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Treatment of oxidative stress-related pathologies with plants in Abidjan (Ivory Coast)

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Abstract
The objective of this study was to identify medicinal plants used in the treatment of some oxidative stress-related diseases such as diabetes, high blood pressure and hemorrhoids. An ethnobotanical survey was conducted in March, 2016 for medicinal plant in three cities of the District of Abidjan. A total of 35 plant species belonging to 22 families used in the treatment of diabetes, hypertension and hemorrhoids were identified. The most treated disease was diabetes (21 species) followed by hemorrhoids (15 species) and high blood pressure (13 species). The most represented families were *Asteraceae* (5 species; 14.28%) followed by *Euphorbiaceae, Caesalpiniaceae, and Rubiaceae, ea*ch with 3 species (8.57%). Four plants (*Alchornea cordifolia, Vernonia Amygdalina, Moringa oleifera*, and *Morinda lucida*) were used for the treatment of these 3 pathologies. The high content of polyphenols and / or flavonoids in the plants studied could justify their use in traditional medicine in the treatment of diabetes, high blood pressure and hemorrhoids.

Keywords: Oxidative stress, medicinal plants, diabetes, hemorrhoidal diseases, high blood pressure

Introduction
Oxidative-stress reflects an imbalance between antioxidant defense systems and the production of reactive oxygen species (ROS) (Atamer *et al.*, 2008) [8]. Oxidative stress is involved in many pathological mechanisms such as high blood pressure, diabetes, hemorrhoidal, atherosclerosis, arthritis and ischemia, damage of many tissues, central nervous system damage, gastritis and cancer (Chun *et al.*, 2005; Rashed *et al.*, 2014) [14, 39]. Most of these diseases occur with age as aging decreases antioxidant defenses and increases mitochondrial multiplication of free radicals and activated oxygen species (Melov *et al.*, 2000) [36]. Conventional medicine offered a wide range of antioxidant-based medicines for the treatment of these diseases. Furthermore, the use of synthetic products for the treatment of these diseases is more and more criticized because of their adverse effects (Tran *et al.*, 2013) [54]. The search for substitute methods, led to a great interest for natural products. Medicinal plants are an endless supply source of substances with a variety of biological and pharmacological activities. The use of plants as sources for new drugs is not well upgraded. In fact, out of 250,000 plant species only 6% were tested for their biological activity (Verpoorte, 2000) [56]. The Ivorian flora, from which five thousand species were documented, seems to be a largely unknown reservoir (Adjanohoun and Aké-Assi, 1979) [1]. Scientific researches in various fields was developed for extraction, identification and quantification of compounds from several natural substances, such as medicinal plants and food products (Sanchez *et al.*, 2002; Marc *et al.*, 2004; Huang *et al.*, 2005) [53, 33, 23]. The present study, based on ethnobotanical surveys, seek to identify medicinal plants used for the treatment of three oxidative-stress related diseases, such as high blood pressure, diabetes and hemorrhoids sold in the markets of the district of Abidjan (Ivory Coast) and then check out the scientific basis of their use in traditional medicine.

Materials and Methods
The investigations were carried out through ethnobotanicals approaches towards medicinal plant traders in three cities of the district of Abidjan (Ivory Coast), such as Abobo, Adjamé and Yopougon in March, 2016. These three cities were selected because they are home to the main herbal markets. Traders were randomly chosen from the three cities.

Ethnobotanical investigations were based on the semi-structured interview technique (Tra Bi *et al.*, 2008; Fah *et al.*, 2013) [55, 18]. It is a participatory tool, providing information on the use of plant species. The various plants investigated were identified by the National Florist Center (NFC) of the University of Félix Houphouët Boigny (Abidjan). From this ethnobotanical survey, a bibliographical synthesis of scientific studies on the phytochemical screening and antioxidant properties performed on the investigated plants were produced. Bibliographical sources consulted are original articles written on investigated plants and published in international databases.

