



Phytochemical Screening and Comparative Evaluation of Antioxidant Activity of Different Parts of *Anonidium mannii* (Oliv) Engl. et Diels.

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Authors' contributions

This work was carried out in collaboration among all authors. Author JEMT designed the study, supervised the work and corrected the first draft of the manuscript while author SNN carried out the tests and wrote the protocol. Author SVF supervised the realization of the tests while author FEM managed the literature searches. Author GMMEL wrote the first draft while author XSN managed the analyses of the study and corrected the written versions of the manuscripts. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aimed at identifying the phytochemical constituents, to evaluate and compare the *in vitro* antioxidant potential of the methanolic extracts of the leaves, trunk (wood and bark) and roots (wood and bark) of *Anonidium mannii* (Oliv) Engl. and Diels which is used in Cameroon for the treatment of rheumatism.

Place and Duration of Study: The work was conducted at the Pharmacochimistry and Natural Substances Laboratories of the Faculty of Medicine and Pharmaceutical Sciences, University of Douala. All the experiments were carried out from the 15th October 2019 to the 31th July 2020.

Methodology: Phytochemical screening was based on conventional techniques focusing on color reactions and precipitation. The evaluation of the antioxidant power was carried out by the method of scavenging the free radical DPPH of the extracts and by reading the absorbance for each concentration at 517 nm.

Results: The phytochemical screening of the extracts revealed the presence of alkaloids, flavonoids, anthraquinones, coumarins, terpenes, steroids, saponins, phenols and anthocyanins. All extracts tested showed antioxidant activity, particularly root wood with an IC₅₀ = 1.85 µg/ml identical to the standard (BHT: Butylhydroxytoluène).

Conclusion: Due to evidence that reactive oxygen species play a causal role in auto-immune diseases, such as rheumatoid arthritis, these results justify the use of the leaves or the stem bark of *A. mannii* in the traditional pharmacopeia for the treatment of rheumatism. However, the wood of the roots having presented the best activity (IC₅₀ = 1.85 µg/ml). It would be beneficial to suggest this plant part to the local populations for the management of that pathology. This study is the first comparative biological study conducted on the different parts of *A. mannii*.

Keywords: Phytochemical screening; antioxidant activity; *Anonidium mannii*; medicinal plant.

1. INTRODUCTION

The use of some synthetic antioxidant molecules is currently a concern due to their association with potential toxicological risks. An antioxidant is a substance which prevents or slows down oxidation by neutralizing free radicals which, in excess, are responsible for cellular damage, in particular on DNA and can promote diseases.

Since few decades, natural antioxidants are gaining a great deal of interest [1,2]. In fact, polyphenols are important natural compounds widely distributed in the plant kingdom particularly thanks to their beneficial effects on health [3]. Their natural antioxidant properties are attracting more interest in the prevention and treatment of cancer, inflammatory, cardiovascular diseases and rheumatism [4]. The importance of antioxidants in rheumatoid arthritis is known [5]. Some studies have shown that consumption of the antioxidants have protective effects against tissue damage and may lead to clinical improvement in patients [6,7]. Antioxidant compounds reduce inflammation by exerting their effects on the transcription factor of NF-κB, in RA patients [7]. They are also used as additives in foods, pharmaceuticals and cosmetic industries [1]. Scientific research has been developed for the extraction, identification and

quantification of these compounds from different sources such as agricultural and horticultural crops or medicinal plants [8-10].

New and bioactive molecules have been isolated from medicinal plants from Cameroon and across the world. In order to contribute to the enhancement of floristic biodiversity in general and in particular to the study of *Anonidium mannii* (Oliv) Engl. and Diels, a medicinal plant from Cameroon, we directed our research to the evaluation of the antioxidant activity of the different parts of this plant, motivated on the one hand by its use in traditional medicine for the treatment of rheumatism [11,12], support by the evidence that antioxidants have a beneficial effect on clinical characteristics of rheumatoid arthritis [13]. On the other hand, a literature review revealed few studies on *A. mannii* including the phytochemical study, the evaluation of the antiprotozoal and cytotoxic activity of the stem bark, the antimycobacterial activities of the leaves and twigs, the antiplasmodial activities of the leaves and stems and the antioxidant, cytotoxic and antibacterial activities of the leaves [14-17]; the other parts have not been studied.

Indeed, this study aimed to identify the classes of secondary metabolites and to evaluate and compare the antioxidant activity of the leaves, trunk wood, stem bark, root wood, root bark of

Anonidium mannii in order to determine the parts displaying the best activity.

