



Phytochemical Analysis and Antiradical Activity of Fruit Extracts of *Tetrapleura tetraptera* (Schumach. and Thonn.)Taub., a Medicinal Plant Used in the North of Côte d'Ivoire

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: *Tetrapleura tetraptera* is a medicinal plant with multiple virtues, used in traditional medicine to treat various pathologies. The aim of this study was to determine the phytochemical profile and antiradical activity of aqueous and 70% hydroethanolic extracts of the fruits of *Tetrapleura tetraptera*, used in northern Côte d'Ivoire.

Methodology: Phytochemical sorting of the extracts was carried out using the tube staining and precipitation technique, while the phenolic compound content was determined by UV spectrophotometry. The antioxidant capacity of the extracts was then determined using the 2,2-azino-bis 3-ethylbenzothiazoline-6 sulphonic acid (ABTS) reduction method, with Trolox as the reference molecule.

Results: The main chemical groups revealed were alkaloids, total polyphenols, anthocyanins, leucoanthocyanins, saponins and tannins. Determination of the phenolic compounds in the extracts showed that the hydroethanol extract had the highest levels of total polyphenols (18.66 ± 0.00 mg EAG/g dry extract); total flavonoids (22.33 ± 0.00 mg EQ/g dry extract); total tannins (36633 ± 1.69 mg EAT/g dry extract). This extract also showed the best anti-free radical activity, with an antioxidant capacity of 1.38 ± 0.001 $\mu\text{molTE/L}$ compared with 1.19 ± 0.001 $\mu\text{molTE/L}$ for the aqueous extract.

Conclusion: The fruits of *T. tetraptera* could be a source of bioactive molecules that could be used in the treatment of various infectious and metabolic pathologies.

Keywords: *Tetrapleura tetraptera*; Tri phytochemical; phenolic compounds; antioxidant power.

1. INTRODUCTION

“Plants with pharmacological value are an integral part of traditional healing systems used by different ethnic communities in Africa. According to the World Health Organization (WHO), about 80% of the African population rely on traditional medicine to maintain good health” [1]. Côte d'Ivoire is no exception to this statement because traditional medicine occupies a very important place in primary health care for the vast majority of its populations [2]. Indeed, medicinal plants produce 70% of medicines, of which approximately 170,000 bioactive molecules have been identified [3]. Among these compounds, there are to a large extent secondary metabolites with various biological activities such as antioxidant, antidiabetic [4] and microbiological [5] activities. This is the case of *Tetrapleura tetraptera*, (Fabaceae-Mimosoideae), a species widespread in the West African sub-region, particularly in Ghana, Nigeria, Cameroon and Côte d'Ivoire [6]. It is mainly used for its medicinal, food, cosmetic and economic virtues by the populations of these different countries. Thus, in ethnomedicine, the dried fruits of *T. tetraptera* are commonly used for the treatment of conditions such as hypertension, convulsions, leprosy, rheumatic pain, diabetes and arthritis [7]. In addition, the fruit has molluscidal, antimicrobial, antiseptic, anticonvulsant, anti-inflammatory and insecticidal properties [8,9]. Despite these

scientific data, the search for natural substances from a chemical and pharmacological point of view in the fruit of *T. tetraptera* remains to be explored in Côte d'Ivoire. It is in this sense that the present work is included, which aims to determine the phytochemical composition, the contents of phenolic compounds and the antiradical activity of the aqueous and 70% hydroethanolic extracts of the fruits of *T. tetraptera* with a view to their valorization.

2. MATERIALS AND METHODS

2.1 Plant Material

The plant material consists of *T. tetraptera* fruits that were purchased at the large market in Korhogo (Northern Ivory Coast) in June 2024. Their authentication was done at the Department of Plant Biology of the Training and Research Unit (UFR) of Biological Sciences of the Peleforo GON COULIBALY University of Korhogo. These fruits were carefully cleaned with tap water to remove all impurities and then crushed into small pieces using a mortar to separate the seeds. The remaining fruits were dried in the dark at room temperature (27 ± 2 °C) for two weeks. At the end of drying, they were pulverized using an electric grinder (RETSCH, Type AS 200) to obtain a fine powder. This plant powder was stored in sterile jars and used for the preparation of extracts.

