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Physicochemical and Microbial Studies of Water Obtained from *Musanga cecropioides* (African Cork Wood or Umbrella or "Uno" Tree)

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Abstract: Levels of some physicochemical and microbial parameters in water samples obtained from *Musanga cecropioides (*The African Cork wood or Umbrella or "Uno" tree) have been determined. This was done to assess the portability of water obtained from this source. Physicochemical and microbial analyses were carried out using standard procedures of the Association of Official Analytical Chemist [1] and the American Water Works Association [2] respectively. Results of this study when compared to recommended standard of the WHO (2011) showed that: water obtained from *Musanga cecropioides* and used locally for various purposes by the people of the study area, contains acceptable levels of heavy metals such as Pb, Fe, Ni, Hg, Cr, V, Cd, Cu, Zn and Mn. It also revealed the presence of pathogenic microorganisms such as *staphylococcus aureus*, *Bacillus* spp and *Streptococci* which can be removed by boiling. Furthermore, levels of parameters such as total hardness, nitrates, ammonia, Ca, K, Na and Mg, though above the limits of the WHO, were observed to be within the recommended daily dietary intakes of the Food and Drug Administration (FDA, 2005) as well as that of Food and Nutrition Association (FNA, 2004). This indicates that, water obtained from this plant could be a source of nutrient supplement for nitrates, Na, Ca, K and Mg; which can be utilized both for dietary and agricultural purposes. Analysis also showed that, the hardness property of the water samples was due mainly to bicarbonate ions which can be removed by boiling. People, particularly the elderly in the study area prefer this water due mainly to their cultural attachment and addiction especially in the treatment of ailments. They also treat this water locally by addition of alum followed by boiling; thereby making it portable. This explains why water from this source has been consumed for decades without possible outbreak of epidemics.

Key words: Physicochemical and microbial status · *Musanga cecropioides* · Akwa Ibom State

INTRODUCTION

Water is one of the most important needs of man. It is estimated that, one can stay for months without food but can only survive a few days without water [3]. Water forms about 55-78% by weight of most living things and is thus very indispensible. Biochemically, water is regarded as a 'life sustainer'. The continuous biochemical reactions that take place in living things are made possible in the presence of water and without it, the cell collapses [4].

The problem of portable water supply in most rural communities has been perennial right from historical times. People had to go as far as many kilometers to fetch water from rivers and streams, most of whose routes are often hilly and slippery. Man had therefore devised various means of getting access to water to satisfy his daily needs [4]. Wells have being dug, dams have been constructed and reservoirs made; all in a bid to sustain water availability.

In some rural communities such as Itu, Etim Ekpo, Abak, Ukanafun, Oruk Anam and Ikot Ekpene local government areas of Akwa Ibom State, Nigeria, certain people particularly the elderly have devised a means of obtaining water in times of severe scarcity especially in dry seasons by cutting the buttress roots of the tree-*Musanga cecropioides.* This tree is known as 'Uno' by the people of Akwa Ibom state in Nigeria. These roots, when cut, drip out water in an appreciable amount. Mostly, the roots are usually cut in the evenings and the

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water is collected overnight. The water obtained is used for drinking, cooking, washing clothes and other domestic purposes. Water from this source is also used as local therapy for the treatment of headache, cough and as laxative. Although the water obtained from this source is apparently colourless, it has a detectable taste and odour.

This study was aimed at assessing the physicochemical and microbial parameters of water obtained from the tree *Musanga cecropioides* in order to evaluate its portability.

MATERIALS AND METHODS

Collection of Samples: The tree-*Musanga cecropioides* were randomly sampled in ten local government areas of Akwa Ibom state, Nigeria. In each of the local government areas, ten different trees from locations spread across the areas were chosen. These sampling points were based on availability and accessibility of the trees. The buttress roots of each tree were cut and the water collected using cleaned plastic bottles.

Samples were collected following standard procedures of the International Standard for Organization [5].