2. MATERIALS AND METHODS

2.1 Plant Material

The plant materials used consisted of leaves, trunk and roots of *Anonidium mannii*. They were harvested in October 2019 (raining season in Cameroon) in a forest of the village Nkolotou'outou, District of Sangmélima, Department of Dja et Lobo, South region of Cameroon. A botanist from the National Herbarium of Cameroon identified the plant by comparison with the botanical collection of D. W. Thomas N° 2188 registered in the same Herbarium under N° 50327/HNC.

2.2 Preparation of Extract

After harvesting, the barks were separated from the wood on the one hand and from the roots on the other. The parts obtained, namely the leaves, trunk wood, stem bark, root wood, root bark, were cut into small pieces, dried and then machine-pulverized into fine fibers. The preparation of methanolic extracts of the plant was carried out in accordance with the method described by Bidié et al. (2008) with some modifications [18]. Eight hundred grams (800 g) of shredded plant leaves were mixed with 5 l of 96% methanol; one thousand grams (1000 g) of shredded wood from the roots of the plant with 6 l of 96% methanol; one thousand one hundred grams (1100 g) of shredded wood from the trunk of the plant with 5 l of 96% methanol; one thousand one hundred grams (1100 g) of shredded bark from the roots of the plant with 6 l of 96% methanol; one thousand one hundred grams (1100 g) of ground bark from the trunk of the plant with 7 l of 96% methanol. The mixture obtained in each case was shaken using a spatula once a day for 2 days at room temperature (25°C), to facilitate the dissolution of the compounds contained in the ground material; then the mixture was filtered three times on cotton and on büchner with 3 mm wathman filter paper. The filtrate was evaporated under reduced pressure at 40°C using a rotary evaporator. The crude extracts obtained were used to carry out the various tests. The yields (Rd) expressed as a percentage (%) were calculated using the formula below:

$$Rd = \frac{\text{initial mass}}{\text{final mass}} \times 100$$

2.3 Phytochemical Screening

The secondary metabolites in the extracts were evidenced following the methods described by Ronchetti and Russo, Hegnauer, Wagner, Békro et al. [19-22]. These methods are based on color and precipitation reactions. Qualitative analysis of methanolic plant extracts was carried out by testing for the presence of alkaloids, flavonoids, anthraquinones, anthocyanes, coumarins, terpenes, phenols, saponins, steroids.

2.4 Antioxidant Activity

2.4.1 Determination of total polyphenols

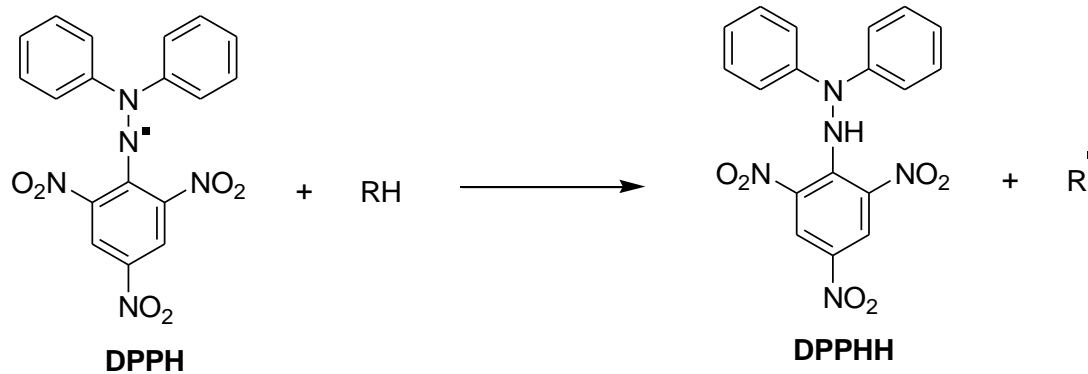
This test was to determine the content of total phenols in the methanolic extracts of the different parts of *Anonidium mannii*. The content of phenolic compounds in the various extracts was estimated by the Folin-Ciocalteu methods, which is based on the reduction of the mixture in the alkaline medium phosphotungstic $((W_{12}O_{40})^{2-})$ phosphomolybdic $((Mo_{12}O_{40})^{2-})$ of Folin-Ciocalteu reagent by the oxidizable groups of the phenolic compounds, leading to the formation of blue-colored reduction products. The latter exhibit an absorption maximum at 765 nm, the intensity of which is proportional to the quantity of polyphenols present in the sample. 1 ml of Folin-Ciocalteu reagent (1/10) was added to 200 µl of extract or standard with suitable dilutions; after 4 min, 800 µl of a sodium carbonate solution (75 mg/ml) were added to the reaction medium; After 2 hours of incubation at room temperature, the absorbance was measured at 765 nm. The concentrations of total polyphenols contained in the extracts were estimated from the regression equation of the calibration range established with gallic acid (0.200 µg/ml) used as standard. The total polyphenol content was calculated and expressed as milligram gallic acid (GA) equivalent per milligram extract (mgEqGA/g extract) [23].