2.2 Preparation of *T. tetraptera* Fruit Extracts

In this study, two types of extraction were carried out: aqueous and 70% hydro-ethanolic. The extracts were prepared according to the method described by Zirihi et al. [10] with some modifications. Indeed, 100 g of each plant powder were macerated in one liter (1L) of distilled water or a 70% hydro-ethanolic mixture (70/30; V/V) under magnetic stirring for 24 hours. After maceration, the mixture obtained was first drained in a square of white cloth, then double filtered on hydrophilic cotton. The filtrates were concentrated in an oven at 50 ° C until complete evaporation of the solvent to obtain the aqueous and hydroethanolic dry extracts 70% of the fruits of *T. tetraptera*. These extracts were weighed and the extraction yield (R) of each extract was calculated using the following formula:

$R (\%) = (m / M) \times 100$ with **M**: mass of the powder (g); **m**: mass of the crude extract (g)

2.3 Phytochemical Analysis of the Extracts

The phytochemical study consisted of screening the molecules of the different extracts (aqueous and hydrol-ethanolic) of *T. tetraptera* by staining and in vitro precipitation tests in tubes as described by Walid et al. [11]. The groups of molecules sought are: alkaloids, total polyphenols, flavonoids, tannins (catechuic and gallic), anthocyanins, leucoanthocyanins, saponins, terpenes and sterols. The phytochemical tests and characteristic reactions are summarized in Table 1.

2.4 Determination of Phenolic Constituents of Extracts

2.4.1 Total polyphenols

The determination of total polyphenols was carried out according to the method described by Wood et al. [12]. To a volume of 30 μ L of extract, 2.5 mL of Folin-Ciocalteu reagent diluted 1/10 were added. The mixture obtained was kept for 2 min in the dark at room temperature and then 2 mL of sodium carbonate solution at 75 g/L were added. The solution obtained was then incubated at 50 °C for 15 min. The absorbance reading was carried out using a spectrophotometer at a wavelength of 760 nm against a blank. Gallic acid was used as a reference standard (of concentration varying from 0 to 0.9 mg mL⁻¹) for establishing the calibration curve and for

quantifying total polyphenol contents expressed in mg of gallic acid equivalent per gram of dry extract (mg GAE/g of extract).

2.4.2 Flavonoids

Flavonoids were quantified according to the method described by Marinova et al. [13]. Indeed, 0.75 mL of 5% (m/v) sodium nitrite and 0.75 mL of 10% (m/v) aluminum chloride were added to 2.5 mL of a methanolic solution of extract diluted to 1/500 (m/v). After 5 min of incubation, the mixture was brought into contact with 5 mL of a 1 M sodium hydroxide solution. The volume obtained was adjusted to 25 mL then shaken vigorously and the absorbance was measured at 510 nm against a blank. Quercetin was used as a reference standard of concentration varying from 0 to 0.9 mg mL⁻¹ and the total flavonoid contents were expressed in milligrams of quercetin equivalent per gram of dry extract (mg EQ/g of extract).

2.4.3 Tannins

The total tannin content was determined according to the method described by Kouamé [14]. A quantity of 50 mL of each extract was added to 1500 μ L of the 4% solution of vanillin in methanol. The resulting mixture was vigorously shaken and 750 μ L of concentrated hydrochloric acid was added. The resulting mixture was left to stand at room temperature for 20 min and the absorbance was measured at 550 nm against a blank. Tannic acid was used as a reference standard of concentration varying from 0 to 0.9 mg mL⁻¹ and the tannin contents were expressed as milligram equivalent of tannic acid per gram of dry extract (mg EAT/g of extract).

