International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 2 Issue 5, May 2015

ISSN: 2394-4404

Effects Of Processing Methods On The Water Purifying Efficacy Of Moringa Oleifera Leaves

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Abstract: ***This study examined the effects of different processing methods on the efficacy of using Moringa oleifera leaves as a purification technique for water. This study also focuses on a simpler, safer and cheaper way of purifying water using Moringa oleifera leaves as acclaimed in some previous studies. 5 grams each of the pounded fresh leaves and the powder 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 of freshly taken sample were then transferred into a double-cork sampling bottles and taken to the laboratory immediately for physical, chemical and bacteriological analysis.***

Processing the leaves of Moringa oleifera by drying with different methods and applying the processed products directly showed that the water samples characteristics are more adversely affected than getting ameliorated thus making the samples not as purified as expected. It is suggested from the findings of this study that dried Moringa leaves and seed should not be applied directly as a water purifier but extracts from the processed products can be used in subsequent studies.

Keywords: Processing methods, water, purity, efficacy, moringa oleifera leaves.

I. INTRODUCTION

Moringa oleifera is the most widely cultivated species of monogeneric family, the Moringaceae, which is indigenous to south Asia, where it grows in the Himalayan foothills from northeastern Pakistan to Northern West Bengal, India (Sharma *et al*., 2011). It has been introduced and become naturalized in other parts of India, Pakistan, Afghanistan, Bangladesh, Sri Lanka, Southeast Asia, West Asia, the Arabian peninsula, East and West Africa, Southern Florida, throughout the West Indies, and from Mexico to Peru, Paraguay and Brazil. In Puerto Rico, it is grown chiefly as an ornamental and in fencerows and hedges and has become naturalized along roadsides on the coastal plains and lower foothills. The rapid growing tree was utilized by the ancient Romans, Greeks and Egyptians; it is now widely cultivated and has become naturalized in many locations in the tropics (Fahey, 2005; Sachan *et al*., 2010).

Moringa oleifera is the best known of the thirteen species in the genus Moringa of family Moringaceae. These are Moringa oleifera, M. arborea, M. borziana, M. concanensis, M. drouhardii, M. hildebrandtii, M. longituba, M. ovalifolia, M. peregrine, M. pygmaea, M. rivae, M. ruspoliana and M. stenopetala (Mahmood *et al*., 2010).

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, M. 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),

 ISSN: 2394-4404

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, biopesticide (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, antidiabetic, hepatoprotective, 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). In the light of aforementioned properties of drumstick tree the following review highlights its vernacular names, distribution, economic and commercial importance along with traditional medicine and culinary uses.

Moringa is widely adapted to the tropics and subtropics. Optimum leaf and pod production requires high average daily temperatures of 25-30°C (77-86°F), well-distributed annual rainfall of 1000-2000 mm (40-80 in), high solar radiation and well-drained soils (Odee, 1998). Growth slows significantly under temperatures below 20°C (68°F). Ideal elevation is less than 600 m (1, 970 f). Moringa is relatively tolerant of drought and poor soils and responds well to irrigation and fertilization. Moringa tolerates a wide range of soil type**s** and pH (4.5-9) but prefers well-drained soils in the neutral pH range.

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.

This study focuses on verifying a simpler, safer and cheaper way of purifying water using Moringa oleifera leaves as acclaimed in some previous studies. It also assesses the effects of processing methods on the efficacy of the purification.

II. MATERIALS AND METHODS

DEFINITION OF GOAL AND DESCRIPTION OF THE STUDY SITE

This study developed different processing methods on leaves of Moringa oleifera and determined the effects of these processing methods on the efficacy of its water purification ability. The study was carried out in the processing laboratory of Agricultural Engineering department of The Polytechnic, Ibadan, Saki Campus while the water samples were taken from a tributary Oge river in Saki town that is impounded for municipal water supply.

SAMPLING PROCEDURES

The various processing methods employed in this study include:

- ✓ Moringa oleifera powder from sun-dried leaves.
- ✓ Moringa oleifera powder from oven-dried leaves.
- ✓ Moringa oleifera recipe from pounded fresh leaves.

The end products of the different processing methods were then used to treat directly three of the water samples from the river while the fourth one was not treated serving as the control experiment.

The three treated water samples are coded A (treated with pounded fresh leaves), B (treated with powder from oven-dried leaves), C (treated with powder from sun-dried leaves), and D (untreated as control experiment) before being put into the sampling bottles.

SAMPLE PREPARATION AND ANALYSIS

5 grams each of the pounded fresh leaves and the powder 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 physical characteristics analysed are appearance and colour and odour and while the chemical characteristics are 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. Total Viable count (TVC), Total Coliform count (TCC), Total Fungi count (TFC), Staphylococcus count (SC) and Eschericia Coli count (E.coli) were analysed as the bacteriological characteristics.

DATA ANALYSIS

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.

III. RESULTS AND DISCUSSIONS

PHYSICAL CHARACTERISTICS OF THE WATER SAMPLES

The result of the physical characteristics is presented in Table 1. The physical characteristics are appearance and colour and odour. The appearance and colour was found to be relatively clearer than when treated with the processed Moringa leaves. For the recipe, the sample appeared greenish and more turbid than when freshly collected with slight odour. For the sun-dried and oven dried leaves powder, the treated water samples also became relatively more turbid with slightly greenish and slightly brownish colour respectively that reduce over time with subsequent sedimentation process. The odour became more pronounced for all the treated samples from the products of the processed Moringa leaves, though not irritating.

