Available online on 15.11.2020 at <http://jddtonline.info>

Journal of Drug Delivery and Therapeutics

Open Access to Pharmaceutical and Medical Research

© 2011-18, publisher and licensee JDDT, This is an Open Access article which permits unrestricted non-commercial use, provided the original work is properly cited



Open Access

Research Article

Evaluation of the Antioxidant Activity of Some Plants Used in the Management of Erectile Dysfunction by the BWA Community in Mali

Dembélé Jean¹, Togola Issiaka^{1*}, Daou Cheickna², Diarra Nouhoum¹, Konaré Mamadou A.¹, Sanogo Rokia³¹ Département de Biologie, Faculté des Sciences et Techniques (FST), Université des Sciences, des Techniques et des Technologies de Bamako (USTTB), Bamako, Mali² Département de Génie-Biologie, Institut des Sciences et Appliquées (ISA), Université des Sciences, des Techniques et des Technologies de Bamako (USTTB), Bamako, Mali³ Department des Sciences Pharmaceutiques et de Médecine Traditionnelle, Université des Sciences, des Techniques et des Technologies de Bamako (USTTB), Bamako, Mali

ABSTRACT

The erection has always symbolized strength and virile health. Erectile dysfunction is undoubtedly a concern as old as humanity. *Tamarindus indica* L., *Guiera senegalensis* J.F.Gmel and *Ximenia americana* L. are commonly used in the traditional treatment of erectile dysfunction by the Bwa community in Mali. The aim of this study was to measure the total polyphenols and flavonoids and then to evaluate the antiradical activity of the extracts (aqueous and hydroalcoholic macerated and decocted) of the organs of these species. The study found that for all species, the hydro-alcoholic macerated extract showed the best results. The polyphenol contents have been 36.85±0.21 mgGAE/g; 32.60±0.25 mgGAE/g and 29.79±0.51 mgGAE/g for *Ximenia americana*, *Tamarindus indica* and *Guiera senegalensis* respectively. The flavonoid contents have been 22.03±0.15 mgQE/g; 17.53±0.02 mgQE/g and 8.03±0.03 mgQE/g for *Ximenia americana*, *Tamarindus indica* and *Guiera senegalensis* respectively. The antiradical activity expressed in IC₅₀ is 37.54±0.75 µg/mL; 52.75±0.71 µg/mL and 54.66±1.14 µg/mL for *Ximenia americana*, *Tamarindus indica* and *Guiera senegalensis* respectively. This study revealed that those plants are rich in total polyphenols and show a good antiradical activity. This finding would justify their traditional use. The biological tests would be necessary to confirm their use in the treatment of erectile dysfunction.

Keywords: Erectile dysfunction, polyphenols, antioxidant activity, Bwatun-Mali.

Article Info: Received 24 Aug 2020; Review Completed 18 Oct 2020; Accepted 27 Oct 2020; Available online 15 Nov 2020



Cite this article as:

Dembélé J, Togola I, Daou C, Diarra N, Konaré MA, Sanogo R, Evaluation of the Antioxidant Activity of Some Plants Used in the Management of Erectile Dysfunction by the BWA Community in Mali, Journal of Drug Delivery and Therapeutics. 2020; 10(6):57-61 <http://dx.doi.org/10.22270/jddt.v10i6.4559>

*Address for Correspondence:

Togola Issiaka, Département de Biologie, Faculté des Sciences et Techniques (FST), Université des Sciences, des Techniques et des Technologies de Bamako (USTTB), Bamako, Mali

INTRODUCTION

Originally, nature was made up of plant life and used as food for animals feeding and humans' nutriment. However, in addition to this nutritional role, peoples discovered several other functions that plants could provide, such as the healing power of plants. In Africa the healing power of plants has been known since ancient times. Erectile dysfunction is defined as "a persistent or recurrent disability of a man to achieve or maintain a sufficient erection of the penis for sexual activity"¹. Psychological and physiological factors and certain classes of drugs induce the production of a large quantity of free radicals that cause oxidative stress, resulting

