MEDWIN PUBLISHERS
Committed to Create Value for Researchers

International Journal of Oceanography & Aquaculture
ISSN: 2577-4050

Antibacterial Activities in Upper River Benue Surface Water With *Diospyros Mespiliformis* Seed Extracts

Mohammed AM* and Uruku NM

Department of Fisheries and Aquaculture, Federal University Wukari, Taraba State, Nigeria

***Corresponding author:** Mohammed AM, Department of Fisheries and Aquaculture, Federal University Wukari, Wukari, Taraba State, Nigeria, Tel: 2347037613666; Email: mohammeda@fuwukari.edu.ng

Research Article

Volume 8 Issue 1

Received Date: February 09, 2024

Published Date: March 11, 2024

DOI: 10.23880/ijoac-16000296

Abstract

In this study, the extracts of *Diospyros Mespiliformis*; crude seed, mucilage and seed was used to investigate the potential effect of microbial activity and percentage turbidity reduction on surface water. The Sample water were collected from Upper River Benue at Jimeta Bridge. The sample was collected in Jerry cans (50 litters) transported to wet Laboratory, Department of Fisheries, School of Agriculture, Modibbo Adama University of Technology Yola. Portion of the water fetched were transferred to microbiology laboratory of same University for antibacterial test where three bacteria wer selected for the analysis. Moreover, part of the sample were used for Turbidity Test. Data obtained were analyzed using Analysis of Variance (ANOVA). The Result shows the potency of *D. mespiliformis* extracts on surface water and percentage turbidity reduction. The following bacteria; Escherichia coli, Bacillus subtilis and Staphylococcus aureus were used for the evaluation with *E. coli* recorded it highest mean of inhibition zone of 21 and zero as it lowest for crude seed at 15mg/l, 22 highest and zero is the lowest for seed mucilage at 15mg/l and 22 was the highest and zero lowest for seed extracts at 10mg/l. B. subtilis had highest mean of inhibition zone of 15 and zero as it lowest for crude seed, 20 highest and zero is the lowest for seed mucilage and 20 was the highest and zero lowest for seed extracts. *S. aureus* had highest mean of inhibition zones of 24 and zero as it lowest for crude seed, 20 highest and zero it lowest for seed mucilage and 22 was the highest and zero is the lowest for seed extracts. *D. mespiliformis* extracts succeeded by reducing very high percentage of the turbid water. *D. mespiliformis* extracts should be used hence forth use as primary coagulants for treatments of raw water for its ability to inhibit bacteria growth.

Keywords: Upper River Benue; West African Ebony; Seed Extracts; Surface Water

Abbreviations: ANOVA: Analysis of Variance; NTU: Nephelometric Turbidity Units; WHO: World Health Organization; SON: Standard Organization of Nigeria.

Introduction

Waste waters and man-made or naturally occurring surface waters can be unsuitable for consumption and irrigation and/or the health and proliferation of naturally occurring freshwater organisms due to the presence of excessive macronutrients and toxic heavy metals and organic xenobiotic compounds. Plant such as Duckweeds can improve water quality by removing or facilitating the removal of the deleterious substances from the water [1].

Diospyros Mespiliformis (kanya) Hochst (Ebenaceae) is used in ethnomedical practice against malaria in northern Nigeria [2]. Beyond pharmacological value, *Diospyros spp*.