CHEMICAL CHARACTERISTICS OF THE WATER SAMPLES

Table 2 revealed the result of the chemical characteristics. For the chemical characteristics, the pH was found to be 7.10 for the untreated sample and ranged from 5.00 to 7.12 when treated with the processed Moringa leaves. The acidity increased from 0.008mg/l for the untreated sample to 0.064mg/l for the sample treated with recipe from pounded Moringa leaves. Alkalinity ranged from 80.00mg/l to 860.00mg/l for the sample treated with powder from sun-dried Moringa leaves. The Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand also follow the same trend with the acidity and alkalinity increasing from 6.40mg/l, 30.60mg/l and 67.40mg/l for the untreated samples to 10.60mg/l, 52.80mg/l and 95.80mg/l respectively. 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 1113.60mg/l for the treatment with sun-dried Moringa leaves powder. Total Solids ranged from 0.99mg/l – 8.42mg/l, Total Dissolved Solids from 70.00mg/l – 350.00mg/l, Phosphate from 2.99mg/l – 54.52mg/l, Sulphate from 4.35mg/l – 115.22mg/l. The micro nutrients are also not excluded in the trend. Iron ranged from 0.68mg/l to 3.61mg/l, Lead ranged from less than 0.05 – 0.31mg/l, and Cadmium from less than 0.002 to 0.11mg/l, Manganese from0.71 to 3.42mg/l and zinc from 0.59 to 1.19mg/l.

Parameters	A	B	C	D
Apperance and Colour	Greenish and turbid	Slightly greenish and turbid	Slightly brownish and turbid	Relatively clearer in colour than others
Odour	Slight odour	Slight odour	Slight odour	Relatively odourless than others

Table 1: Physical characteristics of the treated water samples

Parameters	A	B	C	D
pH	5.66	7.12	5.21	7.10
Acidity	0.064	0.032	0.032	0.008
Alkalinity	220.00	860.00	300.00	80.00
Chloride	540.70	1113.40	795.15	22.26
TS	8.42	6.27	6.86	0.99
TDS	170.00	350.00	250.00	70.00
Phosphate	40.72	39.57	54.52	2.99
Sulphate	58.70	115.22	60.37	4.35
DO	10.60	10.20	9.70	6.40
BOD_5	48.60	51.90	52.80	30.60
COD	95.80	95.50	92.40	67.40
Iron	2.94	3.25	3.61	0.68
Lead	0.22	0.31	0.28	<0.05
Cadmium	0.07	0.11	0.09	<0.002
Manganese	2.46	3.42	3.66	0.71
Zinc	0.94	1.07	1.19	0.59

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

Table 2: Chemical characteristics of the treated water samples

BACTERIOLOGICAL CHARACTERISTICS OF THE WATER SAMPLES

Table 3 presented the bacteriological parameters of the water samples. The bacteriological characteristics like most of the chemical follow trend of increasing from the untreated sample to those treated with the processed Moringa products. The Total Viable count as a bacteriological parameter was $1.2x10^5$cfu/ml for the untreated sample and $4.8x10^5$cfu/ml for treatment with powder from oven-dried Moringa leaves. Total Coliform count from $0.2x10^5$cfu/ml to $0.8x10^5$cfu/ml, Total Fungi count from $0.1x10^5$cfu/ml to $0.2x10^5$cfu/ml, Staphylococcus count ranged from $0.4x10^5$cfu/ml to $1.5x10^5$cfu/ml while Escherichia Coli count ranged from $0.1x10^5$cfu/ml to $0.4x10^5$cfu/ml.

EFFECTS OF THE PROCESSED MORINGA LEAVES ON WATER SAMPLES

The water samples characteristics were significantly affected by the introduction of the different processed Moringa leaves. It was observed that the effects increased these parameters 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 products. The chemical characteristics are also affected negatively. An example is the rise in Lead concentration of the untreated water sample from a low value of less than 0.05mg/l to 0.31mg/l that is above the permissible concentration in the World Health Organization (WHO) standards for drinking water as presented in Table 4. Another example is an increase in the biochemical oxygen demand of the water samples from 30.60mg/l to 51.90mg/l. 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. Total coliform count was also raised from a value of $0.2x10^5$cfu/ml to $0.9x10^5$cfu/ml while Eschericia coli count increased from a relatively lower value of $0.1x10^5$cfu/ml for the untreated water sample to $0.4x10^5$cfu/ml.

Parameters	A	B	C	D
TVC	$3.9x10^5$	$4.2x10^5$	$4.8x10^5$	1.2x105
TCC	$0.8x10^5$	$0.5x10^5$	$0.5x10^5$	0.2x105
TFC	$0.2x10^5$	$0.2x10^5$	$0.2x10^5$	$0.1x10^5$
SC	$1.1x10^5$	$1.0x10^5$	$1.5x10^5$	$0.4x10^5$
E. Coli	$0.4x10^5$	$0.2x10^5$	$0.3x10^5$	$0.1x10^5$

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

Table 3: Biological characteristics of the treated water samples

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)

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

IV. CONCLUSIONS

This study examined the effects of different processing methods on the efficacy of using Moringa oleifera leaves as a purification technique for water. Earlier studies on the uses of the tree for water purification has only revealed the purification technique using the extracts from pounded fresh seeds and not direct introduction of the processed pounded seeds into the water sample (Lea, 2010 and Bergstedt, 2011). Processing leaves of Moringa oleifera by drying with different methods and applying the processed products directly showed that the water samples characteristics are more adversely affected than getting ameliorated thus making the samples not as purified as expected. It is therefore suggested from the findings of this study that dried Moringa leaves should not be applied directly as a water purifier but extracts from the processed products can be used as a further research.

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