$$T = C \times \frac{V \times D}{P_s}$$

T: Content of total phenols; C: Concentration of polyphenols in gallic acid equivalent deduced from the curve; V: Volume of extract; D: Dilution factor; Ps: Weight of dry matter.

2.4.2 DPPH radical scavenging activity assay

To study the antiradical activity of each extract, the diphenyl picryl-hydrazyl (DPPH) method was used following a modified protocol described by Mansouri et al. in 2005 [24]. This test was made to determine, at constant concentration, the antioxidant activity of methanolic extracts of the leaves, trunk wood, stem bark, root wood and root bark of *Anonidium mannii*. The principle is based on the reduction by diphenyl picryl-hydrazyl antioxidants having a violet color to a yellow compound, the color intensity of which is inversely proportional to the ability of the antioxidants present in the medium to donate protons [25].



Procedure: Solution 1 (S1) was obtained by introducing 100000 µg of extract in a test tube and by adding 1000 µg of methanol. The solution obtained had a concentration of 100 µg/µl.

Solution of DPPH was obtained by introducing 20 ml of methanol in 39.4 mg of DPPH: a solution A (SA) with a concentration of 5 Mm is obtained. By diluting to the fifth SA (1ml of SA + 4 ml of methanol), we have acquired solution B (SB) with a concentration of 1 Mm. By diluting the SB to one tenth (1ml of SB + 9 ml of methanol) we have acquired solution C (SC) with a concentration of 0.1 Mm. Each DPPH solution obtained is stored away from light.

Spectrometric measurements: For each concentration range, a solution of DPPH is tested as a control (blank), in order to estimate its decomposition in the absence of the extract studied. For each extract to be analyzed, tests of the ability to reduce the concentration of DPPH with different dilutions of the stock solution S1 were carried out. Using these results, the concentrations were adjusted to obtain a range of extract concentrations for which the curve of the percentage of DPPH consumed in relation to the concentration of extract is within the range of linearity. The stock solutions of DPPH (1 ml) and

extract to be assayed are added to test tubes in order to obtain solutions (2 ml) with a concentration varying from 0.1 µM to 0.5 µM of DPPH and antioxidant between 1-125 µg/ml. Each series is respectively passed through the spectrophotometer for the absorbance reading for each concentration at 517 nm. The tubes containing DPPH were previously incubated for 30 min in the dark and at room temperature. The positive control is represented by a solution of a standard antioxidant: BHT (Butylhydroxytoluene), the absorbance of which was measured under the same conditions as the samples and for each concentration. Each series was carried out in triplicate for each extract as well as for the BHT.

The scavenging activity was estimated according to the equations below:

$$\text{Abs sample} = (\text{Abs samples} + \text{DPPH}) - (\text{Abs sample} + \text{MeOH})$$

$$\% \text{ of scavenging activity} = [(\text{Abs Control} - \text{Abs sample}) / \text{Abs control}] * 100$$

The values of the IC₅₀ (Median inhibitory concentration) were determined graphically by linear regression.

3. RESULTS

3.1 Yield of Extraction

Following the maceration of plant materials using methanol, the respective yields were obtained: 15.02 g (1.80%) of crude extract of leaves, 13.09 g (1,2%) of crude extract of stem bark, 40,57 g (13.7%) of crude extract of Trunk wood, 7.09 g (0.6%) of crude extract of Root bark, and 10.06 g (1.0%) of crude extract of root wood (Table 1).

3.2 Phytochemical Screening

Phytochemical analysis showed that the methanolic extract of the leaves of *A. mannii* contain alkaloids, phenols, anthocyanes, saponins, terpenes and sterols. Stem bark contain alkaloids, flavonoids, phenols, anthocyanes and saponins. Root bark contains alkaloids, flavonoids, phenols, coumarins, saponins and terpenes. Trunk wood contains alkaloids, phenols, anthraquinones, and terpenes. Root wood contains alkaloids, flavonoids, phenols, anthocyanes, anthraquinones, saponins, and terpenes (Table 2).