in a decrease in sexual performance^{2, 3, 4, 5}. To alleviate these disorders numerous treatments using synthetic molecules, such as type 5 phosphodiesterase inhibitors, are currently proposed⁶. However, the high cost of these products, as well as the secondary effects they induce, give new impetus to natural substances in plants that are reputed to be aphrodisiacs^{7, 8, 9}. Studies have shown that many secondary metabolites such as alkaloids, tannins, terpenes, saponins and flavonoids have aphrodisiac effects^{10, 11, 12}. Some erectile disorders have a vascular origin due to the diseases such as diabete and hypertension or stress related origin^{4, 2}. The action of anti-hypertensive and anti-diabetic compounds

such as tannins, saponosides and flavonoids could be taken into account in the restoration of the erection if the cause is eliminated¹³. Many compounds such as the polyphenols are powerful antioxidants that can help to reduce the effect of oxidative stress. The Bwa community in Mali are living in the area called the Bwatun, located in south-eastern Mali. In this area the local population makes extensive use of medicinal plants, and gender issues remain a taboo⁹. An ethnobotanical survey conducted by⁹ revealed that the species *Tamarindus indica*, *Guiera senegalensis* and *Ximenia americana* are commonly used in the traditional treatment of erectile dysfunction in the Bwatun area. They also showed that these plants are very rich in secondary metabolites. Polyphenols are natural compounds that are widespread in the plant kingdom and are becoming increasingly important, particularly due to their beneficial effects on virile health. In this context, the present study set itself the objective of measuring total polyphenols and flavonoids and then evaluating the antiradical activity of extracts of these three plants (*Tamarindus indica*, *Guiera senegalensis* and *Ximenia americana*).

MATERIAL AND METHODS

Plant Materials

The plant material consisted of roots of *Tamarindus indica* "So'o" and *Guiera senegalensis* "Suncawé" and the stem bark of *Ximenia Americana* "Cocognanwé". The samples were collected in the village of Mandiakuy (Bwatun area) in September 2018. These plants were identified at the Laboratory of Tropical Ecology of the Faculty of Science and Technology. They were dried at room temperature (30-35°C) and then reduced to powder. The powders obtained from these organs were used for experimental studies.

Preparation of Extracts

We carried out an extraction on 5 g of the plant material with 50 mL of 80% methanol (MeOH) for 20 minutes at room temperature (30-35°C), then filtered and recovered the supernatant. We evaporated dry under vacuum with the Rotavapor at a temperature of 45°C. We dissolved the residue in 50 mL of 50% methanol and kept it cold for analysis according to the modified protocol described by¹⁴.

Dosage of Total Polyphenols

Polyphenols were determined by spectrophotometric method using the Folin-Ciocalteu reagent according to the protocol of¹⁵, slightly modified by¹⁶. Briefly, 500 µL of Folin-Ciocalteu reagent (diluted 10% in distilled water) was added to 100 µL of extract with well determined concentrations. Four (4) minutes later, 400 µL of Sodium Carbonate (Na₂CO₃) at 75 mg/g are added to the reaction mixture. After a 2 hour incubation at room temperature and protected from light, the absorbance is read at 765 nm. The calibration line is performed with gallic acid of concentration (0.8; 1.6; 2.4; 3.2; 4 µg/mL) following the same assay steps. The concentrations of the phenolic compound are established from the regression line of the calibration curve. The results are expressed in milligram equivalent of gallic acid per gram of extract (mg GAE/g). All manipulations are repeated 3 times.

Dosage of Total Flavonoids

Flavonoids were determined by spectrophotometric method using aluminium trichloride reagent (AlCl₃) according to the protocol described by¹⁷. To 1 mL of extract, we added 1 mL of the AlCl₃ solution (2% in methanol). After 10 min incubation, at room temperature and protected from light, the absorbances were measured by a spectrophotometer at

430 nm. All the manipulations are repeated 3 times. Under the same conditions, a calibration range is carried out with quercetin (5; 10; 20; 40; 80 µg/mL) following the same dosing steps. The quantity of flavonoids is determined from the regression line of the calibration lines. The results are expressed in milligram quercetin equivalent per gram of extract (mg QE/g).