2.5 Evaluation of the Anti-Radical Activity of the Extracts

The anti-radical activity was evaluated by the ABTS⁺ cation radical decolorization test according to the technique used by Khan et al. [15] with some modifications. The ABTS^{o+} cation radical was produced by reaction of an 8 mM ABTS solution and 3 mM potassium persulfate in a ratio of 1:1 (v/v). The mixture was then incubated in the dark at room temperature for 12 to 16 hours. This ABTS⁺ solution was diluted with methanol to obtain a solution whose absorbance was 0.7 \pm 0.02 at 734 nm. Thus, 3.9 mL of this diluted ABTS⁺ solution was added to 100 μ L of each extract. After shaking, the mixture was incubated

Table 1. Phytochemical tests and characteristic reactions

Secondary metabolites	Tests and reagents	Positive reaction
Alkaloids	Burchard and Dragendorff	Reddish brown black
Anthocyanins	Diluted sulfuric acid + 5 mL of ammonia	Blue-purple coloration in basic medium
Flavonoids	Diluted ammonia + aluminum chloride	Yellow coloration
Leucoanthocyanins	Cyanidine	Cherry red or purplish coloration
Polyphenols	Ferric chloride 1%	Dark blue blackish colour
Saponins	Vigorous agitation	Foam index > 100
Tannins	Sulfuric vanillin	Précipitate which turns blue black
Terpens et sterols	Liebermann, Chloroforme, concentrated sulfuric acid	Red-brown ring at the interface

for 16 hours in the dark and the residual absorbance of the ABTS⁺ radical was then measured at 734 nm using a spectrophotometer and should be between 20% and 80% of the blank absorbance. The results were expressed in μmol Trolox equivalent per liter of extract ($\mu\text{mol TE/L}$). A calibration line was performed with the following concentrations: 0; 3.75; 5; 6.25; 10; 11.25; 12.5; 13.75; 15 of Trolox and the inhibition rate **I (%)** of ABTS⁺ was expressed as follows:

$$I (\%) = [(A0 - \text{Absextract}) / A0]$$

A0: diluted ABTS absorbance and **Absextract**: diluted ABTS absorbance + sample.

This line allowed us to express the antioxidant activity of the different extracts as follows:

$$C = (I \times Fd) / (4.99 \times 10)$$

C: Antioxidant capacity and **Fd**: Dilution factor and **I (%)**: inhibition rate.

2.6 Statistical Analysis of Data

The results were analyzed using Graph Pad Prism 8.0 software (Microsoft U.S.A) for multiple variances (ANOVA). The differences between the means were determined according to Duncan's test at the 5% level ($P < 0.05$ is considered significant). The graphical representation of the data was carried out using Excel software. The tests were carried out in triplicate for each sample and the results were expressed as the mean accompanied by the standard error of the mean.

3. RESULTS AND DISCUSSION

3.1 Extraction Yields

The yields obtained after extractions are shown in Table 2. They varied depending on the solvent

used for extraction. Indeed, the best yield was obtained with the hydroethanolic extract (26.50%) compared to the aqueous extract (15.70%). This could be explained by the strong capacity of the ethanolic solvent to extract a large quantity of chemical constituents from plant organs such as the fruits of *T. tetraptera* [16].

3.2 Phytochemical Composition of *T. tetraptera* Fruit Extracts

The Table 3 shows the main chemical constituents found in both extracts. These extracts contain the same chemical groups: alkaloids, total polyphenols, anthocyanins, leucoanthocyanins, catechic tannins and saponins. However, they lack flavonoids, gallic tannins, terpenes and sterols.

These phytochemical groups are already known in the literature to have various pharmacological properties including, antimicrobial, antidiarrheal anti-inflammatory, antioxidant etc [17]. Indeed, several studies have reported that flavonoids, tannins and saponins [18,19] are responsible for the anti-diarrhoeal properties of certain plants such as *Alchornea cordifolia*. Similarly, according to Tiwari et al. [20], alkaloids inhibit the protein synthesis of micro-organisms by intercalating in their DNA.

