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Antioxidant and Antibacterial Activities of Five Verbenaceae Species from Burkina Faso

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Abstract: The present study aimed to evaluate the antioxidant and the antibacterial activities of methanol extracts from five species from Verbenaceae family and to quantify their polyphenols. Two methods i.e., FRAP and DPPH were used to estimate the total antioxidant capacity of the plants materials. Antibacterial activity was measured on serotyped bacteria (4) and pathogenic bacteria (13) using the solid agar dishes diffusion method. Polyphenolic quantification was measured using Folin-Ciocalteu, ammonium citrate iron and $AlCl_3$ reagents, respectively. Fe (III) to iron (II) reducing activity show to be relate to tannins content and the radical scavenging activity by total phenolic and total flavonols. As a whole *Duranta erecta* L. gave a better antioxidant activity (FRAP: 15.03 mmol EAA/g and IC_{50}: 7.88 mmol EAA/g). The best antimicrobial activity was obtained by *Duranta erecta* L. (22.33 mm) at a concentration of 25 µg/mL. This result was obtained on Gram-positive bacteria such as *Staphylococcus épidermidis*. The results obtained in this study showed an interesting antioxidant activity of *Duranta erecta* L. This plant also presented the best antibacterial activity particularly on *Staphylococcus épidermidis*, among the five species of Verbenaceae family. Our findings could partially justify the traditional uses of these plants as indicated in the literature.

Keywords: Antioxidant, antimicrobial, flavonoid content, flavonol content, medicinal plant, phenolic content, tannins content, verbenaceae

INTRODUCTION

Verbenaceae are of various forms in nature: grass, shrubs or lianas and some time trees. This family contains in the world, a hundred genus and 2600 species. It's represented in intertropical Africa by a hundred species divided into 10 genus (Ouattara, 2005). In the world, *D. erecta*, *G. arborea*, *S. angustifolia*, *T. grandis* and *V. doniana* have intensive popular use in the treatment of tumors, malaria with spleen inflammation, scorpion puncture, insects puncture, dysentery and diarrhea (Table 1). In Burkina Faso, Ghana, Nigeria and Tanzania these plants were used in the treatment of infections, parasitic and digestive tract diseases, diabetes, dysentery and diarrhea (Nacoulma, 1996; Maregesi *et al*., 2008; Ghaisas *et al*., 2009; Awah *et al*., 2010; Waterman *et al*., 2010). The former phytochemical investigations highlighted a certain number of molecules in these plants. Yadav *et al*. (2008) isolated an iridoid gycoside 6-*O*-(2,3-dibenzoyl)-α-l-rhamnopyranosylcatalpol (IG) from aerial part of *G. arborea*. The verbascoside which was isolated from *G. arborea* (roots) and *T. grandis* (leaves) showed antimicrobial and antioxidant activities (Dhakulkar *et al*., 2005; Penido *et al*., 2006; Singh *et al*., 2010). The leaves of *S. angustifolia* possess antioxidant and immunomodulatory proprieties (Awah *et al*., 2010). But according to our knowledge, there is little information about the antibacterial and antioxidant properties of these plants.

The aimed of the present study was to evaluate the antioxidant and the antibacterial activities of methanol extracts from five species from Verbenaceae family and to quantify their polyphenols. Antioxidant potential has been determined using Ferric Reducing Antioxidant Power assay (FRAP). 2, 2-Diphenyl-1-Picrylhydrazyl (DPPH) free radical. The antibacterial activity was determined using the solid agar in Petri dishes method.

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Table 1: Traditional uses of five (5) medicinal plant species (Verbenaceae)

Species	Traditional uses	Part used	References
Duranta erecta L.	Antioxidant	Fruits	Fu *et al*. (2010),
Gmelina arborea Roxb	Arterial hypertension, fevers, cool, malaria, diarrhea, scorpion puncture, insects puncture	Fruits, flowers, leaves	Nacoulma (1996), Agunu *et al*. (2005) and Dhakulkar *et al*. (2005)
Stachytarpheta angustifolia (Mill) Vahl	Headache, malaria with spleen inflammation, arterial hypertension, liver pathology, teeth of babies, boil	Stem-leaves, flowers	Nacoulma (1996), Penido *et al*. (2006) and Awah *et al*. (2010)
Tectona grandis L.	Fever, malaria, stimulant, anaemia, diabetes II, antiulcer, clothes industry of bits of matches	Young leaves, bark, wood	Nacoulma (1996), Ghaisas *et al*. (2009) and Singh *et al*. (2010)
Vitex doniana Sweet	Affection of respiratory tracks, tumors, dysentery, diarrhea, painful rules, chicken pox, small pox, evil of chronic stomach, madness	Fruits, bark, leaves, root	Nacoulma (1996) and Agunu *et al*. (2005)