have distinct and complementary important qualities, namely valuable wood, and edible fruits, which provide significant economic benefits and are recognized and utilized in various industrial and commercial sectors [3,4]. Previous studies in laboratory showed that the plant has analgesic, anti-inflammatory andantipyretic effects Adzu B, et al. [5], with CNS activity that is sedative in nature [6]. The plant was also reported to have potent antibacterial Adeniyi BA, et al. [7] and Lajubutu BA, et al. [8], anti-trypanasomal activities [9]. While separate studies have been conducted on identifying the antibacterial activity of many plants, little work was reported to elucidate their combined bactericidal effects [10]. Plant species also showed promising result in antimicrobial effect. Comparing with coagulation properties of plant species, little is known about the potential existence of natural disinfectants (i.e., substances with the ability to kill or inactivate pathogenic microorganisms), even though many herbs and plant extracts are used in traditional medicine and as pesticides in developing countries [11]. Researchers reported antimicrobial activity of *Dolichos lablab*, *Moringa oleifera*, *Azadirachta indica* and other plant species. Yongabi Kenneth A [12], Found that *Moringa oleifera*, *Jatropha curcas* and Hibiscus showed a better coagulation and disinfection activity with the methanol extracts. The antimicrobial effect could be attributed to flocculation Nwaiwu NE, et al. [13] and bactericidal action [14].

Generally, *Diospyros spp*. are tree shrubs or subshrubs with entire alternate leaves, solitary flowers, and fleshy fruits (berries) with usually two or more seeds. The characteristics of the leaves and flowers of these species are often used to identify fossil casts [15-17]. *Diospyros* species are predominantly distributed between the tropics, and the most notable diversity of this botanical genus occurs in Africa [15-18]. As confirmed in the Plant List [19], the WFO Plant List currently contains 1575 species related to the genus *Diospyros*, of which 734 have accepted scientific names [20]. Regarding the Mozambican flora, the genus is represented by 31 species, corresponding to 18 accepted scientific name species, seven accepted subspecies (subsp.), three species that are considered synonyms, and three species that are not yet in the WFO [20], Flora of Mozambique [21] and Da Silva MC, et al. [22].

The hexane fraction of *D. mespiliformis* leaves has antiinflammatory properties (inhibits stronger the LOX), and that the methanolic extracts of different plant parts showed wound healing effects. On the other hand, the butanol and ethyl acetate fractions activate LOX activity. However, it show that *D. mespiliformis* extract can have pro-inflammatory and anti-inflammatory effects [23]. This study is based on the hypothesis that a solution of the antibacterial agents would have a greater range of bactericidal activity than the solutions of other biocides.

Materials and Methods

Sample Location

Water sample was collected from Upper Benue River Adamawa Yola. Adamawa State is located within the climate of Northern Guinea Savannah zone and lies between latitude 80 and 110N and longitude 11.50 and 130E and climate is tropical with two distinct seasons; the dry and rainy seasons. The experiment was conducted at wet laboratory in the Department of Fisheries, School of Agriculture Modibbo Adama University of Technology Yola.

Experimental Design

The experiment was design as a factorial experiment. The crude seed, mucilage and seed extracts were randomly assigned to three (3) treatments with one control and all samples were replicated each to determine the effectiveness of the *Diospyros Mespiliformis* and is one contained containing 0g concentration, treatment 2, 3 and 4 constitute 5g, 10g and 15g respectively. Plastic buckets was used for the experimental set up. The experiment lasted for twelve weeks in every week a liter of water sample from each sample was taken to the laboratory for analysis. In the laboratory Sensitivity test and Turbidity analysis were conducted and results were recorded.

Process of the Extract of *Diospyros Mespiliformis* Crude Seed

Diospyros Mespiliformis seed was dry, dehusk and broken using pestle and mortar the dry crude seeds was grounded to powder form using grinding machine. Process for *Diospyros Mespiliformis* mucilage and seed extracts was conducted at Damaturu, Yobe State.

Sensitivity Test

Serial dilution technique was used three drops of the samples were pipetted into each set of petri-dish containing 20 ml of solidified nutrient agar. The nutrient agar was prepared with distilled water it was heated to boil to dissolve the agar completely. Autoclave at 121°C for 15 minutes. The dispense agar was inverted and incubated at 37°C for 24 hours. The plates containing treatments were removed from the incubator after 24 hours and ruler was used to measure the zone of inhibition in milli-meter.

Statistical Analysis

All the experiments were conducted in triplicate to ensure reproducibility of results. The final results were the average of the three. Data obtained were analyzed using Analysis of Variance (ANOVA).

