Research Article OPEN ACCESS | Freely available online

Preliminary antifungal and antibacterial activities of *Macaranga monandra* Mull.Arg. extracts

Boukandou M.M.M[1,2], Aboughe Angone S[1], Potgieter N[2,3], Traore Ndama A[2]

[1]Pharmacology and Toxicology Department, IPHAMETRA / CENAREST, BP: 1156 Libreville, Gabon. [2]Microbiology Department, University of Venda; Private Bag X5050; 0950 Thohoyandou, South Africa. [3]Dean, School of Mathematics and Natural Sciences, University of Venda; Private Bag X5050; 0950 Thohoyandou, South Africa.

Abstract: The problematic of antibiotic resistance raises the importance of new molecules with antimicrobial effects. Medicinal plants are surely the most promising source of efficient molecules with antimicrobial activity of the last decades. In Gabon, plant based traditional medicine is important in the health care of the population. *Macaranga monandra* (Euphorbiaceae) is used to treat several diseasesin Gabon. Hence, the objective of the present study was to perform a preliminary antimicrobial screening of *M. monandra* extracts against several microorganism strains. *M. monandra* bark extracts were prepared using distilled water and absolute methanol. Well diffusion assay was performed to evaluate antibacterial and antifungal potentialof *M. monandra* extracts at different concentrations (50 mg/ml, 75 mg/ml and 150 mg/ml) on several Gram-positive (*Staphylococcus aureus, Enterococcus faecalis, Bacillus cereus)*, Gram-negative (*Salmonella enterica, Escherichia coli, Shigella sonnei, Klebsiella pneumoniae, Pseudomonas aeruginosa, Enterobacter cloacae*) bacterial and fungal (*Candida albicans*, *Candida glabrata*, *Candida krusei*, *Candida tropicalis*, *Candida parapsilosis*, *Cryptoccocus neoformans* and *Cryptococcus gotti*) strains. The results indicate interesting antibacterial activity especially against Gram-positive bacteria including *S. aureus*, *B. cereus*,*E. faecalis* and *S. pneumoniae* from the lowest concentration (50 mg/ml). Gram-negative bacteria were less sensitive to the extracts as they were active at 75 mg/ml and 150 mg/ml. A weak antifungal effect was displayed by the extracts with diameter of inhibition ranging between 6 mm and 15 mm at 75 mg/ml and 150 mg/ml. This preliminary antimicrobial screening of *Macaranga monandra* barks showed encouraging antimicrobial properties against various bacteria and fungi.

Keywords: Antibacterial, Antifungal, Gabon, *Macaranga monandra*, Preliminary Screening, Well Diffusion Assay.

Citation: Boukandou M.M.M et.al, (2021) Preliminary antifungal and antibacterial activities of *Macaranga monandra* Mull.Arg. extracts, Journal of PeerScientist 4(1): e1000032.

Received: September 30, 2020; **Accepted:** February 06, 2021; **Published:** March 09, 2021.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing Interests: The author have declared that no competing interests exist.

***E-mail:** sophie.aboughe@gmail.com | **Phone:** +24107110703

I. INTRODUCTION

Medicinal plants are possible effective antimicrobial agents. Plant products exhibit molecular complexity, stereo chemical abundance and diversity in the ring system amongst other properties. This particularity of plants renders microorganisms unable to develop resistance to the multiple chemical complexes plant compounds can present [1]. Hence, plant products can be of interest in the fight against infectious diseases, drug resistance and also in the discovery of new molecules. For this reason, during the past years, there has been regain interest regarding medicinal plant extracts for the development of alternative drugs to inhibit, prevent or delay the growth of pathogens [2]. Several studies have been screened plant extracts for antimicrobial activities highlighting plant compounds with promising potential [3-6]. These compounds showed interesting activity against bacteria (Gram-positive, Gram-negative), viruses, fungi and parasites by affecting several key events in the pathogenic process of these microorganisms [7-12].