Plant materials: Plant materials constituted of 5 medicinal plants from interior of Burkina Faso were collected at Ouagadougou between June and November 2010. The plant was botanically identified by Professor Millogo-Rasolodimby from the plants Department of the University of Ouagadougou. A voucher specimen was deposited in the herbarium of the Laboratory of Biology and Plant Ecology (UFR-SVT) of the University of Ouagadougou.

Chemicals: All reagents were of analytical grade: tannic acid and gallic acid quercetin were provided from Sigma-Germany. HCl and sodium carbonate were from Labosi-France. Folin-Ciocalteu reagent was from Sigma-USA. Aluminum trichloride ($AlCl_3$), DMSO and Tween were purchased from Sigma-Aldrich Chemie GmbH (Germany). 2, 2-Diphenyl-1-Picrylhydrazyl (DPPH), trichloroacetic acid, potassium persulfate, methanol, n-hexane, ethyl acetate, dichloromethane were supplied by Fluka Chemie (Buchs, Switzerland). Potassium hexacyanoferrate [$K_3Fe(CN)_6$] was from Prolabo (Paris, France), ascorbic acid and iron trichloride were supplied by Labosi (Paris, France).

Preparation of plant extracts: The dried and powdered samples (10 g) of each plant were extracted with 3×100 mL of technical methanol by steeping over night. Each extract was filtered and concentrated to dryness in a rotary evaporator (BÜCHI Rotavapor R-200, Switzerland).

Biological activity:

Ion (III) to iron (II)-reducing activity (FRAP): The total antioxidant capacity of the plant extracts were determined by the iron (III) reduction method (Hinneburg *et al*., 2006). The diluted aqueous solution of plant extract (1 mL at a concentration of 100 µg/mL) was mixed with phosphate buffer (0.2 M, pH 6.6, 2.5 mL) and 1% aqueous potassium hexacyanoferrate [$K_3Fe(CN)_6$] solution (2.5 mL). After 30 min of incubation at 50°C, 2.5 mL of 10% trichloroacetic acid was added and the mixture was centrifuged at 2000 rpm for 10 min. Then, the upper layer solution (100 µL) was mixed with water (100 µL) and aqueous $FeCl_3$ (0.1%) solution (20 µL). The absorbance was registered at 700 nm Ascorbic acid was used to produce the calibration curve (0-100 mg/mL, R^2 = 0.998). The iron (III) reducing activity determination was performed in triplicate for three independent pools of samples and expressed in mmol ascorbic acid equivalents per gram of extract. The references quercetin and gallic acid were analyzed in the same manner.

DPPH radical scavenging activity: The capability of the extracts to scavenge DPPH* (2, 2-diphenyl-1-picrylhydrazyl) radical was determined according to the method of Velazquez *et al*. (2003) with some modifications. Briefly, 1.5 mL of freshly prepared methanolic solution of DPPH (0.02 mg/mL) was mixed with 0.75 mL of extract solution. After 15 min of incubation in the dark, at room temperature, absorbencies were registered at 517 nm against a blank sample prepared with 1.5 mL of methanol and 0.75 mL of extract. A standard calibration curve was plotted using ascorbic acid (0-200 mg/mL, R^2 = 0.9989). Quercetin and ascorbic acid were used as positive controls. The antioxidant activity is expressed in inhibiting concentration 50 (IC_{50}) i.e., the concentration of the extract likely to cause 50% of inhibition. The free radical scavenging activities were expressed in microliter per liter. The analysis was done in triplicate for three independent pools of samples.