Results and Discussion

Ethnobotanical surveys

The surveys were conducted on 20 medicinal plant sellers, 8 in Abobo, 6 in Adjamé and 6 in Yopougon. As a result, 35 plant species belonging to 22 families used in the treatment of diabetes, hypertension and hemorrhoids were identified. The most treated disease is diabetes (21 species) followed by hemorrhoids (15 species) and high blood pressure (13 species). The most represented families were *Asteraceae* (5 species; 14.28%) followed by *Euphorbiaceae, Caesalpiniaceae,* and *Rubiaceae,* each with 3 species (8.57%). Four plants, such as *Alchornea cordifolia, Vernonia Amygdalina*, *Moringa oleifera*, and *Morinda Lucida*, were used in the treatment of these three pathologies (Table 1). The representativeness of some families such as *Asteraceae* and *Rubiaceae* in the treatment of hypertension and diabetes were reported by Tra Bi *et al.*, (2008) [55]. This is due to the fact that these families belong to the most important species of the Ivorian flora (Aké Assi, 1984; Kouamé, 1998) [6, 28]. In other parts of Africa, some plants were identified for similar uses or in other pathologies in which oxidative stress seems to be involved. *Anthocleista djalonensis* and *Allium ascolanicum* are used in Nigeria in the treatment of diabetes, hemorrhoids but also rheumatism and cancer (Chukwuma *et al.*, 2015) [13]

Table 1: Some plants used for the treatment of oxidative stress related diseases

Order number	Families	Species	Treated disease
1	*Euphorbiaceae*	*Alchornea cordifolia*	High blood pressure, Diabetes Hemorroids
		Jatropha curcas L.	Diabetes, high blood pressure,
		Mareya micrantha	Hemorroids,
2	*Anarcadiaceae*	*Anacardium occidentale*	High blood pressure, hemorroids
		Spondias mombin	Diabetes
3	*Mimosaceae*	*Albizia adianthifolia*	Diabetes, Hemorroids
		Parkia biglobosa	Diabetes, high blood pressure
4	*Amarantaceae*	*Alternanthera repens*	Diabetes
5	*Loganiaceae*	*Anthocleista djalonensis*	Diabetes
6	*Asteraceae*	*Terminalia glaucescens*	Diabetes
		Ageratum conyzoides	Hemorroids.
		Vernonia amygdalina	Hemorroids, high blood pressure, Diabetes
		Bidens pilosa	High blood pressure, Hemorroids
		Chromolaena odorata	Diabetes
7	*Caesalpiniaceae*	*Cassia occidentalis*	Diabetes
		Mezoneuron benthamianum	Hemorroids
8	*Verbinaceae*	*Gmelina Arborea*	Diabetes
9	*Zingiberaceae*	*Costus afer*	Hemorroids, high blood pressure,
10	*Combretaceae*	*Combretum paniculatum*	Hemorroids,
11	*Moringaceae*	*Moringa oleifera*	High blood pressure, DiabetesHemorroids
12	*fabaceae*	*Baphia nitida*	Diabetes
13	*Lamiaceae*	*Ocimum gratissimum*	High blood pressure, Diabetes
14	*Rutaceae*	*Fagara macrophylla*	High blood pressure,
15	*Hippocrataceae*	*Salacia nitida*	Hemorroids
16	*Meliaceae*	*Khaya ivorensis*	Hemorroids.
17	*Sapindaceae*	*Paullinia pinnata*	High blood pressure
18	*Rubiaceae*	*Mitragyna inermis*	Diabetes
		Morinda morindoides	Diabetes
		Morinda lucida	Diabetes, Hemorroids, High blood pressure,
19	*Liliaceae*	*Allium ascolanicum L*	Diabetes
20	*Caricaceae*	*Carica papaya L.*	Diabetes Hemorroids
21	*Apocynaceae*	*Picralima nitida*	Diabetes High blood pressure,
		Landolphia owariensis	Hemorroids.
		Catharantus roseus	Diabetes High blood pressure,
22	*Ulmaceae*	*Trema guineensis*	High blood pressure