Results

Antimicrobial Activity of Surface Water Treated with *Diospyros Mespiliformis* Crude Seed, Mucilage and Seed Extracts.

Table 1 is the laboratory analysis which shows the mean for zone of inhibition against the three test organisms of *Diospyros Mespiliformis* seed extracts recorded with the highest mean inhibition zone of 0 mm^2, 18 mm^2, 21 mm^2 and 24 mm^2 while *Bacillus subtil*is had the lowest mean inhibition zone of 0 mm^2, 11 mm^2, 12 mm^2 and 15 mm^2 for crude seed. The mean inhibition zone of *Diospyros Mespiliformis* seed extracts indicated that *Staphylococcus aureus* had the highest mean for zone of inhibition as: 0 mm^2, 18 mm^2, 22 mm^2 and 21 mm^2 while *E.coli* had the lowest mean for inhibition zone of 0 mm^2, 10 mm^2, 15 mm^2 and 15 mm^2 respectively.

Bacteria	Crude seed (T1)				Mucilage (T2)				Seed extracts (T3)				LSD
	T1x	T1a	T1b	T1c	T1x	T1a	T1b	T1c	T1x	T1a	T1b	T1c	
	(mgL^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	
E. Coli	0	12^{cd}	9^{a}	1^{a}	0	11^{d}	1^{a}	2^{a}	0	0^{d}	15^{b}	5^{b}	3.11***
Bacillus	0	11^{c}	2^{c}	15^{b}	0	2^{c}	9^{a}	0^{a}	0	12^{c}	0^{a}	0^{a}	2.15***
taph	0	18^{d}	21^{bc}	24^{a}	0	19^{cd}	19^{cd}	20^{bcd}	0	8^{d}	22^{b}	21^{bc}	3.20***

Means in same row with different superscripts are significantly different at ($p<0.05$). Key: T1x = Control, T1a = 5 mg L^{-1}, T1b = 10 mg L^{-1} and T1c = 15 mg L^{-1}

Table 1: Culture Inhibition Zones (mm^2) exhibited by Three Test Organisms Treated with *Diospyros Mespiliformis* Extract.

Effect of *Diospyros Mespiliformis* Dosage on Percentage Turbidity Reduction

Table 2 gives information on the weekly results of *Diospyros Mespiliformis* dosage on percentage turbidity reduction of crude seed measured as lowest at 15m/l in the first week with it highest at 68.42%. For the second weeks 17.91% recorded lowest at 10m/l of crude seed 50.75% was the highest of the seed extract at 15m/l. at the third weeks of the experiments 11.11% recorded lowest at 15m/l of *Diospyros Mespiliformis* mucilage while 47.62% was its highest at 15m/l of seed extract. In the fourth weeks 47.62% recorded as lowest at 5m/l of crude seed whereas 85.71% was the highest at 5m/l of *Diospyros Mespiliformis* mucilage. Moreover 50% recorded lowest at 15m/l of crude seed and 81.58% was its highest at 10m/l of seed extract.

Dosage in mg L^{-1}	% turbidity reduction of crude seed	% turbidity reduction of mucilage	% turbidity reduction of Seed extract
WK1 0	0	0	0
5	12.5	18.75	20
10	16.25	8.75	7.5
15	6.25	15	31.25
WK2 5	26.87	37	38.81
10	17.91	25.37	44.78
15	20.9	20.9	50.75
WK3 5	28.57	33.33	34.92
10	17.46	15.87	41.27
15	12.7	11.11	47.62
WK4 5	47.62	85.71	80.95
10	52.38	83.33	71.43
15	57.14	80.95	54.76
WK5 5	55.26	78.94	78.95
10	68.42	71.05	81.58
15	50	76.32	57.89

Key: WK1= Week 1, WK2 = Week 2, WK 3= Week 3, WK4 =Week 4 and WK5 = Week 5

Table 2: Effect of *Diospyros Mespiliformis* Dosage on Percentage (%) Turbidity Reduction.

