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An Assessment of Drying Effects on the Water Purifying Efficacy of Moringa Oleifera Seeds

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Abstract - This study focuses on a simpler, safer and cheaper way of purifying water using Moringa oleifera seeds by examining the effects of different drying methods on the efficacy of using Moringa oleifera seeds as a purification technique for water. 5 grams each of the pounded fresh seeds and the powder from dried seeds were administered into 500mls of the water samples for treatment and it was left for 24 hours for sedimentation to take place before eventual decantation of the treated water samples were done. The treated water samples and the control experiment freshly taken sample were then transferred into a double-cork sampling bottles and taken to the laboratory immediately for physical, chemical and bacteriological analysis.

Moringa oleifera processed seeds by drying with different methods were applied directly. The results revealed that the water samples characteristics are negatively affected rather than getting improved thus making the samples not purified as expected. It is therefore suggested from the findings of this study that extracts from the dried seeds can be used in subsequent studies as water purifying technology.

Keywords - Drying, Water, Purity, Efficacy, Moringa Oleifera Seeds.

I. INTRODUCTION

Moringa oleifera, a slender softwood tree that branches freely can be extremely fast growing. Although it can reach a height in excess of 10 m and a diameter of 20-40 cm at chest height, it is generally considered a small- to medium-size tree. The stem is normally straight but occasionally is poorly formed. The tree grows with a short, straight stem that reaches a height of 1.5-2 m before it begins branching but can reach up to 3.0 m (Foidl et al., 2001). The extended branches grow in a disorganized manner and the canopy is umbrella shaped. Tripinnate compound leaves are feathery with green to dark green elliptical leaflets 1-2 cm (0.4-0.8 in) long. The tree is often mistaken for a legume because of its leaves. The alternate, twice or thrice pinnate leaves grow mostly at the branch tips. They are 20-70 cm long, grayish-downy when young, long petiole with 8-10 pairs of pinnae each bearing two pairs of opposite, elliptic or obovate leaflets and one at the apex, 1-2 cm long (Morton, 1991).

Conspicuous, lightly fragrant flowers are borne on inflorescences 10-25 cm (4-10 in) long, and are generally white to cream colored, 2.5 cm in diameter, borne in sprays, with 5 at the top of the flower, although they can be tinged with pink in some varieties. The flowers, which are pleasantly fragrant and 2.5 cm wide are produced profusely in axillaries, drooping panicles 10-25 cm long (Sachan et al., 2010). They are white or cream colored and yellow-dotted at the base. The five-reflexed sepals are linear-lanceolate. The five petals are slender-spatulate. They surround the five stamens and five staminodes and are reflexed except for the lowest. The fruits are trilobed capsules, and are frequently referred to as pods. Immature pods are green and in some varieties have some reddish color. Pods are pendulous, brown, triangular, splitting lengthwise into three parts when dry, 30-120 cm long, 1.8 cm wide, containing about 20 sec embedded in the pith, pod tapering at both ends and about 9-ribbed (Burkill, 1996). The seeds are round with a brownish semi-permeable seed hull, with 3 papery wings. Seed hulls

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are generally brown to black, but can be white if kernels are of low viability. Viable seeds germinate within 2 weeks. The hull itself has three white wings that run from top to bottom at 120° intervals. Each tree can produce between 15,000 and 25,000 seeds/year. The average weight per seed is 0.3 g and the kernel to hull ratio is 75:25 (Makkar and Becker, 1997).

This fast-growing tree is grown for human food, medicine, dye, fodder and water clarification. It has an impressive range of medicinal uses with high nutritional value. In addition to its compelling water purifying powers and high nutritional value, Moringa oleifera is very important for its medicinal value. All parts of the Moringa tree are edible and have long been consumed by humans. According to Fuglie (1999) the many uses for Moringa include: alley cropping (biomass production), animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, bio-pesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), water purification (powdered seeds) (Adebayo et al., 2011). In the West, one of the best known uses for Moringa is the use of powdered seeds to flocculate contaminants and purify drinking water (Berger *et al*., 1984; Gassenschmidt et al., 1995).

Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, anti-inflammatory (Kumar et al., 2009), antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, anti-diabetic, hepato-protective, antibacterial and antifungal activities and are being employed for the treatment of different ailments in the indigenous system of medicine, particularly in South Asia (Anwar et al., 2007; Fakurazi et al., 2008; Paliwal et al., 2011a). It is generally known in the developing world as a vegetable, a medicinal plant and a source of vegetable oil (Bennett et al., 2003; Paliwal et al., 2011b).

The bark, sap, roots, leaves, seeds and flowers of moringa oleifera have been used in traditional medicine. Extracts from leaves contain low contents of polyphenols which are under basic research for their potential properties. Despite considerable preliminary research on the biological properties of moringa components, few high-quality studies on humans justify its use to treat human diseases (Leone et al., 2015).

Moringa usage in the traditional medicine passed down for centuries in many cultures around the word, for skin infections, anaemia, anxiety, asthma, blackheads, blood impurities, bronchitis, catarrh, chest congestion, cholera, conjunctivitis, cough, diarrhoea, eye and ear infections, fever, glandular, swelling, headaches, abnormal blood pressure, hysteria, pain in joints, pimples, psoriasis, respiratory disorders, scurvy, semen deficiency, sore throat, sprain, tuberculosis, for intestinal worms, lactation ,diabetes and pregnancy (Nikkon et al., 2003). The healing properties of Moringa oil, have been documented by ancient cultures. Moringa oil has tremendous cosmetic value and is used in body and hair care as a moisturizer and skin conditioner. Moringa oil has been used in skin preparations and ointments since Egyptian times (Sairam, 1999).

Moringa oleifera leaf powder was as effective as soap for hand washing when wetted in advance to enable anti-septic and detergent properties from phytochemicals in the leaves (Torondel et al., 2014). Moringa oleifera seeds and press cake have been implemented as wastewater conditioners for dewatering and drying fecal sludge (Gold et al., 2016). Moringa seed cake, obtained as a byproduct of pressing seeds to obtain oil, is used to filter water using flocculation to produce potable water for animal or human consumption. Moringa seeds contain dimeric cationic proteins which absorb and neutralize colloidal charges in turbid water, causing the colloidal particles to clump together, making the suspended particles easier to remove as sludge by either settling or filtration. Moringa seed cake removes most impurities from water. This use is of particular interest for being nontoxic and sustainable compared to other materials in moringa-growing regions where drinking water is affected by pollutants (Hellsing et al., 2013) . A low-cost water purification technique that uses extracts from seeds of the *Moringa oleifera* tree can produce a 90.00% to 99.99% bacterial reduction in previously untreated water (Lea, 2010). The method could help drastically reduce the incidence of waterborne disease in the developing world. Moringa tree seeds, when crushed into powder, can be used as a water-soluble extract in suspension, resulting in an effective natural clarification agent for highly turbid and untreated pathogenic surface water. As well as improving drinkability, this technique reduces water turbidity (cloudiness) making the result aesthetically as well as microbiologically more acceptable for human consumption. This technique does not represent a

total solution to the threat of waterborne disease. Moringa oleifera seeds also contain a natural coagulant able to effectively reduce the turbidity of the raw water. Use of the seed as coagulant in water treatment is often performed as an aqueous extract but requires daily preparation in order to keep its clarification properties (Garcia Fayos et al., 2015).

The broad objectives of this study is to develop a simpler, safer and low-cost and easily accessible technology for purifying water using Moringa oleifera seeds as reported in some previous studies. It also assesses the effects of different drying means on the water purifying ability of the seeds.

II. Materials and Methods

2.1 Definition of Goal and Description of the Study site

This study assessed the effects of drying on the efficacy of water purifying capacity of Moringa oleifera seeds on water sample from a flowing river in Saki West Local Government Area of Oyo State. The drying of the seeds was carried out in the processing laboratory of Agricultural and Bio-Environmental Engineering department of The Oke-Ogun Polytechnic, Saki, Oyo State. The water samples were taken from a tributary of Oge river in Saki town that is impounded for municipal water supply in the Local Government Area.

2.2 Sample treatment and Analysis

The seeds were dried using two methods which are oven drying and sun drying. The dried seeds were then ground into powdery form. A recipe of pounded fresh seeds were also prepared. The end products of the different treatment methods were then introduced directly into the water samples from the river while the fourth one served as the control experiment.