Pharmacological activities of investigated plants

The antidiabetic, anti-hypertension and anti hemorrhoidal activities of ten investigated plants (28.57 %) were justified through experimental studies (Mohammed *et al.* 2012; Osadebe *et al.*, 2012; Osuagwu *et al.*, 2014) [44, 46]. Nine (9) plants were studied for their antidiabetic activity (Table 2). The results are in agreement with our ethnobotanical surveys in which 60 % (21 species) of identified plants were used in traditional medicine for their antidiabetic properties. In these experimental studies, Alloxan and streptomycin were used to

induce diabetes in animals. Administration of plant extracts reduced blood glucose and lipid profile parameters (Cholesterol, triglyceride, HDL, LDL) in diabetic animals. The anti-hypertensive activity of *Bidens pilosa* and *Costa afer* were reported in experimental studies among investigated plants. In these studies, the aqueous extracts of both plants reduced high blood pressure in rabbit, confirming their anti-hypertensive activity (Kouakou *et al.* 2008; Ehoussou *et al.* 2014). [31, 17] The Hemorrhoidal pathology is multifactorial and associated with thrombosis, inflammation, abnormal expansion and tortuosity of hemorrhoidal veins, forming knots in anus and rectum veins. The evaluation of the anti-hemorrhoidal activity is focused on the anticoagulant and anti-inflammatory properties (Gerritsen *et al.* 1995; Muldoon *et al.* 1996) [21, 37]. *Alchornea cordifolia*, one of the investigated plants was evaluated for it anti-hemorrhoidal activity. Administration of the aqueous extract of *Alchornea cordifolia* showed an inhibitory activity on inflammation mediators induced in rats (Nga *et al.*, 2017) [41]

Table 2: Pharmacological properties of some medicinal plants used for the treatment of diabetes, hemorrhoids, high blood pressure

Plants	Part used	Extracts	Pharmacological properties		Authors
			Pathology	Methodology	
Alchornea cordifolia	Leaves	n-butanolic	Diabetes	Streptomycin/ reduction of glucose levels, serum lipid profile (cholesterol, triglyceride) parameters in diabetic rats compared to control group	Mohammed *et al.* 2012
		aqueous	Hemorrhoids.	Carrageenan-induced paw edema in rats and mice/ inflammatory mediator's inhibition: histamine, 5-hydroxytryptamine, kinins and prostaglandins.	Nga *et al.* 2017
Anthocleista djalonensis	Roots	ethanolic	Diabetes [e]	Alloxan/ improvement of glucose level and body weight in diabetic rats	Okokon *et al.* 2012
Bidens pilosa	Roots	Aqueous	High blood pressure	Induction of dose-dependent hypotension and a decrease of adrenaline-induced high blood pressure in rabbits	Kouakou *et al.* 2008
Cassia occidentalis	Leaves	Aqueous	Diabetes	Alloxan / reduction of blood glucose in diabetic rats	Arya *et al.* 2013
Morinda lucida	Roots	Aqueous	Diabetes	Alloxan/induction of dose-dependent hypoglycemic activity in mice	Kamanyi, *et al.* 1994
	Leaves	Aqueous	Diabetes	Streptozotocin/reduction of blood glucose in diabetic rats	Olajide, *et al.* 1999
Picralima nitida	Pod	Methanol	Diabetes	Alloxan/normalization of blood glucose levels in diabetic rats	Inya-Agha *et al.* 2006
Morinda lucida	Leave	Methanol	Diabetes	Alloxan/reduction of glucose levels in diabetic rats	Bamisaye *et al.* 2013
Vernonia amygdalina	Leave	Aqueous	Diabetes	Alloxan/reduction of blood glucose in diabetic rats	Happy *et al.* 2014 Adikwu *et al.* 2010
Costus afer	Stem	Aqueous	Diabetes	Alloxan/reduction of blood glucose levels in diabetic rats	Moke *et al.* 2015
			High blood pressure	Causes hypotension and a decrease in respiratory activity amplitude in rabbits.	Ehoussou *et al.* 2014
Terminalia glaucescens	Leaves	Methanol-methylene chloride	Diabetes	Streptomycin/reduction of glucose levels and serum lipid profile parameters (cholesterol, triglyceride) in diabetic rats compared to control group	Njomen *et al.*, 2008