In Gabon, plant based traditional medicine is important in the health care of the population. It is therefore essential to gather scientific information about plants that are used to treat infections in order to validate their use [13]. Thus, *Macaranga monandra* (Euphorbiaceae) is a shrub (or a tree) reaching 25m in height which is used to treat many ailments in Gabon. The barks are taken as a galactagogue, for the treatment of infertility, dyspnea and in case of threatened abortion. The barks are also taken to alleviate HIV symptoms. The geographical distribution covers many countries including

Angola, Cameroon, Nigeria, Equatorial Guinea and Central African Republic [13]. Around 300 species have been described in the genus Macaranga [14]. Phytochemical composition of *M. monandra* is scarce in the literature, however, the composition of other species of the genus reported the presence of phenols, sterols, diterpenes, tannins, alkaloids and flavonoids [15-23]. Besides, a bio-guided fractionation assay highlighted two clerodane-type diterpenes which exerted an antifungal effect against various plant fungi such as *Colletotrichum acutatum, C. fragariae, Fusarium oxysporum, Phomopsis obscurans* and *P.viticola* [24]. The objective of the present study was to screen for potential antimicrobial activities of *M. monandra* extracts against several pathogenic bacteria and fungi.

II. Results & Discussion

The results showed the antibacterial and antifungal activities of methanolic and aqueous plant extracts at different concentrations using well diffusion assay. The extractions yielded 6.24% for the aqueous extract and 5.05% for the methanol one. Table 1 describes the effect of the extracts tested on various bacterial strains. Both *M. monandra* aqueous and methanolic extracts at 150 mg/mL and 75 mg/mL inhibited the growth of all the strains with diameter of inhibition ranging from 6 mm to more than 16 mm. The Gram-positive bacteria (*S. aureus, B. cereus,E. faecalis* and *S. pneumoniae*) were sensitive to the extracts especially *S. aureus* which showed activity from 50 mg/ml (12 mm<diameter of inhibition<15 mm). All Gram-negative bacteria showed weak activity with diameter of inhibition ranging between 6 mm and 11 mm even at the highest concentration except for *P. aeruginosa* which showed diameter of inhibition between 12 mm and 15 mm at 75 mg/ml and 150 mg/ml.

Table 1: Antibacterial activity of *M. monandra* extracts:

	Aqueous Extract (mg/ml)			Methanol extract (mg/ml)			Genta-micin
	150	75	50	150	75	50	
Staphylococcus aureus	++ +	++	++	++	+++	++	+++
Bacillus cereus	++	++	+	+++	++	+	+++
Enterococcus faecalis	++	++	-	++	++	-	+++
Escherichia coli	+	+	-	+	+	-	+++
Shigella sonnei	+	+	-	+	+	-	
Salmonella enterica	+	+	-	+	+	-	+++
Klebsiella pneumoniae	+	+	-	+	+	-	+++
Pseudomonas aeruginosa	++	++	-	++	++	-	+++
Enterobacter cloacae	+	+	-	+	+	-	+++

(+ = 6<diameter of inhibition <11; ++ = 12 < diameter of inhibition <15; ++ = diameter of inhibition >16; - = No inhibition).

Table 2 shows the fungal inhibitory potential of *M. monandra* extracts. The results indicate an antifungal activity from 75 mg/ml with diameter of inhibition ranged between 6 mm to15 mm for the aqueous extract and from 6 mm to >16 mm for the methanol extract.

Table 2: Antifungal activity of *M. monandra* extracts:

	Aqueous extract (mg/ml)			Methanol extract (mg/ml)			Genta -micin
	150	75	50	150	75	50	
Candida albicans ATCC14053	++	+	-	++	+	-	-
Candida albicans ATCC 90023	++	+	-	++	+	-	-
Candida glabrata	++	+	-	+++	++	+	+
Candida krusei	++	+	-	++	+	-	++
Candida tropicalis	+	+	-	+	+	-	++ +
Candida parapsilosis	+	+	-	+++	+	-	++ +
Cryptoccocus neoformans	+	+	-	++	-	-	++ +
Cryptococcus gotti	+	++	+	+++	++	+	++ +

(+ = 6 < diameter of inhibition < 11; ++ = 12< diameter of inhibition < 15; +++ = diameter of inhibition >16; - = No inhibition)

The present study aimed at evaluating the potential antibacterial and antifungal effects of *M. monandra* extracts against several bacterial and fungal strains. The results revealed a higher sensitivity of Gram-positive bacteria to the extracts compared to Gram-negative bacteria. Several studies report that medicinal plants are more active on Gram-positive bacteria such as the one tested [26]. Gram-positive bacteria are the most common causes of clinical infections and according to Woodford and Livermore [27], infections caused by Gram-positive bacteria constitute major public health burden in terms of mortality, morbidity as well as in terms of increased patient management expenses. In addition, several plants from the same genus such as *Macaranga bancana, M. gigantea, M. pruinosa, M. tanarius* and *M. triloba* were reported to exert strong antibacterial activity [28] what sustains the finding in the

present study as many plants belonging to the same taxa (species, genus, families) share group of characteristic compounds. In another hand, aqueous extract and methanol extract did not show a significant difference in the antibacterial activity as the extracts displayed the same range of diameter of inhibition for all the bacteria tested. Moreover, the yield of the extracts was not significantly different suggesting that similar phytochemicals might have been extracted with the two solvents. *M. monandra* which showed promising potential against Gram-positive bacteria could be a source of antibacterial molecules that's worth to be explored.