3.3 Phenolic Compound Content of Extracts

From the calibration curves for gallic acid ($y = 0.6484x - 0.0025$; $R^2 = 0.995$), quercetin ($y = 0.6455x - 0.0075$; $R^2 = 0.9983$) and tannic acid ($y = 0.0009x + 0.0129$; $R^2 = 0.9994$), respectively, the contents of total polyphenols, flavonoids and tannins were determined and presented in Table 4.

Table 2. Yield of the different extractions

<i>T. tetraptera</i> Extracts	Aqueous	Hydroethanolic 70 %
Yields (%)	15.70 ± 0.06	26.5 ± 0.08

Table 3. Secondary metabolites of various *T. tetraptera* fruit extracts

Secondary metabolites	Aqueous Extract	70% Hydroethanolic Extract
Alcaloids	+	+
Anthocyanins	+	+
Flavonoids	–	–
Leucoanthocyanins	+	+
Polyphenols	+	+
Saponins	+	+
Catechic tannins	+	+
Gallic tannins	–	–
Terpens et sterols	–	–

+ : Presence et - : Absence

Table 4. Phenolic compound content of *T. tetraptera* fruit extracts

Extracts	Phenolic compounds measured		
	Total Polyphenols (mg EAG/g)	Flavonoids (mg EQ/g)	Tannins (mg EAT/g)
Aqueous	13.16 ± 0.00	13.5 ± 0.01 ^a	31204.33 ± 2.92 ^c
Hydro-éthanolic	18.66 ± 0.00*	22.33 ± 0.00 ^b	36633 ± 1.69 ^d

Analysis of the results shows that the hydroethanol extract had the highest levels of phenolic compound compared to the aqueous extract. The content of total polyphenols in the hydroethanol extract was 18.66 ± 0.00 mg EAG/g, significantly higher than that of the aqueous extract (13.16 ± 0.00 mg EAG/g). The same was true for flavonoids and tannins, whose levels in the hydro-ethanolic extract, 22.33 ± 0.00 mg EQ/g and 36633 ± 1.69 mg EAT/g respectively, were the highest, with a significant difference compared to the aqueous extract. The results obtained showed variable levels of the compounds sought depending on the extraction solvents, i.e. water and 70% ethanol. This is in line with the results of Koutouan [21] who concluded that the ethanol-water mixture (70%) was the best solvent for extracting phenolic compounds. The high extraction capacity of these molecules by ethanol is thought to be related to the high solubility of phenolic compounds in polar solvents [22]. In addition, the hydro-ethanolic extract presented with a significant difference the best contents of phenolic compounds compared to the aqueous extract. These data are in line with the work of Gboko et al. [23] on the same extracts (aqueous and hydroethanolic) obtained from *Kaya senegalensis* bark. The richness of *T. tetraptera* fruits in phenolic compounds could justify the traditional use of this plant to treat various

pathologies such as leprosy and haemorrhoids [24].

3.4 Antioxidant Activity of Extracts

The Trolox calibration line ($y = 4.9901x$; $R^2=0.9961$) was used to determine the antioxidant capacity of the extracts as a function of the inhibition rate. The ABTS^{o+} radical inhibition rate of the extracts ranged from 29.01 ± 0.87% to 69.08 ± 0.15%. Fig. 1 show the antioxidant capacity of the extracts. The hydroethanol extract showed the highest antioxidant capacity (1.38 ± 0.001 µmol/Leq Trolox), followed by the aqueous extract (1.19 ± 0.001 µmol/Leq Trolox). However, there was no significant difference between these values. These results are in line with those of the ABTS radical scavenging test already carried out by Kamagate et al. [25] on the same *Kaya senegalensis* stem bark extracts. However, the Trolox equivalent antioxidant capacity (TEAC) of the hydro-ethanolic extract (1.38 ± 0.001 µmol TE/L extract) was slightly higher than that of the aqueous extract (1.19 ± 0.001 µmol TE/L extract) but with no significant difference. The antioxidant activity of the extracts could be linked, on the one hand, to the presence of phytochemical constituents revealed by the phytochemical screening and, on the other hand, to the high phenolic compound