A total of 100 samples representing 10 samples from 10 trees in each of the ten local government areas selected for the study were collected for the analyses ensuring geographical spread. Samplings were carried out during the dry season in 2008 when the practice of obtaining this water is common. The sampling points and their codes were as follows:

S/N	SAMPLING LOCATIONS	SAMPLE CODE
1	ETIM EKPO	A
2	UKANAFUN	B
3	UYO	C
4	ITU	D
5	ETINAN	E
6	ORUK ANAM	F
7	ORON	G
8	ABAK	H
9	IKONO	I
10	IKOT EKPENE	J

Sample Preservation and Treatment: Samples were preserved in a refrigerator and maintained at 4°C. Physical parameters such as colour, odour, temperature and pH were determined insitu by methods of Association of Official Analytical Chemist [1]. Determination of parameters such as alkalinity, total dissolved solids, suspended solids and total hardness, dissolved oxygen, biological oxygen demand, chemical oxygen demand, as well as heavy metals was also carried out using standard procedures of AOAC [1]. For microbial analysis, standard procedures of American Water Works Association [2] were used. The determination of metallic concentration was done using Atomic Absorption Spectrophotometry –ASS [1].

RESULTS AND DISCUSSION

The results of physicochemical and nutrient parameters as well as levels of metals in water samples obtained from *Musanga cecropioides* are given in Table 1. Table 2 shows results of microbial analysis of the water samples. Tables 3 and 4 give coefficient of variation and correlation matrix of the parameters obtained for *Musanga cecropioides.*

The values of each parameter for all the sites were close but for few exceptions. Ranges of average physicochemical parameters obtained for the water samples were as follows: temperature (25.30±0.01-26.70±0.01°C); pH (5.80±0.13-6.60±0.15) and acidity (0.21±0.03-0.32±0.01). Others in mg/l were, alkalinity (171.00±2.58-179.00±2.15); bicarbonate (200.00±4.15-203.00±4.14); carbonate (0.19±.0.01-0.28±0.01); chloride (60.1±0.93-62.00±0.85); total hardness (1876±11.02-1900.00±11.02); Ca (170±2.13-194±2.50), Na (110.00±2.52-150.00±5.25); K (81.00±0.95-107.00±2.53); Mg (75-00±2.50-96.00±2.14); Fe (0.08±0.01-0.74±0.01); Mn (0.31±0.01-0.40±0.01; Cu (0.02±0.01-0.04±0.01); Zn (0.10±0.02-0.15±0.1); Pb (0.00±0.00-0.02±0.00); Cd (0.01±0.00-0.02±0.00); Hg (BDL); V (BDL); Ni (BDL), Nitrates (11.20±1.10-12.81±1.21); Ammonia (48.0±1.15-49.20±2.34); Sulphates (0.70±0.01-0.84±0.01); Phosphate (3.60±0.50-3.80±0.50) and BOD (2.30±0.50-2.51±0.47).

Similarities in variation of concentration were observed for parameters such as Zn and Cu; Pd and Cd; Fe and Mn; alkalinity, Ca, Mg, Na, K and sulphate ions as well as total hardness, Mg, Ca and bicarbonate ions. Generally, the concentration of the parameters was in the order total hardness > bicarbonate > Ca > alkalinity > Na > K > Cl > NH_3 > Nitrates > BOD > sulphates > Fe > Mg > Mn > carbonates > Zn > Cu > Pb > Cd > Cr > Hg = V. For microbial parameters (Table 2), staphylococcus aureus and Bacillus spp was found in all the sites while streptococci occurred only in two sites.

Table 1: Average Values of Physicochemical and nutrient Parameters as well as levels of metals in Water Samples Obtained From *Musanga cecropioides*