Worldwide fungal infections are responsible for hundreds of thousands of deaths each year among individuals with AIDS and HIV [29]. These fungi are causes for numerous infections such as *Pneumocystis pneumonia*, meningitis, histoplasmosis, pulmonary aspergillosis, oropharyngeal and oesophageal candidiasis. Some commensal fungi become harmful and cause infections in immuno-compromised individuals. However, many studies have validated medicinal plants in fighting fungi such as *Candida spp.*, *Aspergillus spp*. and *Cryptococcus spp* by performing assays including agar well diffusion [30-32]. In our study, *M. monandra* extracts were able to exert a weak antifungal activity from 75 mg/ml against all the fungal strains tested including hospital isolates. These findings are in accordance with the study by Salah et al. [24] who pointed at kolavenic acid and 2-oxokolavenic acid as responsible for the fungal growth inhibition of *M. macaranga*. The weak antimicrobial response of the extracts could be due to the ability of some plant compounds to diffuse in agar. Some non-polar molecules can't diffuse properly in agar that can explain the weak activity displayed by the plant extracts [33]. Many factors such as solubility or polarity of the compound may have played an important role in the activity displayed, hence, liquid methods such as broth dilution methods may provide a more realistic idea of the antimicrobial activity of the studied plant especially if a previous screening is done to highlight the most sensitive microorganisms.

III. Conclusion

This study is a preliminary work with the aim of screening *M. monandra* bark aqueous and methanol extracts for potential antibacterial and antifungal properties. Few information is available on the literature regarding the antimicrobial activity of this plant, making a necessity to gather data on its potential antimicrobial activity. The yield of the aqueous and methanol extracts was approximately the same. The results in this study indicate encouraging antimicrobial properties particularly against gram-positive bacteria such as *S. aureus*, *B. cereus* and *E. faecalis*. Nevertheless, *M. monandra* also displayed interesting inhibitory activity against *Pseudomonas aeruginosa* and some strains of Candida (*C. albicans*, *C. glabatra*, *C. krusei*). In addition, the diameter of inhibition induced by the methanol and aqueous extracts did not show a significative difference when compared. In Gabon, *M. monandra* is used to alleviates HIV symptoms and other ailments including infectious diseases caused by bacteria and fungi. We believe that infectious diseases and antibiotic resistance represent a challenge which can be overtaken by the discovery of new antibiotic molecules derived from medicinal plant compounds. This study has demonstrated that the studied plant has a good antimicrobial potential which can explain it utilization in traditional medicine against the above-mentioned pathologies. Yet, further investigation using other methods such as minimum inhibitory concentration and minimum bactericidal concentration determination should be led to validate the activity displayed in this study. In addition, a bio-guided fractionation should be undertaken to identify compounds which can be responsible for the potential antimicrobial activity displayed in this study by *M. monandra* extracts.

IV. Materials & Methods

Sample collection

Macaranga monandra barks were collected in Libreville (Gabon). The plant was identified and authenticated by a botanist from the National Herbarium at the Pharmacopeia and Traditional Medicine Institute (IPHAMETRA) in Libreville (Gabon). The collected plant barks were air dried, ground and then stored in a cool dark place until needed.

Extraction

Extraction was performed using distilled water and methanol (100%). Briefly, hundred (100) grams of the plant powder was macerated into 1000 mL of solvent (sterile distilled water or 100% methanol) for 24 hours with constant shaking. Each solution was filtered using Whatman filter paper number 4 (Sigma Aldrich; St Louis, MO; USA). The aqueous filtrate was evaporated by lyophilization using a FreeZone 2.5 LBenchtop Freeze Dryer (LabConco; Kansas City, MO, USA). The methanolic filtrate was evaporated by rotary evaporation at 50°C using a Buchi Rotavapor R-210 (BüchiLabortechnik AG; Flawil, Switzerland).