3.3 Evaluation of Antioxidant Activity

3.3.1 Total phenol content

Polyphenol concentrations were determined from the calibration curve ($y = 1.4937X + 0.4025$, $R^2 = 0.9935$) plotted using gallic acid as standard. This curve was to calculate the concentrations of the total phenols contained in the extracts (Fig. 1).

The concentrations obtained enabled us to calculate the total phenol content of the various extracts. The values obtained are illustrated in Fig. 2. In the methanolic extract of stem bark the polyphenol content is estimated at 0.11 mgEqAG/g (milligrams equivalents of gallic acid per gram of extract), followed by the root wood 0.08 mgEqGA/g, the trunk wood, and leaves at 0.07 mgEqGA/g and finally root bark at 0.03 mgEqGA/g. Thus a higher total phenol contained is in stem bark compared to the four other methanolic extracts of *A. mannii*.

3.3.2 Antiradical activity

After reading the absorbance on the spectrophotometer, the percentage inhibition of DPPH was calculated and the IC₅₀ values were determined respectively for each extract of the different parts of *A. mannii*. After the analysis of this curve, all extracts showed an ability to reduce the absorbance at 517 nm and therefore to reduce the concentration of the DPPH radical in solution with IC₅₀ values respectively equal to 1.85 µg/ml for the root wood, 2.6 µg/ml for the trunk wood, 3.2 µg/ml for the leaves, 3.2 µg/ml for the root bark and 18.5 µg/ml for the stem bark (Fig. 3).

The root wood (AMMrw) exhibited the best activity and was compared to BHT. It can be seen from Fig. 3 that AMMrw presented an antioxidant activity close to that of BHT with an IC₅₀ value of 1.85 µg/ml (Fig. 4).

Table 1. Extraction yield of the methanolic extracts of leaves, trunk and roots of *Anonidium mannii*

Vegetal material	Steps	Initial mass (g)	Final mass (g)	Yield (%)
Leaves	Drying	15000	5000	33,30
	Grinding	5000	2200	44,00
	Maceration +Evaporation	800	15,02	1,80
Stem bark	Drying	7500	3000	40,0
	Grinding	3000	900	30,0
	Maceration +Evaporation	1100	13,09	1,2
Trunk wood	Drying	10000	4000	40,0
	Grinding	4000	1400	35,0
	Maceration +Evaporation	1100	7,09	0,6
Root bark	Drying	7500	3000	40,0
	Grinding	3000	900	30,0
	Maceration +Evaporation	1100	40,57	3,7
Root wood	Drying	17500	7000	40,0
	Grinding	7000	2700	38,6
	Maceration +Evaporation	1000	10.06	1,0

Table 2. Phytochemical screening of different parts of *Anonidium mannii*

Types of tests	Family of compounds	Observations	Results				
			AMMs _b	AMM _{r_b}	AMM _{t_w}	AMM _{r_w}	AMM _{l_e}
Dragendorff	Alkaloïds	Purple coloring	+	+	+	+	+
Ferric Chlorid (FeCl ₃)	Phenols	Blue or purple coloring	+	+	+	+	+
Schinoda	Flavonoïds	Orange or purplish pink coloring	+	+	-	+	-
Bornsträger	Anthraquinones: Bound quinones	Yellow or orange coloring	-	+	+	+	-
	Free quinones	Purplish red coloring	-	-	-	-	-
Coumarins test	Coumarins	Coloration varying from blue to purple yellow	-	+	-	-	-
Anthocyanes test	Anthocyanes	Greenish purplish blue coloration	+	-	-	+	+
Foam index	Saponins	Presence of foam	+	+	-	+	+
Liebermann-Buchard	Terpenes	Brick red coloring turning purple	-	+	+	+	+
Liebermann-Buchard	Steroïds	Violet blue coloring	-	-	-	-	+

AMM_{l_e} (Methanolic leaves extract of *Anonidium mannii*), AMM_{s_b} (Methanolic extract from the stem bark of *Anonidium mannii*), AMM_{t_w} (Methanolic extract of the trunk wood of *Anonidium mannii*); AMM_{r_b} (Methanolic extract of the root bark of *Anonidium mannii*) AMM_{r_w} (Methanolic extract from the root wood of *Anonidium mannii*); (+) = presence; (-) = absence