Antioxidant activity, flavonoid and polyphenol content

Antioxidants are used for the treatment of pathologies in which oxidative stress is involved (Chun *et al.*, 2005; Rashed *et al.*, 2014) [14, 39]. Antioxidant properties of some investigated plants were evaluated *in vitro*. Methods used by authors to assess the antioxidant properties were through DPPH radical (1, 1-diphenyl-2-picrylhydrazyl) and hydrogen peroxide (H_2O_2) trapping tests. Inhibitory concentration 50% (IC_{50}) for DPPH test ranged from 4.656 µg/mL to 4704, 62 µg/mL (Oluwatosin *et al.* 2015 [47]; Agyare *et al.* 2016) [2]. Plants showing good IC 50 for DPPH were *Baphia nitida (*4,656 µg/mL) and *Albizia adianthifolia* (9,51µg/mL) (Barbosa *et al.* 2014; Agyare *et al.* 2016) [12, 2] (Table 3). It is well known that the antioxidant activity is associated to the content in polyphenols and flavonoids (Scholar, 1990; Kim *et al.*, 2012) [52, 26]. These secondary metabolites are able to act as reducing agents (hydrogen donors), singlet oxygen scavengers ($^1O_2$) or metal chelators (Fatemeh *et al.*, 2007) [20]. In various studies authors evaluated through different methods the content of polyphenols and flavonoids in some investigated plants. Levels of these secondary metabolites were expressed in diverse forms (Table 3). Contents were expressed in the same units and ranged from 33.42 to 7818 µg EAG/g for polyphenols and from 3.86 µg QE/g to 256.85 µg QE/g for flavonoids (Table 3). Medicinal plants with a higher content of phenolic compounds were *Ocimum gratissimum* (7818, 66±265µg EAG/g) *and Alchornea cordifolia* (7011, 57±939, 99 µg EAG/g). *Alchornea cordifolia* contained the higher rate of flavonoids (37%) (Kouakou-Siransy *et al.*, 2010) [29]. Nevertheless, a great variability in the phenolic and flavonoid content was observed in the same species. This might be due to the influence of climate on plant secondary metabolite contents (Dumas *et al.*, 2003; Allam, 2015) [16, 9]. Polyphenols and flavonoids play a key role in human health for their anti-inflammatory, anti-hyperglycemic, cardioprotector, vasodilatator activities (Middlton *et al.*, 2000 ; Ksouri *et al.*, 2007) [32]. Indeed, in type1 and type 2 diabetes, the activation of glycolysis due to chronic hyperglycemia is responsible for the oxidative stress associated or not with insulin resistance (Jenkins *et al.*, 2007). Polyphenols act by inhibiting glucose absorption in the gut or of its uptake by peripheral tissues leading to a decrease of glycemia (Scalbert *et al.*, 2005) [5]. Flavonoids and phenolic acids increase endothelium vasomotricity by reducing blood pressure in tha case of high blood pressure (Del Rio *et al.*, 2012; Gabino *et al.*, 2001, Alonso *et al.*, 2006) [19 ,22, 4]. The high content of polyphenols and / or flavonoids in investigated plants could justify their use in traditional medicine for the treatment of diabetes, high blood pressure and hemorrhoids