Antioxidant Activity

Characterisation of Antioxidant Activity by Thin Layer Chromatography (TLC)

Antioxidant activity was characterised by TLC using the DPPH reagent (2,2-DiPhenyl-1-Picryl-Hydrazyl) according to the protocol described by¹⁸. The system was composed of Butanol - Acetic Acid - Water (BAW) in the proportions (7 : 1 : 2 v/v/v). Ten microliters (10 µL) were deposited as a dot 1 cm apart and located approximately 1 cm from the bottom of the G60F254 0.2 mm silica plate. The antioxidant activity of the plants is characterised by the appearance of yellow stripes on a purple background on the TLC plate after revelation by the 0.024% DPPH solution.

Evaluation of Antioxidant Activity by the DPPH method

The DPPH (2, 2-diphenyl-1-picryl-hydrazyl) test according to the method used by¹⁹ with slightly modified was used to evaluate the antioxidant activity of our extracts. 50 µL of each extract solution to be tested with different concentrations (12.5; 26; 40; 60; 80 µg/mL) are added to 1.95 mL of the methanolic solution of DPPH (0.024 g/L). At the same time, a negative control is prepared by mixing 50 µL of methanol with 1.95 mL of the methanolic DPPH solution. The absorbance reading was taken against a blank at 517 nm after 30 min incubation in the dark and at room temperature. The positive control is represented by a solution of a standard antioxidant, ascorbic acid, whose absorbance was measured under the same conditions as the extracts and for each concentration the test was repeated 3 times. The antioxidant activity related to the scavenging effect of the DPPH radical is expressed as percentage inhibition (PI) calculated from absorbances obtained according to the following formula:

$$[PI] = (A_0 - A_1) / A_0 \times 100$$

A₀=DPPH absorbance; A₁: sample absorbance.

The IC₅₀ (concentrations that inhibit 50% of the DPPH radical) were deduced from the linear regression line obtained from the graph of the percentage inhibition of DPPH.

Data Analysis

Data processing was done using Excel® version 2013 and Minitab 18.1 software. Analyses were run in triplicates and the results were expressed as mean values with standard error mean. The single-factor ANOVA test using the Fisher test was chosen to compare the polyphenol and flavonoid contents and the antioxidant activity of different types of extracts. P-values less than 0.05 were considered statistically significant.

RESULTS

Total Polyphenol and Flavonoid Contents

The contents of total polyphenols and flavonoids are summarised in the Table 1.

Table 1: Summary of total polyphenol and flavonoid contents

Plants	Extract types	Total Phenols (mgGAE/g)	Flavonoids (mgQE/g)
<i>Ximenia americana</i> L.	AM	35,34±0,57 ^B	20,0±0,26 ^B
	Dec	34,10±0,34 ^C	19,7±0,08 ^C
	HAM	36,85±0,21 ^A	22,03±0,15 ^A
<i>Tamarindus indica</i> L.	AM	24,42±0,28 ^G	12,23±0,06 ^E
	Dec	28,70±0,41 ^F	11,17±0,05 ^F
	HAM	32,60±0,25 ^D	17,53±0,02 ^D
<i>Guiera senegalensis</i>	AM	22,68±0,28 ^H	4,77±0,05 ^I
	Dec	25,12±1,25 ^G	2,87±0,03 ^H
J F G.	HAM	29,79±0,51 ^E	8,03±0,03 ^G

*Mean values (±SE) in column with different letters are significantly different (p < 0.05)

Legend: AM: Aqueous Maceration. Dec: Decoction. HAM: Hydroalcoholic Maceration.