	Sampling points									
Parameters	A	B	C	D	E	F	G	H	I	J
TEMPERATURE 0 C	25.30±0.01	27.00±0.03	26.30±0.01	25.00±0.02	25.57±0.01	26.47±0.03	25.00±0.01	26.60±0.01	25.60±0.02	26.70±0.01
pH at 25 0C	6.6±0.01	5.8±0.00	6.0±0.02	6.4±0.02	5.9±0.01	6.0±0.02	7.0±0.15	6.5±0.01	6.9±0.03	6.2±0.01
HARDNESS as CACO3 Mg/L	1600±12.33	1603±11.98	1605±9.87	1601±10.50	1602±8.79	1605±10.76	1603±11.00	1602±11.13	1601±15.6	1603±9.65
Na	110.00±2.52	136±3.67	150±4.89	146±3.25	120±2.34	120±3.44	136±2.57	144±4.76	126±5.01	150.00±5.25
K	81.00±0.95	95±0.98	90±1.23	93±1.34	95±2.20	100±0.87	103±0.98	99±1.67	105±1.23	107.00±2.53
Mg	75.00±2.50	86±1.93	81±0.78	96±0.57	93±0.99	85±1.34	93±2.33	90±1.34	88±0.33	96.00±2.14
Ca	170±2.13	178±3.33	181±1.25	194±1.34	189±0.99	193±2.11	187±2.21	177±1.50	191±0.96	194±2.50
Fe	0.08±0.01	0.72±0.02	0.70±0.22	0.65±0.02	0.74±0.57	0.66±0.03	0.63±0.5	0.71±O.10	0.65±0.05	0.74±0.01
Mn	0.31±0.01	0.40±0.01	0.35±0.01	0.31±0.01	0.37±0.01	0.35±0.01	0.36±0.01	0.37±0.01	0.40±0.01	0.40±0.01
Cu	0.02±0.01	0.04±0.01	0.03±0.00	0.04±0.00	0.02±0.01	0.03±0.01	0.02±0.01	0.04±000	0.03±0.01	0.04±0.01
Zn	0.10±0.02	0.13±0.00	0.15±0.00	0.10±0.01	0.15±0.00	0.12±0.02	0.13±0.01	0.14±0.01	0.13±0.01	0.15±0.1
Pb	0.00±0.00	0.02±0.00	0.01±0.00	0.01±0.00	0.02±0.00	0.01±0.00	0.00±0.00	0.01±0.00	0.01±0.00	0.02±0.00
Cd	0.01±0.00	0.02±0.00	0.01±0.00	0.02±0.00	0.01±0.00	0.02±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.02±0.00
Hg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cr	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
V	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Ni	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BICARBONATES	200.00±4.15	202.00±1.22	201.52±3.33	201.20±1.33	200.00±2.76	201.00±3.33	200.00±2.34	201.22±1.23	201.50±1.09	202.00±4.14
NITRATES	11.20±1.10	11.98±0.99	11.60±1.50	11.20±1.33	11.90±0.50	11.91±0.99	12.00±1.11	11.98±1.23	11.50±1.50	12.81±1.21
AMMONIA	48.0±1.15	48.26±0.98	48.76±1.33	48.20±1.50	48.26±1.87	48.60±1.44	48.25±1.22	49.00±0.50	48.67±0.99	49.20±2.34
SULPHATES	0.70±0.01	0.80±0.01	0.79±0.05	0.80±0.01	0.81±0.02	0.78±0.10	0.81±0.05	0.79±0.22	0.83±0.15	0.84±0.01
PHOSPHATE	3.60±0.50	3.70±0.10	3.70±0.10	3.72±0.25	3.72±0.15	3.60±.50	3.60±0.05	3.66±1.22	3.54±0.12	3.80±0.50
CHLORIDE	60.1±0.93	61.01±1.22	61.10±0.55	60.40±0.87	60.60±1.11	62.00±0.56	60.40±1.02	60.01±0.77	60.10±0.93	62.00±0.85
TOTAL HARDNESS mg/l	1876±11.02	1888±5.55	1889±0.99	1878±0.33	1879±1.11	1888±0.55	1889±1.11	1876±0.99	1900v7.77	1900.00±11.02
ACIDITY	0.21±0.03	0.24±0.01	0.22±0.02	0.23±0.01	0.23±0.01	0.28±0.01	0.30±0.00	0.23±0.01	0.30±1.11	0.32±0.01
ALKALINITY	171.00±2.58	175±1.22	174.00±2.33	178±1.56	173.00±1.23	170±1.22	176.00±0.55	178.00±1.55	176.50±2.33	179.00±2.15
BOD	2.30±0.50	2.50±0.55	2.41±0.05	2.50±0.10	2.45±0.50	2.30±0.33	2.50±0.78	2.30±0.50	2.40±0.49	2.51±0.47

Table 2: Microbiological Analysis Of Water Samples Obtained From *Musanga cecropioides*