Microorganisms tested

Bacterial strains (Anatech Instruments, Gauteng, South Africa) used in this study were ; *Staphylococcus aureus* (ATCC 25923), *Salmonella enterica* (ATCC

51741), *Escherichia coli* (ATCC 25922), *Shigella sonnei* (ATCC 25931), *Enterococcus faecalis* (ATCC 29212), *Klebsiella pneumoniae* (ATCC 27736), *Pseudomonas aeruginosa* (ATCC 27853), *Enterobacter cloacae* (ATCC 13047) and *Bacillus cereus* (ATCC 10876). While the fungal strains (Anatech Instruments, Gauteng, South Africa) were *Candida albicans* (ATCC 14053), *Candida albicans* (ATCC 90023), *Candida glabrata* (ATCC 90030), *Candida krusei* (ATCC 6258), *Candida tropicalis* (ATCC 750), *Candida parapsilosis* (ATCC22019) and clinical strains *Cryptoccocus neoformans* and *Cryptococcus gotti.*

Well diffusion assay

The antimicrobial screening was performed according to Hassan and Ullah [25] with some modifications. Briefly, bacterial and fungal colonies were collected from a 24 h mother culture and suspended in broth solution (nutrient broth for bacteria or Sabouraud broth for fungi). A suspension corresponding to 0.5 McFarland standard was prepared. A sterile cotton swab impregnated with the inoculum was used to evenly streak the entire surface of the agar (Sabouraud dextrose agar for fungi and Mueller Hinton agar for bacteria). Then, 6 mm wells were punched onto the plate. Afterwards, 50 µL of different plant extract concentrations (50 mg/mL, 75 mg/mL, 150 mg/mL) was transferred to the corresponding well, followed by incubation at 37°C for 24 h for the bacteria and 48 h for the fungi. Gentamicin (10 mg/mL) was the positive control. The test was run in triplicate.

Authors' contribution: All authors equally contributed in designing, execution, data collection, analysis of the results, drafting, editing and finalizing the manuscript work. All authors have read and approved the final manuscript.

REFERENCES

1. Gupta, Pooja D., and Tannaz J. Birdi. "Development of botanicals to combat antibiotic resistance." *Journal of Ayurveda and integrative medicine* 8.4 (2017): 266-275.
2. Salameh, Nihaya, et al. "Screening of Antioxidant and Antimicrobial Activity of Micromeria fruticosa serpyllifolia Volatile Oils: A Comparative Study of Plants Collected from Different Regions of West Bank, Palestine." *BioMed research international* 2020 (2020): 7.
3. Sisay, Mekonnen, et al. "Investigating In Vitro Antibacterial Activities of Medicinal Plants Having Folkloric Repute in Ethiopian Traditional Medicine." *Journal of evidence-based integrative medicine* 24 (2019): 2515690X19886276.
4. Anyanwu, Madubuike Umunna, and Rosemary Chinazam Okoye. "Antimicrobial activity of Nigerian medicinal plants." *Journal of intercultural Ethnopharmacology* 6.2 (2017): 240-259.
5. Weckesser, S., et al. "Screening of plant extracts for antimicrobial activity against bacteria and yeasts with dermatological relevance." *Phytomedicine* 14.7-8 (2007): 508-516.
6. Le Anh Dao, Nguyen, et al. "Screening and comparative study of in vitro antioxidant and antimicrobial activities of ethanolic extracts of selected Vietnamese plants." *International Journal of Food Properties* 23.1 (2020): 481-496.
7. Bazaka, Kateryna, et al. "Anti-bacterial surfaces: natural agents, mechanisms of action, and plasma surface modification." *Rsc Advances* 5.60 (2015): 48739-48759.
8. Díaz-de-Cerio, Elixabet, et al. "Health effects of Psidium guajava L. Leaves: An overview of the last decade." *International journal of molecular sciences* 18.4 (2017): 897.
9. Chiavari-Frederico, Marcela Oliveira, et al. "Antimicrobial activity of Asteraceae species against bacterial pathogens isolated from postmenopausal women." *Plos one* 15.1 (2020): e0227023.
10. Joshi, Bishnu, et al. "Antibacterial, antifungal, antiviral, and anthelmintic activities of medicinal plants of Nepal selected based on ethnobotanical evidence." *Evidence-Based Complementary and Alternative Medicine* 2020 (2020): 14.
11. Tripathi, Ashutosh, Sukrat Sinha, and Brijesh Kant Dwivedi. "An Attempt to Evaluate Antiviral Activity of Plant Extracts to Combat Infections Caused by Viruses Including SARS COV-2." *Available at SSRN 3599444* (2020).
12. Ismaila, Fyaz MD, et al. "Antiparasitic natural products." *Medicinal Natural Products: A Disease-Focused Approach* 55 (2020): 115-151.
13. Schmelzer GH. *Macaranga monandra* Mull..Arg. Record from PROTA4U. Schmelzer h and Gurib-Fakim A. PROTA (Plant Ressources of Tropical Africa/ Ressourcesvegetales de l'AfriqueTropicale), Wageningen, Netherlands. Cited 21 Sept 20. Available from http:/www.prota4u.org/search.asp.
14. Webster, Grady L. "Classification of the Euphorbiaceae." *Annals of the Missouri Botanical Garden* (1994): 33-144.
15. Thoison, Odile, et al. "Vedelianin, a hexahydroxanthene derivative isolated from Macaranga vedeliana." *Phytochemistry* 31.4 (1992): 1439-1442.
16. Van Der Kaaden, Jacobus E., Thomas K. Hemscheidt, and Susan L. Mooberry. "Mappain, a New Cytotoxic Prenylated Stilbene from Macaranga m appa." *Journal of natural products* 64.1 (2001): 103-105.
17. Hnawia, Edouard, et al. "A geranyl substituted flavonol from Macaranga vedeliana." *Phytochemistry* 29.7 (1990): 2367-2368.
18. Yang, Da-Song, et al. "Three new prenylated flavonoids from Macaranga denticulata and their anticancer effects." *Fitoterapia* 103 (2015): 165-170.
19. Schütz, Barbara A., et al. "Prenylated flavanones from leaves of Macaranga pleiostemona." *Phytochemistry* 40.4 (1995): 1273-1277.