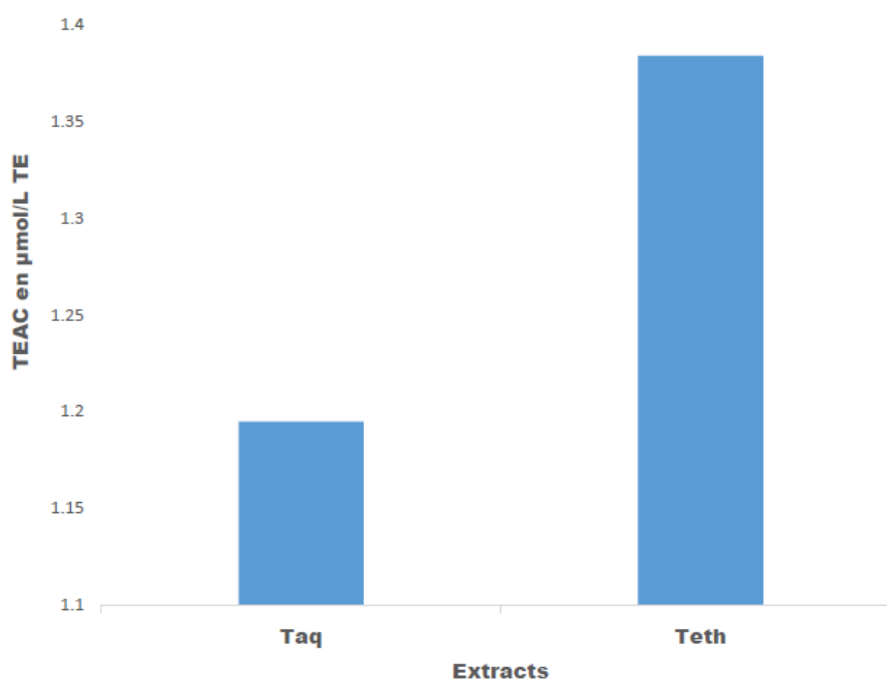


Fig. 1. ABTS+ antioxidant capacity of the two *T. tetraptera* extracts Taq: (aqueous extract) and Teth: (70% hydroethanolic extract)

content of the plant fruit extracts. The strong antioxidant power of these secondary metabolites has already been demonstrated by several authors [26,27]. They effectively combat oxidative stress, the main initial cause of a number of diseases such as diabetes, Alzheimer's disease and cardiovascular disease [28], cancer and accelerated ageing [29]. Furthermore, these results are consistent with those of Ouattara et al. [30], Koné [31] who found a good correlation between the antioxidant activity of the plants studied and the secondary metabolites they contain, in particular phenolic compounds. This could also justify the fact that in ethnomedicine, the dried fruits of *T. tetraptera* are commonly used for the treatment of multiple conditions such as hypertension, convulsions, leprosy, rheumatic pain, ulcers; diabetes, arthritis [32,33].

4. CONCLUSION

This research is a contribution to the development of Ivorian medicinal plants with a view to their use in medicine. Phytochemical studies of *T. tetraptera* fruit extracts have shown that the hydroalcoholic extract is rich in secondary metabolites of interest with antioxidant activity, justifying its many traditional uses. These results could be used to develop Traditionally

Improved Medicines (TIMs) to combat a wide range of diseases.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

No artificial intelligence technology was used in the writing of this manuscript.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. WHO. Strengthening the role of traditional medicine in health systems: a strategy for the African region. 63rd WHO session, Republic of Congo. 2013;14.
2. Saraka AI, Camara D, Bene K, Zirihi GN. Ethnobotanical survey of medicinal Euphorbiaceae used among the Baoulé of the Yamoussoukro District (Côte d'Ivoire). J Appl Biosci. 2018;126:12734-12748.
3. Chaabi M. Phytochemical and biological study of African plant species:

- Euphorbia stenoclada* Baill. (Euphorbiaceae), *Anogeissus leiocarpus* Guill. & Perr. (Combretaceae), *Limoniastrum feei* (Girard) Batt. (Plumbaginaceae). Doctoral thesis, Louis Pasteur University; 2008.
4. Madani Yousfi M. Polyphenols assay and search for antiradical activity of olive leaves. Department of Biology, University of Tlemcen. 2017;28.
 5. Boni AP. Phytochemical screening and antimicrobial activities of almond extracts from kernel of two mango (*Mangifera indica* L.) varieties grown in Korhogo (North of Ivory Coast). GSC Biol Pharm Sci. 2023;24(2):317–327.
 6. Adesina SK, Iwalewa EO, Johnny II. *Tetrapleura tetraptera* Taub - Ethnopharmacology, chemistry, medicinal and nutritional values. A review. Br J Pharm Res. 2016;12(3):1-22.
 7. Nwaichi EO. Effect of heat treatment on the antioxidant properties of *Tetrapleura tetraptera*, *Xylopi aethiopica*, and *Piper guineense*. Int J Biotech Food Sci. 2013;1(1):1-5.
 8. Aladesanmi AJ. *Tetrapleura tetraptera*: Molluscidal activity and chemical constituents. Afr J Tradit Complement Altern Med. 2007;4(1):23-36.
 9. Abugri DA, Pritchett G. Determination of chlorophylls, carotenoids and fatty acid profiles of *Tetrapleura tetraptera* seeds and their health implication. J Herbs Spices Med Plants. 2013;19(4):391-400.
 10. Zirih GN, Kra AM, Guédé-Guina F. Evaluation of the antifungal activity of *Microglosa pyrifolia* (Lamarck) O. Kunze (Asteraceae) "PYMI" on the in vitro growth of *Candida albicans*. Afr Med Pharmacol Rev. 2003;17:11-18.
 11. Walid K, Nassima L, Abdessamed T, Abderrahmene L, Ali K. Antilithiasis plants used in traditional medicine in the city of Orian, Algeria: ethnobotanical and phytochemical approach. Ethnoecol Rev. 2016;9:2511.
 12. Wood JE, Senthilmohana ST, Peskin AV. Antioxidant activity of procyanidin-containing plant extracts at different pHs. Food Chem. 2002;77(2):155–161.
 13. Marinova D, Ribarova F, Atanassova M, Marinovaa. Total phenolics and flavonoids in Bulgarian fruits and vegetables. J Univ Chem Technol Metallurgy. 2005;40(3):255-260.
 14. Kouamé KT. Determination of total polyphenol, total flavonoid and tannin contents in young unopened leaves of *Piliostigma thonningii* (Caesalpiniaceae). Int J Biol Chem Sci. 2021;15(1):97-105.
 15. Khan RAMR, Sahreen S, Ahmed M. Evaluation of phenolic contents and antioxidant activity of various solvent extracts of *Sonchus asper* (L.) Hill. Chem Cent J. 2012;6(1):12.
 16. Sultana B, Anwar F, Ashraf M. Effect of extraction solvent/technique on the antioxidant activity of selected medicinal plant extracts. Molecules. 2009;14(6): 2167-2180.
 17. Olasunkanmi OO, Akinpelu DA, Adeniyi PO, Femi Ajayi O, Omololu-Aso J, Olorunmola FO. Investigations into antibacterial, phytochemical and antioxidant properties of *Vitellaria paradoxa* (Gaertn.) stem bark extracts. J Pharm Res Int. 2017;20(5):1-17.
 18. Méite S, N'guessan JD, Bahi C, Yapi HF, Djaman AJ, Geude Guina F. Antidiarrheal activity of the ethyl acetate extract of *Morinda morindoides* in rats. Trop J Pharm Res. 2009;8(3):2001-2007.
 19. Dosso K, N'guessan BB, Bidie AP, Gnanngoran BN, Méité S, N'guessan D, Yapo EE, Ehilé. Antidiarrheal activity of an ethanolic extract of the stem bark of *Piliostigma reticulatum* (Caesalpiniaceae) in rats. Afr J Tradit Complement Altern Med. 2012;9(2):242-249.
 20. Tiwari P, Kumar B, Kaur M, Kaur G, Kaur H. Phytochemical screening and extraction: A review. Int J Pharm Sci. 2011;1.1:98-106.
 21. Koutouan FP. Total polyphenol and tannin composition of leaves of nine varieties of *Cajanus cajan* (L.) Millsp. during the first growth cycle and according to the exploitation mode. Int J Biol Chem Sci. 2019;13(2):882-898.
 22. Ghedadba N, Hambaba L, Ayachi A, Aberkane MC, Bousseisela H, Oueld-Mokhtar SM. Total polyphenols, anti-inflammatory and antioxidant and antimicrobial activity of extracts of the leaves of *Marrubium deserti* de Noé. 2015;12.
 23. Gboko AO, Kamagate T, Kassim D, Boni AP, Toure A, Kablan ALC. Phytochemical screening and in vitro antioxidant activity of the stem bark of *Khaya senegalensis* (Desv.) A.Juss., a medicinal plant from