Discussion

Antimicrobial Activity of Surface Water Treated with *Diospyros Mespiliformis* Crude Seed, Mucilage and Seed Extracts

The crude seed, mucilage and seed extracts of *D. mespiliformis* were tested against *E. coli, S. aurius* and *B. subtilis*. In a similar work reported by Shekhar C, et al. [24] in which crude ethanol extract of *M. oleifera* was tested against *E. coli*, *S. typhii*, *V. cholera*, *Shigella dysentriae* and *Pseudomonas aeruginosa*, showed it activity against *E. coli* only. This study showed that all the treatments had antibacterial activity against *E. coli, S. aurius* and *B. subtilis*. With *B. subtilis* recorded the mean 20 mm at 15mg/l dosage of *D. Mespiliformis* Mucilage and 20 mm at 15mg/l dosage of the Seed Extracts. Similarly, biogenic silver nanoparticles demonstrated excellent antibacterial activity against a broad range of bacteria, with the highest antibacterial activity observed against *E. faecalis* (17.77 mm) and *B. subtilis* (20 mm), also demonstrating good hemocompatibility against humans and rat red blood cells [25].

In humans, *Salmonella* are the cause of two diseases called salmonellosis: enteric fever (typhoid), resulting from bacterial invasion of the bloodstream, and acute gastroenteritis, resulting from a food borne infection/ intoxication. It was shown that *D. mespiliformis* crude seed, mucilage and the seed extracts has antimicrobial properties against *E. coli, Bacillus subtilis* and *Staphylococcus aureus* bacteria. It was observed that *S. aureus* was the most sensitive to the seed extracts as compared to *B. subtilis* and *E. coli*. This is an indication that the seed extracts can be effectively used to treat water contaminated with *S. aureau*. Meningitis is potentially epidemic and life-threatening and transmission of *S. aureus* in humans can occurs through contaminated water body. To prevent it from spreading, water if possible food as well must therefore be kept clean and the domestic water can be treated using *D. mespiliformis* crude seed, mucilage and the seed extracts. In this study, inhibition activity against *S. aureus* for *D. mespiliformis* extract was observed at the highest concentrations of 15 mg/l. This indicated that *S. aureus* was the most tolerant bacteria species to Diospyros extract as compared to *E. coli* and *B. subtilis*.

Turbidity

The declared World Health Organization guideline for turbidity for safe drinking water is 5 NTU (log100.700NTU) [26]. This is in consonance with the result obtained in this study with almost same value of 6 NTU of surface water treated with 5g of *D. mespiliformis* mucilage. Since groundwater has aquifers, the streams water is filtered by normal process, while the surface water encounter immediate effect as there are aquifers to channels the contaminants. The most significant result of using *D. mespiliformis* as coagulant agent is it reduction ability from the initial reading at 5 mg/L 12.5% turbidity reduction of crude seed and 85.71% turbidity reduction of seed mucilage same concentration but different treatment. The important of dosage on turbidity has been emphasized by Zand AD, et al. [27]. Over dosage should be avoided because there is a probability of destabilization of the destabilized particles to occur due to the saturation of the polymer bridge [28]. The settling of the particles is disturbed making it impossible to reach the desired turbidity needed. This is the reason why both coagulants used showed similar trend of increasing turbidity after achieving their optimum dosage. The effects of *Diospyros* extracts on percentage turbidity reduction is as shown in table 2 at *D. mespiliformis* extracts dosage of 0, 5, 10 and 15mg/L in the first week, the percentage reduction in turbidity of the sample water were 0, 12.5, 16.25 and 6.25% respectively. This shows that 5 mg/L dosage is sufficient enough to control turbid water, it is in line with the finding of Muyibi SA, et al. [29] who shows Moringa olefeira extract is less efficient in low turbid water. However, the maximum allowable turbidity value for safe drinking water as declared by WHO and SON guideline is 5 NTU [30,31].