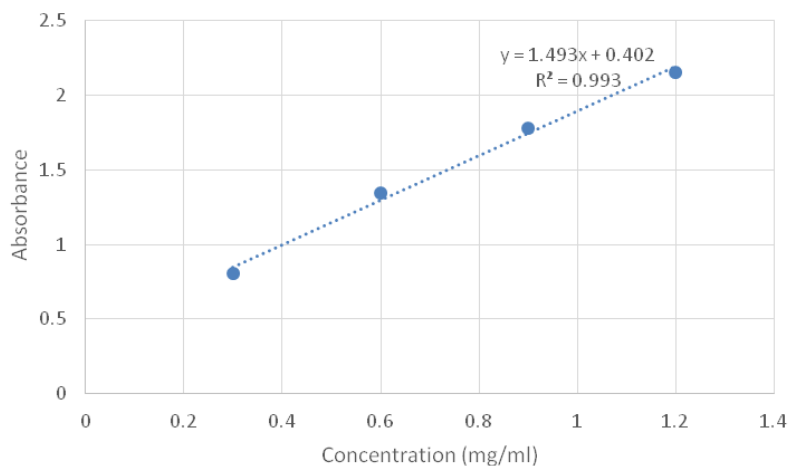


Fig. 1. Gallic acid calibration curve

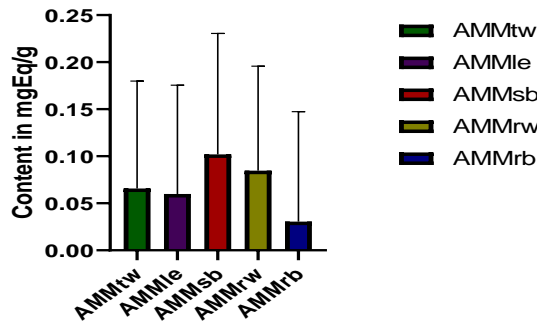


Fig. 2. Total polyphenol content of *Anonidium mannii* expressed as milligrams equivalents of gallic acid per gram of extracts (mg EGA/g)

AMMle (Methanolic leaves extract of *Anonidium mannii*), AMMSb (Methanolic extract from the stem bark of *Anonidium mannii*), AMMtw (Methanolic extract of the trunk wood of *Anonidium mannii*); AMMrb (Methanolic extract of the root bark of *Anonidium mannii*) AMMrw (Methanolic extract from the root wood of *Anonidium mannii*)

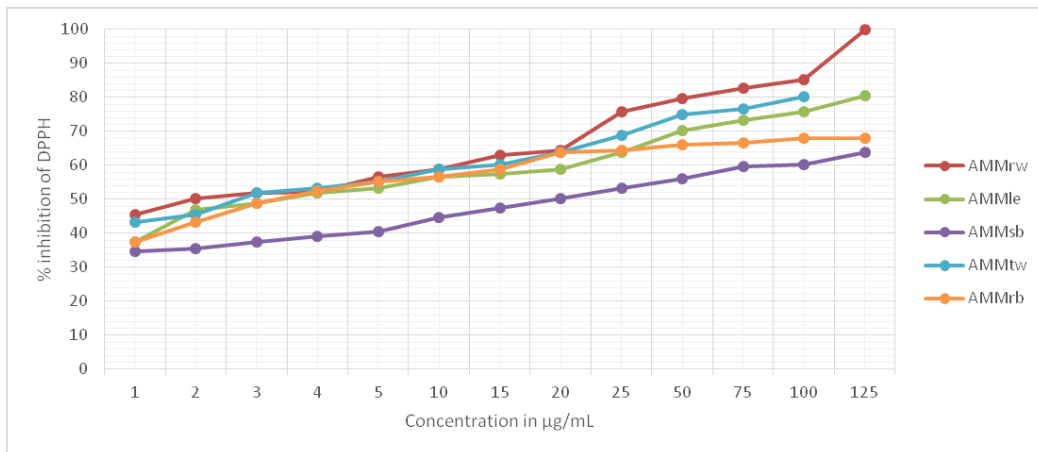


Fig. 3. Plot of percentage inhibition of DPPH as a function of different concentrations of extracts