Sample no	Sample location	Pigmentation	Colony forming unit CFU/ml X104	GRAME STAINED REACTION	PROBABLE MICROOGANISM
A	URUAN	GOLDEN YELLOW	21.4	POSITIVE	STAPH AUREUS
		WHITE	6.7	POSITIVE	Bacillus spp
B	IBESIKPO	Golden yellow	25.8	‘’ ‘’	Staph. Aureus
		White	6.0		Bacillus spp
			6.3		Streptococci
C	UYO	Golden yellow	35.0	‘’ ‘’ ‘’	Staph. aureus
		White	4.2		Bacillus spp.
D	ITU	Golden yellow	73.1	‘’ ‘’ ‘’	Staph. Aureus
		White	4.0		Bacillus spp
E	OKOBO	Golden yellow	30.87	‘’ ‘’ ‘’	Staph. Aureus
		White	3.6		Bacillus spp.
F	ETINAN	Golden yellow	32.55	‘’ ‘’ ‘’	Staph aureus
		White	6.1		Bacillussspp
G	ABAK	Golden yellow	21.6	‘’ ‘’ ‘’’	Staph aureus
		White	4.5		Bacillus spp
H	ORON	GOLDEN YELLOW	30.6	‘’’ ‘’’ ‘’	Staph aureus
		WHITE	4.8		Bacillus spp
			6.0		streptococci
I	IKONO	Golden yellow	21.6	‘’ ‘’’ ‘’	Staph aureus
		White	3.8		Bacillus spp
			4.6		Streptococci
J	IKOT EKPENE	Golden yellow	33.3	‘ ‘’ ‘’’	Staph aureus
		White	5.6		Bacillus spp

Table 3: Coefficient of variation for Physicochemical and nutrient Parameters as well as levels of metals in Water Samples Obtained From *Musanga cecropioides at* $p<0.05$

PARAMETERS	NO OF SAMPLES	RANGE	SD	MEAN	CV%
TEMPERATURE 0 C	100	25.0-27.0	0.781354	25.905	3.016229
pH at 25 0C	100	5.8-6.9	0.416619	6.275	6.639347
HARDNESS as CACO3 Mg/L	100	1600-1605	1.767767	1602.625	0.110304
Na	100	110-150	14.4593	132.75	10.89213
K	100	81-107	6.845228	94.5	7.243627
Mg	100	75.0-96.0	7.029276	87.375	8.044951
Ca	100	170.0-194.0	8.484229	183.625	4.620411
Fe	100	0.08-0.74	0.217941	0.61125	35.65494
Mn	100	0.31-0.40	0.030589	0.3525	8.677857
Cu	100	0.02-0.04	0.009258	0.03	30.86067
Zn	100	0.10-0.15	0.019821	0.1275	15.54559
Pb	100	0.00-0.02	0.007559	0.01	75.59289
Cd	100	0.00-0.00	0.005175	0.01375	37.63994
Hg	100	0.00-0.00	0	0	0
Cr	100	0.00-0.00	0	0	0
V	100	0.00-0.00	0	0	0
Ni	100	0.00-0.00	0	0	0
BICARBONATES	100	200.0-202.0	0.776287	200.8675	0.386467
NITRATES	100	11.2-12.81	0.34585	11.72125	2.950627
AMMONIA	100	48.0-49.2	0.335769	48.41625	0.693506
SULPHATES	100	0.7-0.84	0.035857	0.785	4.567753
PHOSPHATE	100	3.54-3.8	0.054968	3.6625	1.50082
CHLORIDE	100	60.1-62.0	0.651608	60.7025	1.073445
TOTAL HARDNESS mg/l	100	1876-1900	6.104741	1882.875	0.324224
ACIDITY	100	0.21-0.32	0.031053	0.2425	12.80534
ALKALINITY	100	170-179	2.973094	174.375	1.705
BOD	100	2.3-2.51	0.094226	2.4075	3.91386

Table 4: Correlation Matrix for the Physicochemical and Nutrient Parameters as well as levels of Metals in Water Samples Obtained From *Musanga cecropioides*