5 grams each of the pounded fresh seeds and the powder from the dried seeds were administered into 500mls of the water samples for treatment and it was left for 24 hours for sedimentation to take place before eventual decantation of the treated water samples were done. The treated water samples and the control experiment freshly taken sample were then transferred into a double-cork sampling bottles and taken to the laboratory immediately for analysis. The samples were analysed for its physical, chemical and bacteriological characteristics to access the purification effects of the Moringa oleifera products administered and the eventual effects of the processing methods of these products on the purification efficacy on the water samples.

The treated water samples are coded A (treated with pounded fresh seeds), B (treated with powder from oven-dried seeds), C (treated with powder from sun-dried seeds), and D (untreated as control experiment) before being put into the sampling bottles for analysis. The physical characteristics analysed are appearance and colour and odour and while the chemical characteristics include pH, Acidity, Alkalinity, Chloride, Total Solids (TS), Total Dissolved Solids (TDS), Phosphate, Sulphate, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Iron, Lead, Cadmium, Manganese and Zinc. The bacteriological characteristics analysed are Total Viable count (TVC), Total Coliform count (TCC), Total Fungi count (TFC), Staphylococcus count (SC) and Eschericia Coli count (E.coli).

The concentrations of the analysed physical, chemical and bacteriological characteristics were presented in mg/l. The deviation in the concentrations when compared with the maximum allowable levels of these characteristics in drinking water according to World Health Organization (WHO) were also considered to assess whether they fall within the acceptable limits after treatment.

III. Results and Discussions

The physical characteristics analysed are appearance and colour and odour and the results are as presented in Table 1. The appearance and colour was found to be best with the control experiment, better with the recipe from the pounded fresh seeds and adversely affected when treated with the dried Moringa seeds powder. For both the sun-dried and oven dried seeds powder, the treated water samples became relatively more turbid with slightly brownish colour that reduces over time with subsequent sedimentation process. The odour became more pronounced for all the treated samples though not irritating.

Table 1 physical characteristic of the treated water samples

Parameters	A	C	E	G
Apperance	Clear but lesser than	Brownish and turbid	Brownish and turbid	Relatively clearer in

and Colour	untreated sample			colour
Odour	Slight odour	Slight odour	Slight odour	Relatively odourless

Table 2 showed the result of the chemical characteristics of the water samples. The pH ranged from 5.00 for the water sample treated with recipe from pounded fresh Moringa seeds to 7.12 for the control experiment. The acidity increased from 0.008mg/l for the untreated sample to 0.032mg/l for all other samples treated with the Moringa seeds. Alkalinity ranged from 80.00mg/l to 260.00mg/l for the sample treated with powder from oven-dried Moringa seeds. The Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD) follow the same trend increasing from 6.40mg/l, 30.60 mg/l and 67.40mg/l for the untreated samples to 9.80mg/l, 44.70mg/l and 98.60mg/l respectively for the treatment with pounded fresh seeds. Other chemical properties follow the same trend increasing from the control experiment to the treated samples. Chloride ranged from 22.60mg/l for the untreated sample to 699.73mg/l for the treatment with oven-dried Moringa seeds powder. Total Solids ranged from 0.99mg/l – 10.92mg/l, Total Dissolved Solids from 70.00mg/l to 220.00mg/l, Phosphate from 2.99mg/l to 28.07mg/l, Sulphate from 4.35mg/l to 61.96mg/l. Heavy metals are also not excluded in the trend. Iron ranged from 0.68mg/l to 2.73mg/l, Lead ranged from less than 0.05 – 0.41mg/l, Cadmium from 0.002 to 0.11mg/l, Manganese from0.71 to 2.94mg/l and zinc from 0.59 to 1.35mg/l.