Conclusion

This study provided valuable insights that *D. mespiliformis* extracts is very effective in it ability for antibacterial functions and reduction of turbid water. At maximum dose 5 mg/l of *D. mespiliformis* mucilage mostly observed to be more effective. *D. mespiliformis* mucilage and seed extract are more effective to *S. aureus*, *E.coli* and *B. subtilis* when compared with *D. mespiliformis* crude seed. This plant species have made the requirements of drinking water quality in terms of maximum permissible limit of turbidity (≤5 NTU) and in it capacity to inhibit the activities of *S. aureus*, *E.coli* and *B. subtilis* if there are used for rural area household water treatment.

Mohammed AM, et al. [32] reported the presence of flavonoids in *D. mespiliformis*, this may be the main reason for the antibacterial activity of the extract. In similar study Castillo-Lopez RI, et al. [33] reported that Flavonoids compounds such as quercetin and kaempferol in *M. oleifera* to be the main reason for the antioxidant activity of the plant. Flavonoids compound are known to have antioxidant, antibacterial, antifungal; and antiviral activity.

References

1. Ziegler AS, Mcllroy SJ, Larsen P, Albertsen, M, Hansen AA, et al. (2016) Dynamics of the Fouling Layer Microbial Community in a Membrane Biorector. PLoS One 11(7): e0158811.

2. Etkin NL (1997) Antimalarial plants used by Hausa in northern Nigeria. Tropical Doctor 27(1): 12-16.

3. Rauf A, Uddin G, Patel S, Khan A, Halim SA, et al. (2017) Diospyros, an underUtilized, Multi-Purpose Plant Genus: A Review. Biomedicine and Pharmacotherapy 91: 714-730.

4. Mallavadhani UV, Panda AK, Rao YR (1998) Review Article Number 134 Pharmacology and Chemotaxonomy of Diospyros. Phytochemistry 49(4): 901-951.

5. Adzu B, Amos S, Dzarma S, Muazzam I, Gamaniel KS (2002) Pharmacological evidence favouring the folkloric use of *Diospyros Mespiliformis* Hochst in the relief of pain and fever. Journal of Ethnopharmacological 82(2-3): 191-195.

6. Adzu B, Amos S, Muazzam I, Inyang US, Gamaniel KS (2002) Neuropharmacological screening of *Diospyros Mespiliformis* in mice. Journal of Ethnopharmacological 83(1-2): 139-143.

7. Adeniyi BA, Odelola HA, Oso BA (1990) Anti-microbial potentials of *Diospyros Mespiliformis* (Ebenaceae). African Journal of Medical Science 25(3): 221-224.

8. Lajubutu BA, Pinney RJ, Roberts MF, Odelola HA, Oso BA (1995) Antibacterial activity of diosquinone and plumbagin from the root of *Diospyros Mespiliformis* (Hostch) (Ebenaceae). Phytother Research 9(5): 346-350.

9. Freiburghaus F, Kaminsky R, Nkunya MHH, Brun R (1996) Evaluation of African medicinal plants for their in vitro trypanocidal activity. Journal of Ethnopharmacology 55(1): 1-11.

10. Fox DI, Pichler T, Yeh DH, Alcantar NA (2012) Removing Heavy Metals in Water: The Interaction of Cactus Mucilage and Arsenate (As (V)). Environmental Science and Technology 46(8): 4553-4559.

11. Robert L, Matthews M, Templeton R, Sabtri KT, Kiran B (2009) Disinfection of waterborne coliform bacteria by Neem oil. Environmental Engineering Science 26(9): 1435-1441.

12. Yongabi Kenneth A (2011) Africa: Use of Biocoagulants for Water Clarification, IOBB Forum. Integrated phytodisinfectant-sand filter drum for household water treatment in sub-saharan Africa. Journal of Environmental science and Engineering 5: 947-954.

13. Nwaiwu NE, Lingmu B (2011) Studies on the effect of settling time on coliform reduction using Moringa oleifera seed powder. Journal of Applied Science and Environmental Sanitation 6(3): 279.