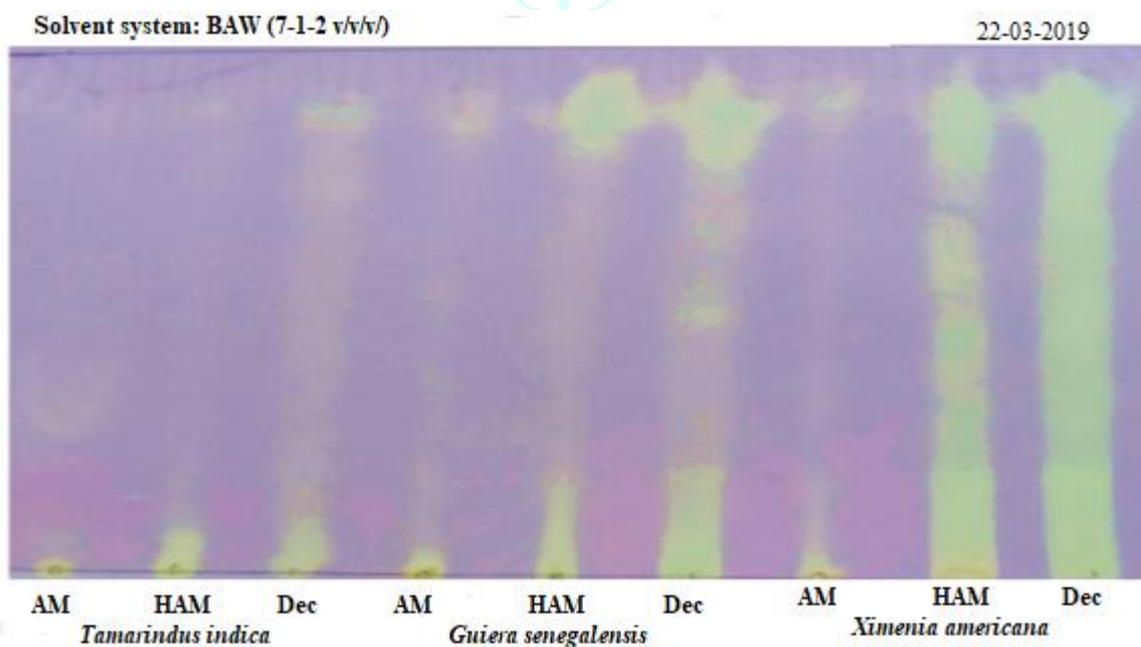
All the polyphenol (mgGAE/g) and the flavonoid (mgQE/g) contents differ from one solvent to another (p<0.05) and from one plant to another (p<0.05). The highest contents of polyphenols (36.85±0.21 mgGAE/g) and flavonoids (22.03±0.15 mgQE/g) were obtained with hydroalcoholic extracts of *Ximenia americana*. The hydro-alcoholic extract has shown the best results in all plants. *Ximenia americana* has presented the highest levels of polyphenols (36.85±0.21 mgGAE/g) followed by *Tamarindus indica* (32.60±0.25 mgGAE/g) and *Guiera senegalensis* (29.79±0.51 mgEAG/g). *Ximenia americana* had the highest levels of flavonoids

(22.03±0.15 mgQE/g) followed by *Tamarindus indica* (17.53±0.02 mgQE/g) and *Guiera senegalensis* (8.03±0.03 mgQE/g).

Antioxidant Activity

Characterisation of Antioxidant Activity by Thin Layer Chromatography (TLC)

The Figure 1 shows the chromatogram of the antioxidant activity of extracts of *Tamarindus indica*, *Guiera senegalensis* and *Ximenia americana*.



Legend: AM: Aqueous Maceration. HAM: Hydroalcoholic Maceration. Dec: Decoction.

Figure 1: Chromatogram of the different extracts revealed to the DPPH

The yellow stains have been observed with all the extracts and on all the plants, indicating the antiradical activity. The

yellow spots observed with *Ximenia americana* are much more remarkable.