Table 3: Values of IC_{50} and levels of polyphenols and flavonoid

Medicinal plants	Part used	Antioxidant tests	Secondary metabolite content		Authors
			Polyphenols	Flavonoids	
Alchornea cordifolia	Leaves[b,c,d]	IC_{50} (H_2O_2)= 6.5 µg /mL [c] IC_{50} (DPPH)= 26 µg /mL[a]	1.12 – 42.2 % [b,c,d,e] 7011.57±940 µgEAG/g[e]	5.33 – 37.6 % [b,c,d,e]	Osuagwu *et al.*, 2014[b] Kouakou-Siransy *et al.*, 2010 [c] Alikwe *et al.* 2014 [d] N'Guessan *et al.* 2011[e] N'ga *et al.* 2017[a]
Anthocleista djalonesis.	Leave	IC_{50} (DPPH)= 4704.6 µg/mL	33.4 µg EAG/g		Oluwatosin *et al.* 2015
Baphia nitida	Root	IC_{50} (DPPH)= 4.6 µg/mL			Agyare *et al.* 2016
	Leave	IC_{50} (H_2O_2)= 97.9 µg/mL			Kouakou Siransy *et al.* 2009
Cassia occidentalis	Leave		6.7µg/g	3.2 µg/g	Sathya *et al.* 2012
Parkia biglobosa	Leave		144.18 - 8805.9 µg EAG/g[k]	256.8 µg QE/g[a]	Komolafe *et al.* 2015[a] Ouattara *et al.* 2016 [k]
Mezoneuron Benthamianum	Root, bark	IC_{50} (DPPH)= 15.55-781.5µg/mL[s]	5473.5 µg EAG/g [k]	10.1 % QE /g [k]	Fayemil *et al.* 2012 [s] Ouattara *et al.* 2016 [k]
Costa afer	Stem	IC_{50} (DPPH)= 92 µg/mL	550 µg EAG/g	3.8 µg QE/g	Akaninwor *et al.*, 2014
Ocimum gratissimum,	Leave	IC_{50} (DPPH)= 206.3 µg/mL[w]	7818.7±265µg EAG/g[t]	18. ±4.78 %[t]	Omale *et al.*, 2008[w] N'Guessan *et al.* 2011[t]
Paullinia pinnata	Leave		4741.6±821.1µg EAG/g		N'Guessan *et al.* 2011
Albizia adianthifolia	Leave	IC_{50} (DPPH)= 9.5 µg/mL			Barbosa *et al.* 2014

All expressions having the same letter in the same row are from the same author. GAE: Gallic Acid Equivalent; QE: Quercetin Equivalent

Conclusion

Thirty five (35) plant species used for the treatment of3 oxidative stress related diseases in Ivory Coast such as high blood pressure, diabetes and hemorrhoids were identified. Experimental studies carried out on some of these medicinal plants demonstrated their pharmacological activities justifying their use in traditional medicine. These encouraging results are far from being satisfactory on account of the wide range of the Ivorian flora in medicinal plants which is not well upgraded. Extensive studies should be conducted on a large number of plant species in order to record more samples. Research should be focus on determining molecule structures and evaluating their activity on the biological markers of oxidative stress.

Conflict of interest

The authors declare no competing interest.