			HARD												BICARBO	NITR	AMM	SULP	PHOS	CHLO	TOTAL	ACIDITY	
	TEMP	pH	NES	Na	K	Mg	Ca	Fe	Mn	Cu	Zn	Pb	Cd	Ni	NATES	ATES	ONIA	HATES	PHATE	RIDE	HARDNESS	ALKALINITY	
TEMP	1																						
pH	-0.62	1																					
HARDNESS	0.55	-0.5	1																				
Na	0.31	-0.09	0.33	1																			
K	0.24	0.21	0.27	0.34	1																		
Mg	-0.10	0.07	-0.02	0.49	0.69	1																	
Ca	-0.13	-0.02	0.23	0.23	0.68	0.72	1																
Fe	0.42	-0.36	0.79	0.61	0.68	0.68	0.58	1															
Mn	0.59	-0.13	0.24	0.22	0.72	0.32	0.21	0.61	1														
Cu	0.59	-0.28	0.12	0.68	0.30	0.35	0.18	0.48	0.29	1													
Zn	0.50	-0.32	0.5	0.40	0.46	0.28	0.14	0.67	0.70	0.07	1												
Pb	0.50	-0.73	0.23	0.28	0.31	0.42	0.33	0.66	0.62	0.49	0.56	1											
Cd	0.61	-0.47	0.26	0.26	0.21	0.31	0.45	0.28	0.07	0.64	-0.23	0.46	1										
BICAR	0.71	-0.34	0.31	0.63	0.36	0.15	0.19	0.5	0.53	0.87	0.27	0.56	0.55	1									
BONATES																							
NITRATES	0.59	-0.25	0.45	0.37	0.68	0.48	0.29	0.55	0.69	0.29	0.69	0.54	0.3	0.3	1								
AMMONIA	0.62	-0.08	0.40	0.58	0.60	0.28	0.27	0.53	0.5	0.53	0.64	0.37	0.09	0.62	0.65	1							
SULPHATES	0.20	-0.03	0.27	0.56	0.85	0.79	0.72	0.87	0.71	0.38	0.60	0.57	0.2	0.48	0.57	0.52	1						
PHOSPHATE	0.35	-0.61	0.19	0.60	0.03	0.46	0.19	0.43	0.13	0.48	0.40	0.68	0.45	0.38	0.49	0.31	0.34	1					
CHLORIDE	0.57	-0.6	0.74	0.20	0.32	0.10	0.45	0.37	0.26	0.26	0.31	0.47	0.67	0.43	0.62	0.42	0.28	0.44	1				
TOTAL	0.28	0.10	0.35	0.25	0.69	0.19	0.5	0.38	0.69	0.16	0.40	0.26	0.21	0.54	0.49	0.50	0.64	-0.02	0.48	1			
HARDNESS																							
ACIDITY	0.08	0.34	0.22	0.14	0.88	0.47	0.64	0.35	0.57	0.077	0.25	0.09	0.23	0.24	1.22	0.44	0.65	-0.10	0.42	0.83	1		
ALKA	0.05	0.30	-0.22	0.77	0.53	0.71	0.28	0.47	0.37	0.62	0.25	0.24	0.13	0.48	0.34	0.48	0.65	0.41	-0.16	0.27	0.33	1	
LINITYBOD	-0.12	-0.09	0.04	0.49	0.33	0.65	0.44	0.46	0.31	0.20	0.22	0.41	0.34	0.25	0.32	-0.08	0.64	0.54	0.17	0.37	0.32	0.54	1

DISCUSSION

Total hardness, Alkalinity, Bicarbonates, Ca, Na, K, Cl and Nitrates: Generally the level of parameters such as total hardness, alkalinity, bicarbonates, Ca, Na, K, Cl and nitrates were observed to be high in the water samples obtained from *Musanga cecropioides*. These parameters are nutrients parameters and indicate the level of soil fertility (Ogunkunle, 1998). The values of these parameters were also observed to be fairly constant (Cv < 50%) in all the water samples obtained in all the sites (Table 1). This either indicates similarity in the soil quality of the study areas where this plant grows or shows that M. *cecropioides* has a unique mechanism of absorbing and retaining certain quantities of these substances. With respect to the first point, several researchers such as Ogban *et al*. [7]; Udoh *et al*. [8], as well as Effiong and Ibia [9] had reported fertile and similar soils in the study area. These studies also indicated high contents of nutrient parameters such as Na, K, Ca and nitrates in the soil of the study areas. Furthermore, the people of this study area are farmers of food crops particularly vegetables like fruited pumpkin, water leaves, pepper, water melon, okro etc; most of which thrive best in soils with appreciable high contents of Na, K, Ca and nitrates. It is therefore deduced that the source of the high content of these parameters in the water sample obtained from the plant is the soil.

