly, multifunction and biodegradable nature in water purification (Asrafuzzaman *et al*, 2011).

This research will investigate the use of desert date *(Balanite Aegyptiaca*) seed kernel as anti-bacteria in water purification.

MATERIALS AND METHODS

Balanite Aegyptiaca also known as desert date was obtained from a local market. The fruit was soaked in clean water for 5-6hours, washed thoroughly to remove peel and pulpandwas sun dried. Using a metal hammer, the shell was cracked and the kernel was obtained. The kernel was ground with blender to increase surface area. The grinded kernel wasdried in an oven at 80^{0}c till constant weight then sieved through 600microns sieve. Ninety grams (90g) of the powder was charged in a Soxhlet extractor for oil extraction. The residue obtained after oil extraction was washed severally with distilled water then oven dried.The dried residue was weighed and kept in an air tight container for use as anti-bacteria.

Method of oil extraction: 90g of the prepared kernel powder was put inside a thimble made from paper which was loaded into the chamber of the Soxhlet extractor. The Soxhlet extractor was placed on to a flask containing 1l n. hexane used as the extraction solvent. The Soxhlet was then equipped with a condenser and the solvent in the flask was heated to reflux. The solvent vapor travelled up a distillation arm and then flooded into the chamber housing the thimble of solid. The chamber containing the solid material was slowly filled with warm solvent. When the Soxhlet chamber was almost full, the chamber was automatically emptied by a siphon side arm, with the solvent running back down to the distillation flask. After many circles, the desired compound was concentrated in the distillation flask and the solid was free of oil. The defatted powder was weighed, ground and sieved again through 600 microns and kept in an air tight container.

Jar test: Jar test was conducted using flocculate with six beakers on river Ngadda raw water to determine optimum dosage of *Balanite Aegyptiaca* kernel powder used as anti-bacteria. The raw water was obtained under the bridge along Logos Street Maiduguri. It was a random sample. 1000ml of the water was poured into each beaker labeled 1 -6. The 6thbeaker was the control.Mass of 2,3,4,5, 6g were measured and added into the beaker, first beaker represent under-dose and the fifth beaker represent over-dose. The stirring paddles were lowered into the beaker.Stirring apparatus started and operated for 1min at a speed of 200rpm. Stirring speed was then reduced to 10rpm for 15mins. The liquid was allowed to stand for 30min before samples were withdrawn from each beaker for microbial analysis only. Microbes analysed were Total Coliform, Escherica coli (E.coli), Salmonella and Shigella.

ANALYSIS OF RAW WATER

Bacteriological analysis of the water was carried out before and after treatment.

Initial and final bacterial count was carried out using a tenth fold dilution with normal saline, after treatment. The percentage (%) reduction was calculated using the formular in equation (1)

$$\text{Percentage reduction} = \frac{C_1 - C_2}{C_1} \times 100\% \quad \ldots\ldots(1)$$

Where C_1 = Initial bacterial count (cfu)

C_2 = final bacterial count (cfu)

RESULTS AND DISCUSSIONS

Balanite Aegyptiaca seed kernel oil could be a creamy source for domestic and industrial applications if properly processed. It is observed in Table 1, which contain values for the factors used for the extraction of oil from the kernel. The results showed that temperature, extraction time and particle size were among factors that affected the extracts yield during oil extraction from the seed kernel.

Table 1- Factors used and the responses obtained for the oil extraction

Particle size (mm)	Temperature ^{0}c	Extraction time (hr)	Oil yield %	Oil density g/cm
0.60mm	80^{0}c	7	40.12%	0.8

The results in table 1 obtained complies with literature as written by (Yero *et al*, 2021). The findings further revealed that the more the surface area, the lower the extraction time and the higher the yield of the extract. The weight of the kernel powder was reduced from 90g to 47.59g after the oil extraction.

Microbial properties of the water before and after treatment: The reduction in bacteria concentrations was assessed. Table 2 shows the result of final concentrations.

The initial concentrations of the bacteria before treatment being 10x10^{3}cfu, 7x10^{3}cfu, 1x10^{3}cfu and 2x10^{3}cfu for Total Coliform, E.coli, Salmonella and Shigella counts respectively. Table 2 shows percentage reduction after treatment.

Table 2 – Percentage Reduction in Bacteria after Treatment

Dose of anti-*bacteria* (g)	% Reduction in Total Coliform	% Reduction in E.coli	% Reduction in Salmonella	% reduction in Shigella
2	50	42.86	+50	100
3	+62.96	+56.25	+85.71	+50
4	90	85.71	100	100
5	60	42.86	100	100
6	**100**	**100**	**100**	**100**

The performance of the kernel powder is showed in table (2) for each dose of the powder and for each bacteria. 100% reductions was recorded for 6g dose in all aspects. 100% reduction was equally recorded for 4g and 5g doses (Salmonella) and also for 2g, 4g and 5g doses (Shigella).

The + signs means there was increase in the bacterial count after treatment. Bacteria regrowth was observed after 24 hours of treatment. The two later observations implies that the material (Balanite Aegyptiaca) may have served as nutrients to the microbes.

CONCLUSION AND RECOMMENDATIONS

Total Coliform, E.coli, Salmonella and Shigella were detected in the raw water. According to the WHO maximum acceptable concentration of such bacteria for drinking water is non-detectable per100ml; this means that in order to conform to the guidelines for every 100ml of drinking water tested no bacteria should be detected. The treatment of raw water using *Balanite Aegyptiaca* seed kernel has recorded some remarkable successes in which 6g/l may be considered as the optimum dosage since 100% reduction was achieved in all aspects. However, the regrowth of bacteria after 24 hours may be addressed by further filtration of the water immediately after treatment. Moreover, the oil extracted is appreciable quantity wise and can be used as edible oil for domestic and industrial purposes if properly processed.

Balanite Aegyptiaca seed kernel showed promising as anti-bacteria in treating raw water. The study also recommends scaling up of the process for larger industrial application.

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