References

1. **A**djanohoun ES, Ake A. Contribution au recensement des plantes médicinales de Côte d'Ivoire. Centre National de Floristique de l'Université Nationale de Côte d'Ivoire. Tome I, 1979, 356.
2. Agyare C, Oguejiofor S, Bekoe OE, Adu-Amoah L, Boakye DY. Anti-inflammatory and Anti-infective Properties of Ethanol Leaf and Root Extracts of *Baphia nitida*. Br. Microbiol Res J. 2016; 11(4):1-11.
3. Alikwe PCN, Owen OJ. Evaluation of the Chemical and Phytochemical Constituents of *Alchornea cordifolia* Leaf Meal as Potential Feed for Monogastric Livestock. Int. J. Pharm. Drug. Anal. 2014; 2(3):360-368.
4. Alonso CP, Zhou Q, Martinez ZMJ. Meta-analysis of flavonoids for the treatment of haemorrhoids. Br. J. Surg.2006; 93:909-20.
5. Akaninwor OJ, Essien BE, Tonkiri A, Uvoh MS. Phytoconstituents of *Costus afer* Methanolic Stem Extract and Its *in vitro* Radical Scavenging Activities. J Agric. Biotechnol. Res. 2014 ; 3(7):99-110.
6. Aké AL. Flore de la Côte-d'Ivoire: Etude descriptive et biogéographique, avec quelques notes ethnobotaniques. Tomes I, II, III. Thèse Doctorat ès-Sciences Naturelles, FAST. Université d'Abidjan (Côte-d'Ivoire). 1984, 1205.
7. Arya S, Saini J, Singh S. Antidiabetic activities of Cassia occidentalis. Recent Res. Sci Tech. 2013; 5(1):51-53.
8. Adikwu UM, Uzuegbu BD, Okoye CT, Uzor FP, Ogochukwu AM, Amadi VB. antidiabetic effect of combined aqueous leaf extract of *Vernonia amygdalina* and metformin in rats. J Basic Clin Pharm. 2010; 1(3):197-202.
9. Allam SL. Effet des facteurs climatiques sur la variation de quelques métabolites secondaires suivis de l'activité antibactérienne chez les deux espèces *Hyoscyamus albus* L. et *Hyoscyamus muticus* L. Diplôme de Master Algérie, 2015.
10. Atamer A, Bilici A, Yenice N, Selek S, Ilhan N, Atamer Y. The importance of paraoxonase activity, nitric oxide and lipid peroxidation in hepatosteatosis. J lnt Med Res. 2008; 36:771-776.
11. Bamisaye FA, Odutuga AA, Minari JB, Dairo JO, Oluba OM, Babatola LJ. Evaluation of hypoglycemic and toxicological effects of leaf extracts of *Morinda lucida* in hyperglycemic albino rats. Int. Res. J Biochem. Bioinform. 2013; 3(2):37-43.
12. Barbosa AP. Pharmacologically active saponins from the genus albizia (fabaceae). Int J Pharm Pharm Sci. 2014; 6(11):32-36.
13. Chukwuma CE, Soladoye OM, Feyisola TR. Traditional medicine and the future of medicinal Plants in Nigeria. J Med Plants Studies. 2015; 3(4):23-29.
14. Chun SS, Vattem DA, Lin YT, Shetty K. Phenolic antioxidants from clonal oregano (Origanum vulgare) with antimicrobial activity against Helicobacter pylori, Process Biochemistry. 2005; 40;809-816.
15. Del Rio D, Rodriguez-Mateos A, Spencer JP, Tognolini M, Borges G, Crozier A. Dietary (poly) phenolics in human health: structures, bioavailability, and evidence of