The plant-*Musanga cecropioides* grows in bush and forest, swampy or mash-like environments. An area of typical descriptions where this plant grows is either in farmland, forest or semi-forest. Again, the study areas are environments with little or no industrial activities. Alluvial deposits and parent rock contributions had already been reported as potential sources of nutrients such as K, Na, Ca and nitrates in soils of areas where industrial and other developmental activities of man have not yet set in. furthermore, soils in nearby environment and even some points of the study areas have already been reported to have appreciable deposits of limestone, clay and other mineral [3]. Therefore, the source of these parameters is most likely to be from natural alluvial or parent rock contributions.

Musanga cecropioides belongs to the plant family *Uticaceae Juss* [10]. High levels of the parameters such as: Na, k, Ca, bicarbonates, nitrates and total hardness had also been reported in extracts and cell saps of some members of this family [11-13]. The result of this study also shows high levels of Na, K, Ca, bicarbonates, nitrates and total hardness in the water samples obtained from

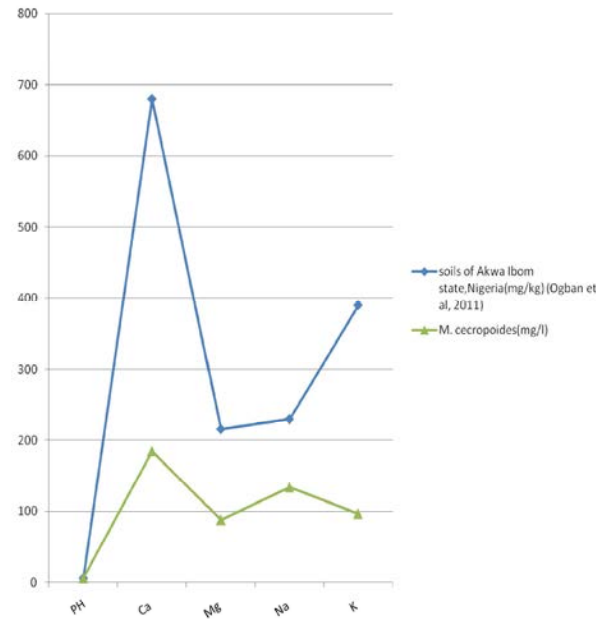

Fig. 1: A Comparison Of Some Parameters Obtained in M. *cecropioides* with that of the soils of the study area (Ogban *et al, 2011)*. NOTE: values of Ca is X 10^2. Mg X 10^2, Na X 10 and K X 10 mg/kg in Ogban *et al, 2011.*

Musanga cecropioides. A comparison of the levels of these parameters obtained in the water samples of M. *cecropioides* with that of cell saps of some plants such as pumpkin, water leaf and okro within the study areas [14, 15] shows that, the values obtained for M. *cecropioides* is relatively higher. This disparity clearly indicates that, the plant *Musanga cecropioides* has a unique capacity of obtaining and retaining high amount of these parameters.

Sulphates, Acidity and the Heavy Metals: Parameters such as sulphates, acidity and heavy metals like Fe, Mn, Cu, Zn, Pb, Cd and Cr were found in very low amounts in the water samples. Some heavy metals like Hg, V and Ni were all below detection limits. This again also points to the state of the soil of the study area. Quality study of the soil of the study area [7-9] had shown that, these soils have low levels of heavy metals probably due to the absence of much industrial activities so far in this zone.

Figure 1 shows that, levels of the parameters in the water samples obtained from the plant are an indication of their levels in soils where they grow. Therefore, certain plants e.g *Musanga cecropioides* can be used to monitor soil quality and extent of pollution, or fertility of a soil sample.