Evaluation of antioxidant activity by the DPPH method

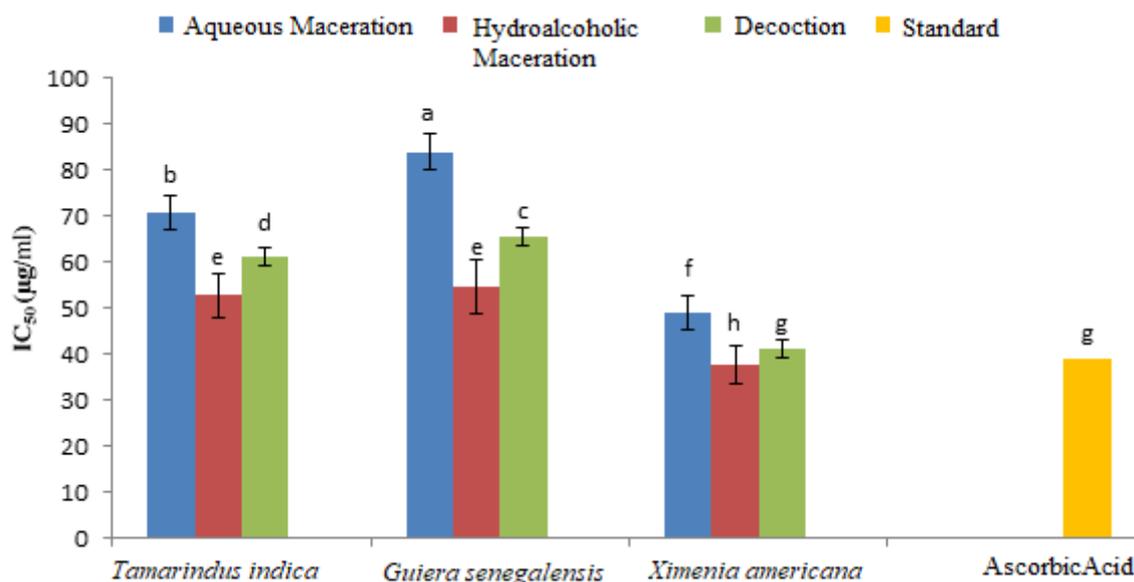


Figure 2: Variation of IC₅₀ by extracts and plant

The Figure 2 summarises the antioxidant activity of the extracts of the three plants studied and this activity is expressed in IC₅₀. Analysis of these data showed that the antioxidant power varies according to the solvent ($p=0.4.10^{-16}$) and and the species ($p=0.35.10^{-15}$).

Extracts of *Ximenea americana* have an antiradical activity similar to that of ascorbic acid. Methanolic extracts were found to be more active than the other two types of extracts.

DISCUSSION

Ximenea Americana had the highest polyphenol content (36.85 ± 0.21 mgGAE/g) followed by *Tamarindus indica* (32.60 ± 0.25 mgGAE/g) and *Guiera senegalensis* (29.79 ± 0.51 mgGAE/g). The results obtained in this study with the stem bark of *Ximenea americana* are lower than those obtained with its leaves, 43.10 mgGAE/mL²⁰. The data found with *Tamarindus indica* are in agreement with those of²¹ which were 30.4 ± 2.6 mg/g with the hexanic extract of the stem bark.²² reached 58 mgEAG/g with the ethanolic extract of the leaves of *Guiera senegalensis*, which is higher than ours. As for the flavonoids, *Ximenea americana* has exhibited the highest content with (22.03 ± 0.15 mgQE/g) This content is higher than that obtained by²³ with the butanolic extract of the leaves, i.e. 10.02% . With *Tamarindus indica*, we attained 17.53 ± 0.02 mgQE/g, a value higher than that found with the hydroethanolic extract of the fruits, which was 8.3 mg/g²⁴. In 2013,²² obtained 36 mgQE/g with the ethanolic extract from the leaves of *Guiera senegalensis*, which is higher than ours (8.03 ± 0.03 mgQE/g). Hydroalcoholic extracts showed the highest antioxidant activity with IC₅₀s of 37.54 ± 0.75 µg/mL; 52.75 ± 0.71 µg/mL and 54.66 ± 1.14 µg/mL respectively for *Ximenea americana*; *Tamarindus indica* and *Guiera senegalensis*. The antioxidant power of *Ximenea americana* is higher than that obtained by²⁰ which was 2.78 µg/ml with the methanolic extract of the leaves and lower than that obtained by²⁵ which was 82.5 ± 3.60 µg/ml with the methanolic extract of the trunk bark. The antiradical power obtained by²⁴ was 15 mg/ml with the hydroethanolic extract of the pulp of the fruit of *Tamarindus indica* and is higher than ours. Our results are higher than those obtained by²⁵ which were 39.12 ± 4.1 µg/mL with the methanolic extract of the leaves of *Guiera senegalensis*. The polyphenol

compounds have a role as natural antioxidants that is attracting increasing interest in the prevention and treatment of inflammatory and cardiovascular diseases²⁶(Talbi *et al.*, 2015). An ethnobotanical survey conducted by⁹ revealed that the species of *Tamarindus indica*, *Guiera senegalensis* and *Ximenea americana* are commonly used in the traditional treatment of erectile dysfunction at Bwatun area in Mali. They also showed that these plants are very rich in secondary metabolites. Many studies have shown that the flavonoids have the antioxidant properties and are reported to raise androgen levels in animals; they may also contribute to the observed aphrodisiac effect²⁷. The saponins stimulate testosterone and sperm production²⁸. The tannins are used to treat and cure haemorrhoids, which are the main cause of sexual dysfunction¹¹. This study found that those plants are rich in total polyphenols and have good anti-free radical activity. These polyphenols could help reduce the effect of oxidative stress and restore erection.