14. Oluduro AO, Aderiye BI, Connolly JD, Akintayo ET, Famurewa O (2010) Characterization and antimicrobial activity of 4-(ß-dglucopyranosyl-→ 4-a-l rhamno pyranosyloxy) benzylthio carboxamide; a novel bioactive compound from Moringa oleifera seed extract. Folia Microbiology 55(5): 422-426.

15. Wallnöfer B (2001) The Biology and Systematics of Ebenaceae: A Review. Annalen des Naturhistorischen Museums in Wien 103 Bd, pp: 485-512.

16. White F (1983) Ebenaceae. Flora Zambesiaca 7: 269-271.

17. Denk T, Bouchal JM (2021) Dispersed Pollen and Calyx Remains of Diospyros (Ebenaceae) from the Middle Miocene “Plant Beds” of Søby Denmark. GFF 143(2-3): 292-304.

18. Burrows JE, Burrows SM, Lötter MC, Schmidt E (2018) Trees and Shrubs of Mozambique. Print Matters Heritage: Cape Town, South Africa, pp: 757-1114.

19. (2013) The Plant List. Version 1.1. Published on the Internet.

20. WFO (2013) Plant List World Flora Online.

21. (2022) Impatiens wuerstenii, a new endemic Impatiens from Mt Gorongosa finally described. Flora of Mozambique.

22. Da Silva MC, Izidine S, Amude AB (2004) A Preliminary Checklist of the Vascular Plants of Mozambique. Southern Africa Botanical Diversity Network Pretoria, South Africa.

23. Ebbo AA, Sani D, Suleiman MM, Ahmad A, Hassan AZ (2022) Assessment of Antioxidant and Wound Healing Activity of the Crude Methanolic Extract of *Diospyros Mespiliformis* Hochst. Ex A. DC. (Ebenaceae) and Its Fractions in Wistar Rats. South African Journal of Botany 150: 305-312.

24. Shekhar C, Shukla R, Kumar, Dubey NK (2000) Laboratory of herbal pesticides, Centre of advance study on botany, Banaras Hindu University Varanasi India. European Journal of Clinical Microbiological Infectious Disease 6: 23-28.

25. Polash SA, Hamza A, Hossain MM, Tushar MH, Takikawa M, et al. (2022) *Diospyros malabarica* Fruit Extract Derived Silver Nanoparticles: A Biocompatible Antibacterial Agent. Frontiers Nanotechnology 4: 888444.

26. World Health Organization (WHO) (2022) WHO Traditional Medicine Strategy: 2014– 2023.

27. Zand AD, Hoveidi H (2015) Comparing aluminum sulfate and Poly-Aluminum Chloride (PAC) performance in turbidity removal from synthetic water treatment. Journal of Applied Biotechnology Reports 2(3): 287-292.

28. Megersa MA, Beyene A, Ambelu D, Asnake Bekele T (2016) A premilinary evaluation of locally used plant coagulants for household water treatment. Water Conservation Science Engineering 1: 95-102.

29. Muyibi SA, Okuofu CA (1995) Coagulation of low turbidity surface water with *Moringa oleifera* seeds. International Journal of Environmental Studies 48(3-4): 263-273.

30. World Health Organization (WHO) (2011) Guidelines for Drinking-water Quality. In: 4th (Edn.), Geneva, Switzerland.

31. Standard Organization of Nigeria (SON) (2007) Nigerian standard for drinking water quality. pp: 15-16.

32. Mohammed AM, Jauro I, Modu AB, Haruna MY, Dauda AM (2022) Evaluation of Selected Metals Using West African Ebony (*Diospyros Mespiliformis*) Crude Seed, Mucillage and Seed Extracts on Upper River Benue Surface Water. Nigerian Journal of Tropical Agriculture 26: 151-158.

33. Castillo-Lopez RI, Leon-Felix J, Angulo-Escalante MA, Gutierrez-Dorado R, Muy-Rangel MD, et al. (2017) Nutritional and Phenolic characterization of Moringa oleifera leaves grown in Sinaloa, Mexico. Pakistan Journal of Botany 49(1): 61-168.