Comparison of the Result Obtained with Reccomended Standards

Heavy Metals, Temperature, pH, BOD, Sulphates, Chlorides, DO and COD: Levels of all the heavy metals namely Fe, Mn, Cu, Zn, Hg, Cr, V and Ni in the water samples were all within the recommended limits of the WHO (2011) standard. This indicates that water obtained from M. *cecropioides* is safe for drinking in terms of these heavy metals. Other parameters such as temperature, pH, BOD, sulphates, chlorides, DO and COD were also within recommended limits of the WHO standard.

Ammonia, Nitrates, Total hardness and Bicarbonates: The levels of ammonia, nitrates, total hardness and bicarbonates were well above the recommended limits of the WHO. Ammonia and nitrates indicate the amount of organic matter present in the sample (WHO, 2011). The plant M. *cecropioides* has already been reported to be involved in soil nitrogen fixation [10]. Therefore, the high levels of nitrates and ammonia observed in the water samples obtained from this plant is as expected. High values of these two parameters are also as expected in the water sample since it came from an organic source (plant). Ammonia, nitrate and nitrite play the most important role in biochemical processes of humans and other animals. Nitrogen is a dietary requirement for all organisms because it is a constituent of all proteins and nucleic acids [16]. However, Nitrate toxicosis can occur through enterohepatic metabolism of nitrate to nitrite being an intermediate [17]. Nitrites oxidize the iron atoms in hemoglobin from ferrous iron (2+) to ferric iron (3+), rendering it unable to carry oxygen [18]. This process can lead to generalized lack of oxygen in organ tissue and a dangerous condition called methemoglobinemia. Although nitrite converts to ammonia, if there is more nitrite than can be converted, the animal slowly suffers from a lack of oxygen [18].

In plant, nitrogen is the most commonly used mineral nutrient. It is often utilized in the form of nitrates and it is important for the production of protein. It plays a pivotal role in many critical functions (such as photosynthesis) in plants and is a major component of amino acids - the critical element constituent component of proteins. These amino acids are then used in the formation of protoplasm which is the site of cell division and plant growth. Nitrogen is necessary for enzymatic reactions in plants since all plant enzymes are proteins [19]. It is a necessary component of several vitamins, e.g., biotin, thiamine, niacin and riboflavin. Nitrogen is part of the nucleic acids (DNA and RNA). Deficiency of nitrogen causes chlorosis (yellowing) of the leaves due to decreased levels of chlorophyll. Since nitrogen is highly mobile within the plant; yellowing shows first on older leaves, with progressively younger leaves yellowing as the deficiency becomes more severe. Nitrogen deficient plants tend to be stunted, grow slowly and produce fewer tillers than normal [20].

The high nitrates and ammonia levels in the water sample obtained from this plant therefore shows that, it could be a good source of soil nitrogen and nitrates and can thus be utilized for dietary and agricultural purposes.

High levels of total hardness indicate hard water. This shows that, water obtained from this source when used for washing will form scum and cause soap wastage. From the result, there exists a positive relationship between total hardness, Ca, Mg, sulphates and bicarbonates ions. However, the concentration of bicarbonate ion in the water samples is observed to be far greater than that of the sulphates (Table 1). Therefore, although total hardness is a sum of temporary and permanent hardness associated with bicarbonates and sulphates of Ca and Mg respectively, the relatively high values of bicarbonates compared to sulphates in the results obtained suggests that, the hardness property of the water sample should be more of temporary hardness than permanent. This however, can be managed by boiling and used of detergents during washing. Furthermore, water of considerable hardness is considered to have some laxative effects (Aquapro, 2011). This seems to support some of the uses of the water obtained from this plant locally as a sort of laxative.