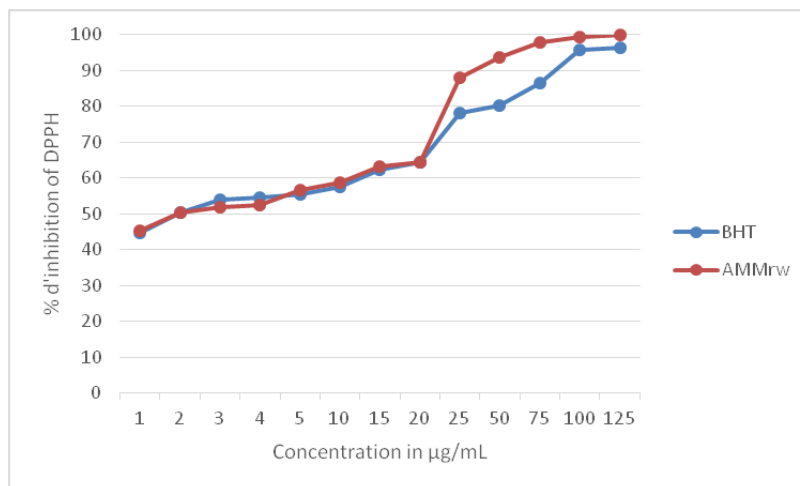


Fig. 4. Comparative curve of the percentage of inhibition of DPPH according to different concentrations of BHT and AMMrw

4. DISCUSSION

4.1 Extraction

The solvent used for the study was methanol. It was chosen in this study for its low boiling temperature, which is around 65°C, thus minimizing the risks to damage the secondary metabolites during the evaporation of the macerate. Methanol also possesses the ability to dissolve large proportions of polar and non-polar compounds [26].

The drying yield was 40.0% for all parts of *A. mannii* with the exception of the leaves, where the yield was 33.3% and therefore lower than the other parts. This could be due to the low water content of the leaves compared to other parts of *A. mannii* (Table 1).

The grinding yield was 44.0%, 30.0%, 35.0%, 38.6% respectively for leaves, stem bark, trunk wood, root bark, and root wood. These yields could be due on the one hand to losses during handling. On the other hand, they could be due to the texture of the different ground materials obtained (Table 1). The maceration yield was 1.8%, 1.2%, 0.6%, 3.7%, 1.01% respectively for the leaves, stem bark, trunk wood, root bark, and root wood (Table 1).

4.2 Phytochemical Screening

The results obtained in Table 2 depicts the different families of compounds present in the plant materials. These results corroborate the work of Kuete et al. in 2013 and Djeussi et al. in 2013 reporting the presence of the same secondary metabolite classes in the leaves of *A. mannii* [17,27]. They also agree with the results obtained by Achenbach et al in 1985 who isolated molecules of the class of prenylated bisindole alkaloids from the barks of the stems of *A. mannii* [28]. The methanolic extract of the root bark of *A. mannii* was found here to be the extract containing the largest number of compounds' families namely: alkaloids, flavonoids, anthraquinones, coumarins, saponins and terpenes.

4.3 Evaluation of the Antioxidant Activity

The dosage of total polyphenols revealed that the methanolic extract of the stem bark had the richest content in polyphenols, followed by the methanolic extract of the root wood, the leaves, then the trunk wood and finally, the root barks

proved to be the poorest in polyphenols (Fig. 2). The phytochemical screening demonstrated the presence of phenols and other classes of polyphenols in each of the extracts. The difference observed could be due to the types and amount of phenols present in the different parts of the plant. The study of the antioxidant activity of the extracts suggested that all the methanolic extracts of *A. mannii* tested possess antioxidant activity (Fig. 3). However, the methanolic extract of the root wood showed the best activity with an IC₅₀ of 1.85 µg/ml, close to that of BHT, used as the standard antioxidant in this study. Moderate antioxidant activity was observed for the methanolic extracts of the trunk wood with an IC₅₀ of 2.6 µg/ml lower than that of BHT, then leaves, and root bark with an IC₅₀ of 3.2 µg/ml and finally the stem bark showed the lowest antioxidant activity with an IC₅₀ of 18.5 µg/ml (Fig. 4).

According to the phytochemical screening of the extracts tested, four classes of polyphenols tested (flavonoids, anthraquinones, anthocyanes and saponins) were found in the root wood that also exhibited the best antiradical activity with IC₅₀ of 1.85 µg/ml, while only two or three classes in the other plant parts. This variation in IC₅₀ values could thus be due to the rate of polyphenol present in each extracts. Except for the stem bark, the phenol levels for the other plant parts are in agreement with the antioxidant activities observed. Our work is in agreement with that of Dzoyem et al. in 2014 which showed that the acetone extract of the leaves of *A. mannii* had an antioxidant activity by inhibition of following standard free radicals: DPPH, ABTS, FRAP, with respectively IC₅₀ values of 165.3; 216.28; 0.19 and a total phenol content of 69.0 mgEqGA/mg. On the other hand, the anti-inflammatory activity of the acetone extract of the leaves of *A. mannii* exhibited > 40% inhibition of 15 lipoxygenase, the anti-inflammatory potency being attributed to the antioxidant potency of *A. mannii* leaves [12].