- Northern Ivory Coast. J Pharm Res Int. 2023;35(33):28-39.
24. Ouattara LH, Kabran GRM, Kadja AB, Tano MB, Akhanovna J, Bekro YA. Phytochemical study and antioxidant activity of extracts of plants from Ivory Coast used in the traditional treatment of hemorrhoids. Int J Innov Appl Stud. 2016;15(4):881-893.
25. Kamagate T, Gboko AO, Kassim D, Toure A, Boni AP, Kablan ALC. Antioxidant and antibacterial activity of aqueous and alcoholic stem bark extracts of *Kaya Senegalensis* (Desv) A. Juss., in human urinary infections. Microbiol Res J Int. 2024;34(7):124-132.
26. Alkadi H. Determination of chemical composition, antioxidant activity, and antimicrobial activity of essential oils of Damask *Ocimum basilicum* L. J Mater Environ Sci. 2021;12(7):919-928.
27. Larbie C, Robertson FCM, Quaiocoe EB, Opoku R, Kabiri NC, Abrokwah RO. *Tetrapleura tetraptera* of Ghanaian origin: Phytochemistry, antioxidant and antimicrobial activity of extracts of plant parts. J Pharm Res Int. 2020;32(35):78-96. DOI: 10.9734/jpri/2020/v32i3530981
28. Favier A. Oxidative stress and human pathologies. French Pharm Ann. 2003; 64:390-396.
29. Grabsi W, Boudeffa H. Phytochemical study and evaluation of antioxidant and antibacterial activities of the species: *Hibiscus sabdariffa* L. and *Lepidium sativum* L. Master 2 thesis, University of the Mentouri Brothers, Algeria Constantine, 2016;23.
30. Ouattara A, Traore Y, Gboko AO, Konate G, Ouattara K, Coulibaly A. Antioxidant and anti-gastroenteritis activities of *Funtumia elastica* (Apocynaceae) and *Caesalpinia bonduc* (Caesalpiniaceae). Int J Biol Chem Sci. 2020;14(1):170-180.
31. Koné KPFO. Application of chromatography and spectroscopy techniques in the identification of secondary metabolites of three antidiabetic and antihypertensive plants of the Ivorian pharmacopoeia. Doctoral thesis, Felix Houphouët-Boigny National Polytechnic Institute of Yamoussokro, Côte d'Ivoire. 2018;73-74.
32. Aka PA, Nwabie AI. Use of *T. tetraptera* as anti-convulsant. Fototerapia. 1993;64:42.
33. Kuate D, Kengne APN, Biapa CPN, Azantsa BGK, Wambw M. The spice *Tetrapleura tetraptera* attenuates high-carbohydrate, high-fat diet-induced obese and type 2 diabetic rats with features of metabolic syndrome. Lipids Health Dis. 2015;14(50):1-13.

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