K, Na, Ca and Mg: The levels of metals such as K, Na, Ca and Mg in the water samples are well above the recommended limit of WHO (2011). A further comparison of these values with the recommended daily dietary intake of these substances (K, Na, Ca and Mg) in food by the Food and Nutrition Board (FNB) of the United States [21] and the United States Food and Drug Administration (FDA, 2005), shows that, the level of these substances in the water samples is within the limits of daily dietary intake. Average daily intake of water of an adult human is between 1-2 litres minimum and 1-4 litres maximum; the precise amount depends on the level of activity, temperature, humidity and other factors [22]. From our results, a litre of the water sample contains Ca (170±2.13-194±2.50), Na (110.00±2.52-150.00±5.25); K (81.00±0.95-107.00±2.53) and Mg (75-00±2.50-96.00±2.14). Therefore, 2 litres minimum and 4 litres maximum intake of water from the source will contain between 340-388 and 680-776mg of Ca; 220-300 and 440-600mg of Na; 150-192 and 300-384mg of Mg as well as 162-214 and 324-428 mg of K in 2litres minimum and 4 liters maximum daily water intake respectively. The amount of each of these substances if consumed via drinking of the water obtained from this source still does not exceed the daily intake of the FDA (2005) and FNB (2004). Shortage of these parameters in human, animal and plant's nutrition results in severe deficiency diseases [23, 24].

However, excess of these parameters is linked with several malfunctioning of humans and other animals. The availability of these parameters (K, Na, Ca and Mg) in such high amount in the water samples shows that, water obtained from *M. cecropioides* could be a source of these nutrient parameters in times of deficiency.

Microorganisms: The result of microbial analysis shows the presence of *Staphylococcus aureus* and *Bacillus spp* in all the water samples and the presence of *Streptococci* in most of the water samples. These microbes are pathogens of diseases. As microorganisms, they are found everywhere in the environment. However, no report has been made concerning the presence of these microorganisms in cell saps of plants. The presence of these microbes in the water samples obtained from the plant is most likely to be from contaminations by the environment. The water obtained can be sterilized by boiling.

Statististical Analysis of Results: Coefficient of variation obtained for the various parameters in the water samples shows that, the values of individual parameters were similar in all the water samples obtained from the plant at different locations. This observation possibly point to the fact that M. *cecropioides* have a unique mechanism of acquisition and storage of nutrients and metallic parameters. The positive correlations observed for most of the parameters also further supports the above observation. It also points to the fact that, water samples were obtained from similar sources.

Further Discussions: People in the study area, particularly the elderly, used water from this source for several purposes such as drinking, cooking, washing of clothes and bathing etc mainly due to lack of alternative sources especially during the dry season. Dr God'swill Akpabio-led administration in Akwa Ibom State, Nigeria has achieved a lot in terms of provision of portable water through provision of bore holes to make water available in rural areas. However, greater population of elderly in the rural areas still prefer this source of water for their drinking because they are used to it due to cultural attachment overtime. They also believe the efficacy of this water in the treatment of ailments.

Locally, coagulation with alums is a common practice for water purification in the study area. Coagulation helps remove organic and particulate substances. Boiling kills microorganisms and removes temporary hardness in water. Therefore, if the water obtained from this tree is coagulated and boiled, it could serve as an alternative source of portable water in communities where this plant is found especially in abundance.

Possible limitations associated with this water source include the fact that the trees are endangered and may go extinct due to the continual use of it as a water source. Again, bush burning, deforestation (clearing) for the purpose of agricultural activities and other developmental projects further post a serious threat to the endangered species of the plant-*Musanga cecropioides*.

CONCLUSION

The result of this study has shown that, water obtained from *Musanga cecropioides* and used locally for various purposes by the people of the study area contains acceptable levels of heavy metals such as Pb, Fe, Ni, Hg, Cr, V, Cd, Cu, Zn and Mn. However, the presence of pathogenic microorganisms tends to render it unfit for usage. Furthermore, a relatively high concentration of parameters such as total hardness, nitrates, ammonia, Ca, K, Na and Mg indicates that, although the water is hard and could waste soap during washing; water obtained from this plant could be a source of nutrient supplement for Na, Ca, K and Mg; which can be utilized both for dietary and agricultural purposes. This study also confirms possible laxative effect of the water sample due to the significant presence of magnesium and sulphate ions.

It is observed that, the elderly people in the study area prefer this water due to their cultural attachment and addiction especially in the treatment of ailment. They also treat this water by addition of alum and followed by boiling. These treatments in fact render the water portable and therefore safe for drinking.

The study has shown that, the plant is already endangered and continual use of it as a source of water aggravates the problem of extinction of the specie. It is necessary therefore to recommend that, individuals and government should join effort to check the threat of extinction by conscious planting and conservation of this endangered tree – *Mussanga cecropioides*.

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