5. CONCLUSION

The phytochemical screening of the extracts from *A. mannii* revealed the presence of alkaloids, flavonoids, anthraquinones, anthocyanins, coumarins, terpenes, steroids, saponins, phenols. The evaluation of the antioxidant activity revealed that the methanolic extracts of the leaves, trunk wood, stem bark, root wood, root bark of *A. mannii* exhibited antioxidant activity. The root wood displayed the best antioxidant

activity close to that of BHT with an IC₅₀ value of 1.85 µg/ml. Due to evidence that reactive oxygen species play a causal role in autoimmune diseases, such as rheumatoid arthritis, these results could justify the use of the leaves and stem bark of *A. mannii* in the treatment of rheumatism, as recommended by the traditional pharmacopoeia.

This work was the first study on the wood of the trunk, the bark and the wood of the roots of *A. mannii*.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All authors declare that 'ethical clearance was obtained from the Institutional Ethics Committee of the University of Douala for the conduct of this study and for the publication of this article'. All experiments were reviewed and approved.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Suhaj M. Spice antioxidants isolation and their antiradical activity: A review. *J Food Compos Anal.* 2006;19(6-7):531-7. DOI: 10.1016/j.jfca.2004.11.005
2. Tadhani MB, Patel, VH, Subhash R. *In vitro* antioxidant activities of *Stevia rebaudiana* leaves and callus. *J Food Compos Anal.* 2007;20(3-4):323-9. DOI: 10.1016/j.jfca.2006.08.004
3. Koechlin-Ramonatxo C. Oxygen, oxidative stress and antioxidant supplementation, or another way of nutrition in respiratory diseases. *Nutr Clin Métab.* 2006;20:165-77. DOI: 10.1016/j.nupar.2006.10.178
4. Vârbăn DL, Duda M, Vârbăn R, Muntean S. Research concerning the Organic Technology for *Satureja Hortensis* L. Culture. *Bull Univ Agric Sci Vet Med Cluj Napoca.* 2009;66(2):1843-5386. DOI: 10.15835/BUASVMCN-AGR:4236
5. Abdollahzad H. Importance of antioxidants in rheumatoid arthritis. *Austin Arthritis.* 2016;1(1):1005.
6. Nourmohammadi I, Athari-Nikazm S, Vafa M, Bidari A, Jazayeri S, Hoshyarrad A, et al. Effects of antioxidant supplementations on oxidative stress in rheumatoid arthritis patients. *J Biol Sci.* 2010;10:63-6.
7. Pattison DJ, Winyard PG. Dietary antioxidants in inflammatory arthritis: do they have any role in etiology or therapy? *Nat Clin Pract Rheumatol.* 2008;4:590-6.
8. Huang D, Ou B, Prior RL. The chemistry behind antioxidant capacity assays. *J Agric Food Chemist.* 2005;53:1841-56. DOI: 10.1021/jf030723c
9. Marc F, Davin A, Deglène-Benbrahim L, Ferrand C. Méthodes d'évaluation du potentiel antioxydant dans les aliments. *Med/Sci.* 2004;20(4):458-63. DOI: 10.1051/medsci/2004204458
10. Sanchez-Moreno C. Methods used to evaluate the free scavenging activity in foods and biological systems. *Food Sci Technol Int.* 2002;8(3):121-37. DOI: 10.1106/108201302026
11. Kabién S. Pharmacopée traditionnelle Baka et aliments curatifs Bantu. Yaoundé : CEPER S.A, Centre d'édition et de production pour l'enseignement et la recherche. 2013;131.
12. Dzoyem JP, Kuete V, McGaw LJ, Eloff JN. The 15-lipoxygenase inhibitory, antioxidant, antimycobacterial activity and cytotoxicity of fourteen ethnomedically used African spices and culinary herbs. *J Ethnopharmacol.* 2014;156:1-8. DOI: 10.1016/j.jep.2014.08.007
13. Richard M. van Vugt, Philip J. Rijken, Anton G. Rietveld, Arno C. van Vugt Ben, A. C. Dijkmans. Antioxidant intervention in rheumatoid arthritis: Results of an open pilot study. *Clin Rheumatol.* 2008;27(6): 771-5. DOI:10.1007/s10067-008-0848-6
14. Musuyu MD, Fruthb BI, Nzunzu LJ, Mesiaa GK, Kambua OK, Tonaa GL, Kanyanga CR, Cos P, Maes L, Apers S, Pieters L. *In vitro* antiprotozoal and cytotoxic activity of 33 ethonopharmacologically, selected medicinal plants from Democratic Republic of Congo. *J Ethnopharmacol.* 2012;141: 301-8. DOI: 10.1016/j.jep.2012.02.035