CONCLUSION

The present study shows that the root extracts of *Tamarindus indica* and *Guiera senegalensis* and the stem bark extracts of *Ximenea americana* are rich in total polyphenols and present a good antiradical activity. This richness would justify the use of these plants in the traditional treatment of erectile dysfunction by the traditional practitioners. In the hypothesis that the roots and stem bark of the plants could be replaced by its leaves, to better preserve biodiversity, the investigations should then be carried out to compare their phytochemical compositions and their biological activities. The biological tests would also be necessary to confirm their use in the treatment of erectile dysfunction.

CONFLICTS OF INTERESTS:

The authors have not declared any conflicts of interests.

REFERENCES

- Sharma M., Arya D., Bhagour K., and Gupta R. S. Natural aphrodisiac and fertility enhancement measures in males. A review. *Current Medicine Research and Practice* 2017; 7:51–58.
- Bivalacqua TJ, Usta MF, Kendirli M. and Pradhan L. Superoxide anion production in the rat penis impairs erectile function in diabetes: influence of *in vivo* extracellular superoxide dismutase

- gene therapy. *The Journal of Sexual medicine*, 2005; 2(2):187-198.
3. Esper R J, Nordaby RA, Vilarino J O, Paragano A, Cacharron J L and Machado R. Endothelial dysfunction: a comprehensive appraisal. *Cardiovasc Diabetol*, 2006; 5(1):4.
 4. Kuhn J. M. Hypogonadisme et dysfonction érectile. *Act méd Int*. 2001; 5(6):256-262.
 5. Hafez E. S and Hafez S. D. 2005. Erectile dysfunction: anatomical parameters, etiology, diagnosis, and therapy. *Archives of Andrology*, 51: 15-31.
 6. Lue T. F. Erectile dysfunction. *The New England Journal of Medicine*, 2000; 342:1802-1813.
 7. Carpentier M., Sahpaz S. et Bailleul F.: Plantes et dysfonction érectile. *Phytothérapie*. 2004 ; 2(3):66-71. <https://doi.org/10.1007/s10298-004-0024-3>.
 8. Morabandza C.J., Ondeke R., Elion Itou R.D.G., Etou Ossibi A.W., Imbiella C., Mokondjimobe E., Ongoka P. R. and Abena A. A. Aphrodisiac activity of aqueous and hydro ethanolic extracts of the stem bark of *strychnos camptoneura* (longaniaceae) in wistar rat. *Asian Journal of Science and Technology*, 2017; 08(10):6055-6059.
 9. Togola I, Dembélé J, Daou C, Dénou A, Diarra N, Badiaga M, Konare MA, Karembé M, Sanogo R. Ethnobotanical Survey and Phytochemical Screening of Some Plants used in the Management of Erectile Dysfunction in Bwatun (Mali). *Journal of Natural Product and Plant Resources*, 2020; 9(1):1-8.
 10. Drewes SE, Georges J. and Khan F. R. Recent findings on natural products with erectile dysfunction activity. *Phytochemistry*, 2003; 62:1019-1025.
 11. Andzouana M. and Mombouli J.B. Assessment of the Chemical and Phytochemical Constituents of the Leaves of a Wild Vegetable *Ochthocharis dicellandroides* (Gilg). 2012.
 12. Boua B. B., Mamyrbekova-Bekro J. A., Kouamé B. A., Bekro Y. A. Criblage phytochimique et potentiel érectile de *Turraea heterophylla* de Côte d'Ivoire. *Journal of Applied Biosciences* 2013; 68:5394-5403.
 13. Dey L.M., Anoja S., Attele D. and Chun-Sun Y.M. 2002. Alternative therapy for type 2 diabetes. *Alternative Medicine Review* 2002; 7(1):45-58.
 14. Keita JN, Traore N, Diarra N, Koné D, Mariko B, Pelcouliba D. and Poisson JF. Isolation and Identification of Nicotiflorin from the Leaves of *Costus spectabilis* (Fenzl) K. Schum. *Der Chemica Sinica* 2019; 10(1):782-787.