Table 2 Chemical characteristics of the treated water samples

Parameters	**A**	**C**	**E**	**G**
pH	5.00	6.72	6.77	7.10
Acidity	0.032	0.032	0.032	0.008
Alkalinity	194.00	200.00	260.00	80.00
Chloride	636.12	540.70	699.73	22.26
TS	10.92	8.18	7.69	0.99
TDS	200.00	170.00	220.00	70.00
Phosphate	27.15	9.66	28.07	2.99
Sulphate	39.13	40.22	61.96	4.35
DO	9.80	9.40	7.40	6.40
BOD_5	44.70	42.80	37.80	30.60
COD	98.60	92.70	83.70	67.40
Iron	1.47	1.28	2.73	0.68
Lead	0.33	0.41	0.39	0.05
Cadmium	0.08	0.06	0.11	0.002
Manganese	2.94	1.99	2.86	0.71
Zinc	1.09	0.87	1.35	0.59

*All parameters in mgl^{-1} except otherwise stated.

The bacteriological parameters of the water samples are presented in Table 3. The bacteriological characteristics like most of the chemical follow trend of increasing from the untreated sample to those treated with the Moringa products. The Total Viable count as a bacteriological parameter was 1.2×10^5cfu/ml for the untreated sample to 4.9×10^5cfu/ml for the treatment with powder from oven-dried Moringa seeds. Total Coliform count from $0.2x10^5$cfu/ml to $0.9x10^5$cfu/ml for pounded fresh seeds, Total Fungi count from $0.1x10^5$cfu/ml to $0.3x10^5$cfu/ml for oven-dried seeds

powder, Staphylococcus count ranged from $0.4x10^5$cfu/ml to $1.6x10^5$cfu/ml for pounded fresh seeds while Escherichia Coli count ranged from $0.1x10^5$cfu/ml to $0.4x10^5$cfu/ml for pounded fresh seeds.

Table 3 Bacteriological characteristics of the treated water samples

Parameters	A	C	E	G
TVC	$4.6x10^5$	$4.9x10^5$	$2.7x10^5$	$1.2x10^5$
TCC	$0.9x10^5$	$0.6x10^5$	$0.6x10^5$	$0.2x10^5$
TFC	$0.2x10^5$	$0.2x10^5$	$0.3x10^5$	$0.1x10^5$
SC	$1.6x10^5$	$1.2x10^5$	$1.0x10^5$	$0.4x10^5$
E. Coli	$0.4x10^5$	$0.3x10^5$	$0.3x10^5$	$0.1x10^5$

*All parameters in $cfuml^{-1}$ except otherwise stated.

3.1 Effects of Moringa seeds drying on the water samples

The water samples characteristics were significantly affected by the introduction of the different dried and pounded Moringa seeds. It was observed that the input increases these characteristics contrary to the general belief that the concentrations of these characteristics must be reduced thereby making the samples to be purified relatively. The physical characteristics of almost all the samples appeared more turbid after the treatment with the processed Moringa seeds and leaves. The chemical characteristics are also affected negatively. Examples are the increase in Lead and Cadmium concentrations of the untreated water sample from a low value of less than 0.05mg/l and 0.002mg/l to 0.41mg/l and 0.11mg/l respectively which are values above the permissible concentrations in the World Health Organization (WHO) standards for drinking water as presented in Table 4. The bacteriological characteristics are also increased but not as much as the chemical characteristics revealing that the effects are not felt on the bacteriological characteristics as on the chemical characteristics. For example, the Total viable count was increased from$1.2x10^5$cfu/ml for the untreated sample to $4.9x10^5$cfu/ml after treatment.

Table 4: World Health Organization (WHO) Standards for drinking water.

Parameters	WHO Standards
Zinc	3
Manganese	0.5
Cadmium	0.003
Lead	0.01
Iron	0.3
Chloride	250
Nitrate	50 (Total nitrogen)
Sulphate	500
Phosphate	No guideline
Turbidity	Not mentioned
pH	Neutral

*All parameters in mgl^{-1} except otherwise stated.

Source: WHO (2006)

IV. Conclusions

The effects of drying on the efficacy of using Moringa oleifera seeds as a purification technique for water were assessed in this study. Earlier studies on the uses of the tree for water purification has only revealed the purification technique using the extract from recipe of pounded fresh seeds and not direct introduction of the processed pounded seeds into the water sample (Lea, 2010 and Bergstedt, 2011). Processing the seeds of Moringa oleifera by drying and grinding into powdery form to treat water samples directly showed that the water samples characteristics are more adversely affected than getting ameliorated thus making the samples not as purified as expected. Further study on the efficacy of purification ability of the seeds using solution extracts from the dried and fresh seeds should be encouraged.

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