protective effects against chronic diseases. Antioxid Redox Signal. 2013; 18:1818-1892.
16. Dumas Y, Dadomo M, Di LG, Grolier P. Effects of environmental factors and agricultural techniques on antioxidant content of tomatoes. J Sci Food Agric. 2003; 83:369-382.
17. Ehoussou CN, Nene BSA, Soro TY, Traoré F. Effets pharmacologiques d'un extrait aqueux de *Costus afer* (Zingiberaceae) sur l'activité cardiaque *et al.* pression artérielle couplée à la respiration de mammifères. Int. J Biol. Chem. Sci. 2014; 8(4):1644-1655.
18. Fah L, Klotoé JR, Dougnon V, Koudokpon H, Fanou VB, Dandjesso C. Etude ethnobotanique des plantes utilisées dans le traitement du diabète chez les femmes enceintes à Cotonou et Abomey-Calavi (Bénin) J Anim. Plant Sci. 2013; 18(1):2647-58.
19. Fayemil SO, Adeleke O, Olubunmi A. *In vitro* anticandidal and antioxidant potential of *Mezoneuron benthamianum*. J Acute Dis. 2012; 1(2):120-125.
20. Fatemeh A, Mahdi K, Mohammad S. Antioxydant activity *of Kelussia odoratissima Mozaff* in model systems. Food chemistry. 2007; 105:57-64.
21. Gerritsen ME, Carley WW, Ranges GE, Shen CP, Phan SA, Ligon GF *et al.* Flavonoids inhibit cytokine-induced endothelial cell adhesion proteingene expression. Amer. J Pathol. 1995; 147:278-292.
22. Gabino G, Deyarina G, Carla D, Nadine B, Gypsy Q, Alberto JNS *et al.* Analgesic and anti-inflammatory effects of *Mangifera indica* L. extract (Vimang). Phytother. Res. 2001; 15:18-21.
23. Huang D, Ou B, Prior RL. The chemistry behind antioxidant capacity assays. J Agric Food Chem. 2005; 53:1841-1856.
24. Happy INI, Ezejindu DN, Emmanuel NE. A Comparative Study on the Effect of Vernonia amygdalina (Bitter leaf) and Glibenclamide in the Treatment of Diabetes in Alloxan-Induced Diabetic Albino Wistar Rats. Int J Dent Med Spec. 2014; 1(1):2-5.
25. Inya-Agha SI, Ezea SC, Odukoya OA. Evaluation of *Picralima nitida*: hypoglycemic activity, toxicity and analytical standards. Int. J pharmacol. 2006 ; 2(5):576-580.
26. Kim SN, Kim MR, Cho SM, Kim SY, Kim JB, Cho YS. Antioxidant activities and determination of phenolic compounds isolated from oriental plums (Soldam, Oishiwase and Formosa). Nutr. Res. Pract. 2012; 6:277-285.
27. Komolafe K, Oyelade WA. Phytochemical Screening and in Vitro Antioxidant Activity of *Parkia biglobosa* extract. J Biol Agric Healthc. 2015 ; 5(9):1-6.
28. Kouamé NF. Influence de l'exploitation forestière sur la végétation *et al.* flore de la forêt classée du Haut-Sassandra (Centre-Ouest de la Côte d'Ivoire). Thèse 3ème cycle. Université de Cocody-Abidjan (Côte d'Ivoire), 1998, 227.
29. Kouakou-Siransy G, Sahpaz S, Irié NG, Datte YJ, Kablan J, Gressier B. *et al.* Oxygen species scavenger activities and phenolic contents of four West African plants. Food Chemistry. 2010; 118:430-435.
30. Kouakou SG, Nguessan IG, Kablan BJ. Activité antioxydante et antiélastasique de trois plantes à usage antiasthmatique en médecine traditionnelle. J. Sci. Pharm. Biol. 2009; 1:6-12.
31. Kouakou KL, Kouakou AJC, Traoré F, Ehile EE. Effet antihypertensif de BpF2, une fraction d'extrait aqueux de feuilles de *Bidens pilosa* L. (Asteraceae) chez le lapin. Sciences & Nature. 2008 ; 5(1):29-37.
32. Ksouri R, Megdiche W, Debez A, Falleh H, Grignon C, Abdelly C. Salinity effects on polyphenol content and antioxidant activities in leaves of the halophyte *Cakile maritima*. Plant Physiol. Biochem. 2007 ; 45:244-249.
33. Marc FR, Davin A, Deglène-Benbrahim L, Ferrand C. Méthodes d'évaluation du potentiel antioxydant dans les aliments. Erudit, M/S : médecine sciences. 2004 ; 20(4): 458-463.
34. Moke EG, Ilodigwe EE, Okonta JM, Emudainohwo JOT, Ajaghaku DL, Erhirhie OE. *Et al.* Antidiabetic Activity and Toxicity Evaluation of Aqueous extracts of *Spondias mombin* and *Costus afer* on Wistar Rats. Br J Pharmacol. 2015; 6(5):333-342.
35. Mohammed RK, Ibrahim S, Atawodi SE, Eze ED, Suleiman JB, Malgwi IS. The Study of the effects of n-butanol fraction of *Alchornea cordifolia* leaf extract on lipid profile and liver enzymes in streptozotocin-induced diabetic rats. Global Glob. J. Med. Plant Res. 2012; 1(1):1-7.
36. Melov S. Mitochondrial oxidative stress. Physiologic consequences and potential for a role in aging. Ann NY Acad Sci USA. 2000; 908:219-25.
37. Muldoon MF, Kritchevsky SB. Flavonoids and heart disease. Brit. Med. J.1996; 312:458–459.
38. Middleton E, Kandaswami C, Theoharides CT. The Effects of Plant Flavonoids on Mammalian Cells:Implications for Inflammation, Heart Disease, and Cancer. Pharmacological Reviews. 2000 ; 52(4):673-751.
39. N'Guessan HA, Dago DC, Evelyne Mamyrbékova BJA, Békro YA. CCM d'extraits sélectifs de 10 plantes utilisées dans le traitement traditionnel de l'hypertension artérielle en Côte d'Ivoire. Eur. J. Sci. Res. 2011; 66(4):575-585.
40. Njomen NS, Kamgang R, Oyono EL, Njikam N. Antioxidant potential of the methanol–methylene chloride extract of *Terminalia glaucescens* leaves on mice liver in streptozotocin-induced stress. J. Pharmacol. Indien. 2008 ; 40(6):266-270.
41. Nga NE, Yinyang J, Bidias BE, Etame LG, Dibong DS. Etude phytochimique et pharmacologique d'*Alchornea cordifolia* (Schum. & Thonn.) Mull. Arg. et de Mangifera indica dans le traitement traditionnel de la maladie hémorroïdaire. J appl. Biosci.2017 ; 109:10649-10661
42. Okokon JE, Bassey SA, Udobang AJ. Antidiabetic activities of ethanolic extract and fraction of *Anthocleista djalonensis*. Asian Pac. J Trop. Biomed. 2012; 2(6):461-464.
43. Ouattara LH, Kabran MG, Kadja AB, Tano BM, Bekro MAJ, Bekro AY. Etude phytochimique et activité antioxydante d'extraits de plantes de Côte d'Ivoire utilisées dans le traitement traditionnel des hémorroïdes. Int J Innov Appl Stud. 2016; 15:881-893.
44. Osadebe P, Okoye FBC, Uzor FP, Nneka RN, Ijeoma EA, Nkemakonam CO. Phytochemical analysis, hepatoprotective and antioxidant activity of *Alchornea cordifolia* methanol leaf extract on carbon tetrachloride-induced hepatic damage in rats. Asian Pac J Trop Med. 2012; 5(4):289-293.
45. Omale J, Olajide JE, Okafor PN. Comparative evaluation of antioxidant capacity and cytotoxicity of two Nigerian *ocimum* species. Int. J. Chem. Sci. 2008; 6(4):1742-1751.
46. Osuagwu GGE, Ihenwosu AO. Phytochemical