20. Hui, W. H., et al. "Isolation and structure of macarangonol, a diterpene ketol from Macaranga tanarius." *Phytochemistry* 10.7 (1971): 1617-1620.

21. Jang, Dae Sik, et al. "Prenylated flavonoids of the leaves of Macaranga conifera with inhibitory activity against cyclooxygenase-2." *Phytochemistry* 61.7 (2002): 867-872.

22. Phommart, Suporn, et al. "Constituents of the Leaves of Macaranga t anarius." *Journal of Natural Products* 68.6 (2005): 927-930.

23. Rekha K, Pandey R, Jain N, Supriya B, Babu KS and Rao JM. "Chemical constituents from *Macaranga peltata* roots and screening of their cytotoxic activity". *Int J Pharm Chem Sci.* 3.2 (2014): 415-419.

24. Salah, Martin A., et al. "Antifungal clerodane diterpenes from Macaranga monandra (L) Muell. et Arg.(Euphorbiaceae)." *Journal of agricultural and food chemistry* 51.26 (2003): 7607-7610.

25. Hassan, Amir, and Himayat Ullah. "Antibacterial and antifungal activities of the medicinal plant veronica biloba." *Journal of Chemistry* (2019): 7.

26. Rana, SM Masud, et al. "Susceptibility of microorganism to selected medicinal plants in Bangladesh." *Asian Pacific Journal of Tropical Biomedicine* 4.11 (2014): 911-917.

27. Woodford, Neil, and David M. Livermore. "Infections caused by Gram-positive bacteria: a review of the global challenge." *Journal of Infection* 59 (2009): S4-S16.

28. Rianti Putri, Rudi Hendra, and Hilwan Y. Teruna. "Anti-Bacterial and Anti-Fungal Activities from Macaranga bancana Leaves Extract." *growth* 10 (2019): 100.

29. Saloman L. The role of fungal infections in HIV. 2017. Cited 21 Sept 20. Available from www.contagionlive.com/news/the-role-of-fungal-infections-in-hiv.

30. Kumari, Poonam, et al. "Antifungal and anti-biofilm activity of essential oil active components against Cryptococcus neoformans and Cryptococcus laurentii." *Frontiers in microbiology* 8 (2017): 2161.

31. Murtaza, Ghulam, Muhammad Mukhtar, and Aysha Sarfraz. "A review: Antifungal potentials of medicinal plants." *Journal of Bioresource Management* 2.2 (2015): 23-31.

32. Aqil, Farrukh, et al. "Antifungal activity of medicinal plant extracts and phytocompounds: a review." *Combating Fungal Infections* (2010): 449-484.

33. Scorzoni, Liliana, et al. "The use of standard methodology for determination of antifungal activity of natural products against medical yeasts Candida sp and Cryptococcus sp." *Brazilian Journal of Microbiology* 38.3 (2007): 391-397.