 15. Singleton, V. L.; Orthofer, R.; Lamuela-Raventos, R. M. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu Reagent. *Methods Enzymol*. 1999; 299:152-178.
 16. Togola I, Dembélé AA, Toukara F, Diarra N, Konaré MA, Karembé M, Maiga SZ, Dembélé D. Evaluation of in vitro Antioxidant Activities of Ethanol Extracts of *Datura innoxia* Mill. Leaves and Seeds Harvested in Mali. *Annual Research and Review in Biology* 2019; 33(2):1-8.
 17. Chang C, Yang M, Wen H, Chern J. 2002. Estimation of total flavonoids content in propolis by two complementary colorimetric methods. *J Food Drug Analysis*. 10: 178-182.
 18. Traoré K., Haidara M., Dénou A., Kanadjigui F., Sogoba M.N., Diarra B., Maïga S. et Sanogo R. Criblage phytochimique et activités biologiques de quatre plantes utilisées au Mali dans la prise en charge du paludisme chez les enfants. *European Scientific Journal*, 2019; 15(6):212-226.
 19. Brand Williams W, Cuvelier ME, Berset C. Use of free radical method to evaluate anti-oxidant activity. *Lebensmittel Wissenschaft and Technologie*. 1995; 28(1):25-30.
 20. Mariko M., Sarr S.O., Diop A., Modi I. A., Dackouo B., Diop Y. M. Antioxidant activity study and total phenolic determination of leaf extracts of *Ximenia americana* L. (Olacaceae) an antitumor plant used traditionally in Mali. *Journal of Applied Biosciences*, 2016; 106:10258-10265.
 21. Nurhanani R., Sarni M. J., Amirah F. A. M., Senthilkumar S., Azlina A. A. 2012. Effects of various solvents on the extraction of antioxidant phenolics from the leaves, seeds, veins and skins of *Tamarindus indica* L. *Food Chemistry* 2012; 131:441-448.
 22. Abubakr M, Sirag N, Osman I, Osman M, Abakar S and Aboul-Enein AM. Anticancer and antioxidant activities of *Guiera senegalensis*. *Sudan JMS* 2013; 8(3).
 23. Kabran G. R. M., Ambeu N. C., Mamyrbékova-Békro J. A. ; Békro Y. A. Phenols et flavonoïdes totaux dans les extraits organiques de dix Plantes utilisées dans la tradithérapie du cancer du sein en Côte d'Ivoire. *European Journal of Scientific Research*, 2012; 68(2):182-190.
 24. Ahodegnon D. K., Gnansounou M., Bogninou R. G. S., Kanfon E. R., Chabi B et al., Biochemical profile and antioxidant activity of *Parkia biglobosa* and *Tamarindus indica* fruits acclimated in Benin. *Int. J. Adv. Res.* 2018; 6(11):702-711.
 25. Maikai, V. A., Kobo, P. I. and Maikai, B. V. O. Antioxidant properties of *Ximenia Americana*. *African Journal of Biotechnology*, 2010; 9(45):7744-7746.
 26. Kouamé, J. C. G., Palé E., Bassolé H., Guissou I. P., Simporé J, Nikiéma J. B. Etude des propriétés cytotoxiques et anti-radicalaires d'extraits de feuilles et de galles de *Guiera senegalensis* J. F. Gmel (Combretaceae). *Science et technique, Sciences de la santé*, 2009.
 27. Talbi H., Boumaza A., Karym. E. M., Talbi J., Hilali A. Evaluation de l'activité antioxydante et la composition physico-chimique des extraits méthanolique et aqueux de la *Nigella sativa* L. *Journal of Materials and Environmental Science* 2015; 6(4):1111-1117.
 28. Saleem A., Ahotupa M. and Pihlaja K. Total phenolics concentration and antioxidant properties of extracts of medicinal plants of Pakistan. *Zeitschrift Naturforschung* 2001; 56(11-12):973-978.
 29. Gauthaman K. and Adaikan P. The hormonal effects of *Tribulus terrestris* and its role in the management of male erectile dysfunction: an evaluation using primates, rabbit and rat, *Phytomedicine*, 2008; 15(1-2):44-54. doi: 10.1016/j.phymed.2007.11.011.