composition and antimicrobial activity of the leaves of *Alchornea cordifolia* (schum and thonn), *Sanseviera liberia* (gerand labr) and *Uvaria chamae* (p. beauv) Int. J. Trad. Nat. Med. 2014; 1(1):14-21.
47. Oluwatosin OJ, Gloria AA. Antioxidant activity among selected medicinal plants combinations (multi-component herbal preparation). Int. J. pharm. res. health sci. 2015; 3(1):526-532.
48. Olajide OA, Awe SO, Makinde JM, Morebise O. Evaluation of the anti-diabetic property of *Morinda lucida* leaves in streptozotocin-diabetic rats. J Pharm Pharmacol. 1999; 51(11):1321-1324.
49. Rasheda K, Butnariu M. Antimicrobial and antioxidant activities of *Bauhinia racemosa* Lam. and Chemical Content. Iran J Pharm Res. 2014; 13(3):1073-1080.
50. Sathya A, Ambikapathy V, Selvam PA. Studies on the phytochemistry, antimicrobial activity and antioxidant properties of *Cassia occidentalis* L. Asian J Plant Sci Res. 2012; 2(4):530-533.
51. Scalbert A, Manach C, Morand C. Dietary Polyphenols and the prevention of diseases. Crit Rev Food Sci Nut. 2005; 45:287-306.
52. Scholar P. Natural antioxidant exploited commercially In BJF Hudson. Food Antioxid. 1990; 99:170-176.
53. Sanchez MC. Review: methods used to evaluate the free radical scavenging activity in foods and biological systems. Food Sci Technol Int. 2002; 8(3):121-137.
54. Tran Amy V. Do BHA and BHT Induce Morphological Changes and DNA Double-Strand Breaks in Schizosaccharomyces pombe? Scripps Senior Thesis. 2013, 152.
55. Tra BFH, Irié GM, Kohué CN, Clejesson HBM. Études de quelques plantes thérapeutiques utilisées dans le traitement de l'hypertension artérielle et du diabète: deux maladies émergentes en Côte d'Ivoire. Sci. Nat. 2008 ; 5(1):39-48.
56. Verpoorte R. Pharmacognosy in the new millennium: lead finding and biotechnology. J. Pharmacol. 2000; 52:253-262.