15. Taffou T, Hounda JB, Zeuko'o ME, Tchokouaha YL, Ngoutane MA, Simo KM et al. Anti-yeast potential of some Annonaceae species from Cameroonian biodiversity. *Int J Bio Chem Sci.* 2017; 11(1):15-31.
16. Fekam BF, Tsouh FPV, Tchokouaha YRL, Ngoutane MA, Madiesse KE, Fon MW, Tsamo E, Amvam ZPH, Gut J, Philip J Rosenthal PJ. Potent antiplasmodial extracts from Cameroonian Annonaceae. *J Ethnopharmacol.* 2011;134:717–24. DOI: 10.1016/j.jep.2011.01.020
17. Djeussi DE, Noumedem AKJ, Seukey AJ, Fankam GA, Voukeng KI, Tankeo BS, Nkuete LAH, Kuete V. Antibacterial activities of selected edible plants extracts against multidrug-resistant Gram-negative bacteria. *BMC Complement Altern Med.* 2013;13:164-71. DOI: 10.1186/1472-6882-13-164.
18. Bidié AP, Yapo FA, Yéo D, N'Guessan JD, Djaman JA, Guede-Guina F. Effet de *Mitragyna ciliata* (MYTA) sur le système cardiovasculaire de rat. *Phytother.* 2010;8 (1):3–8. DOI: 10.1007/s10298-009-0519-z.
19. Ronchetti F, Russo G, Bombardelli E, Bonati A. A new alkaloid from *Rauwolfia vomitoria*. *Phytochemistry.* 1971;10: 1385-8. DOI: 10.1016/S0031-9422(00)84347-2
20. Hegnauer R. *Chemotaxonomie der pflanzen*, band 6, birkhäuserverlag, baselundstuttgart; 1973.
21. Wagner GJ. In « isolation of Membranes and Organelles from Plants Cells ». Hall J L and Mooreeds AL. Academics press, London, New-York, Paris, San-Diego, San-Francisco, Saul-Paulo, Sydney, Tokyo, Toronto; 1983.
22. Békro Y-A, Mamyrbekova JA, Boua BB, Tra BFH, Ehile EE. Étude ethnobotanique et screening phytochimique de *Caesalpinia benthamiana* (Baill.) Herend. et Zarucchi (Caesalpinaceae). *Sci Nat.* 2007;4(2):217-25. DOI: 10.4314/scinat.v4i2.42146
23. Li H, Cheng KW, Wong CC, Fan KW, Chen F, Jiang Y. Evaluation of antioxidant capacity and total phenolic content of different fractions of selected microalgae. *Food Chem.* 2007;102(3):771-6. DOI: 10.1016/j.foodchem.2006.06.022
24. Mansouri A, Embarek G, Kokkalou E, Kefalas P. Phenolic profile and antioxidant activity of the Algerian ripe date palm fruit (*Phoenix dactylifera*). *Food Chem.* 2005; 89(3):411-20. DOI: 10.1016/j.foodchem.2004.02.051
25. Wainstein J. *Le Larousse Médical.* Paris : Larousse; 2009.
26. Mengone LE, Feuya TGR, Nsi-Emvo E. Antiproliferative effect of alcoholic extracts of some Gabonese medicinal plants on human colonic cancer cells. *Afr J Tradit Complement Altern Med.* 2009;6(2):112-7. DOI: 10.4314/ajtcam.v6i2.57081
27. Tsabanga N, Tsouh FPV, Yamthe TLR, Noguema B, Bakarnga-Viab I, Dongmo NMS, Nkongmeneck BA, Fekam BF. Ethnopharmacological survey of Annonaceae medicinal plants used to treat malaria in four areas of Cameroon. *J Ethnopharmacol.* 2012;139(1):171– 80. DOI: 10.1016/j.jep.2011.10.035
28. Achenbach H, Renner C. Constituents of West African medicinal plants XVIII: The annonidines - A new class of prenylated bisindole alkaloids from *Anonidium manni*, *Heterocycles.* 1985;23(8):2075-81. DOI: 10.3987/R-1985-08-2075

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