Antibacterial study:

Microorganisms: The microorganisms used in this study consisted of clinical isolated and serotyped strains. The clinical isolated were *Citrobacter freundii*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pantoea* sp., *Pseudomonas aeruginosa*, *Salmonella typhi* (fish),

Salmonella typhi (salad), *Shigella flexneri*, *Staphylococcus aureus*, *Streptococcus agalactiae*, *Staphylococcus epidermidis*, *Vibrio cholerae* (water) and *Vibrio cholerae* (salad). The following serotyped strains used in this study are: *Bacillus cereus* ATCC9144, *Escherichia coli* ATCC 25922, *Proteus mirabilis* ATCC35659 and *Staphylococcus aureus* ATCC 25923. Before testing, pure cultures were realized with all the strains in Müeller Hinton Agar and Tryptic soy broth. The inocula were prepared by adjusting the turbidity of the suspension to match the 0.5 Mc Ferland standards.

Antibacterial test: The effectiveness of the extracts compared to the micro-organisms was evaluated according to the method of Arias *et al.* (2004) with some modifications. We made ran 10 mL of solid agar in Petri dishes and put in incubation during 24 h to check sterility. Sowing is then carried out by the technique by flood. This technique consists in flooding the surface of the solid agar with a bacterial suspension of a density of 10^6-10^7 bacteria/mL. Excess is taken and eliminated. Discs made up of paper Whatman nº1 of 6 mm (sterilized) are deposited on the solid agar. A volume of 15 µL of extract of a concentration of 25 µg/mL in methanol 1% is deposited on each disc. The Petri dishes were then put in incubation for 24 h. The diameters of inhibition zones were materialized by clear zones around the discs are then measured using a ruler. Commercial antibiotic discs of Gentamicin (10 µg/disc), Amoxicillin (10 µg/disc), Ciprofloxacin (5 µg/disc) and Cotrimoxazol (25 µg/disc) were used as positive controls. Methanol 1% was used as a negative control.

Determination of polyphenolics compounds:

Determination of the total phenolic content: The total phenolics of plant extract were determined by the Folin-Ciocalteu method (Bangou *et al*., 2011).

Determination of tannins content: Tannins content was determined according to the European Commission (2000) as adapted by Bangou *et al.* (2011).

Determination of the total flavonoids content: The total flavonoids were estimated according to the Dowd method as adapted by Bangou *et al*. (2011).

Determination of the total flavonols content: Flavonol content was determined according to Almaraz-Abarca *et al*. (2007) method, by linear regression analysis from the standard curve of quercetin (0-50 mg/L) ($Y = 0.0353x+0.0016$; $R^2 = 0.9988$). We have put in each test tube 1 mL of extract (100 µg/mL) and 1 mL of aluminum trichloride (20%). The absorbance of three independent tests was registered at 425 nm after ten min. The flavonols contents were expressed in mg Quercetin Equivalents (mg QE) /100 mg extract.

Statistical analysis: All assays were carried out in triplicates and results are expressed as Means±Standard Deviation (SD) calculated with Excel 2007. Statistical comparisons were done with the XLSTAT7.5.2, using Spearman correlation. Differences were considered to be significant at $p<0.05$.

RESULTS

With regard to the antioxidant activities, two methods were adopted: the Ferric Reducing Antioxidant Power (FRAP) and the radical scavenging activity of 2, 2-Diphenyl-1-Picrylhydrazyl (DPPH), using methanolic extract. The results of this study are indicated in Table 2. The inhibitory activities varied from 11.7 to 16.86 mmol EAA/g. The highest reduction activity of iron (III) to iron (II) were obtained with *V. doniana* (16.86 mmol EAA/g) and *S. angustifolia* (16.81 mmol EAA/g) followed by *G. arborea* (16.23 mmol EAA/g). The lowest value was registered for *T. grandis* (11.7 mmol EAA/g). Compared to the substances of references, the reduction produced of *V. doniana>S. angustifolia>G. arborea>D. erecta* are not significantly different from that of quercetin (13.19±2.17 mmol AAE/g) and from that of the gallic acid (18.46±1.51 mmol AAE/g). All the extracts gave a better antioxydant activity compared to the ascorbic acid. Concerning radical scavenging (DPPH) activity, the inhibitions were ranged between 7.88 and 43.49 µg/mL. The antioxidant activity is expressed in inhibiting concentration 50 (IC_{50}) i.e., the concentration of the extract likely to cause 50% of inhibition. The best activity was found with *D. erecta* (7.88 µg/mL) and *G. arborea* (43.49 µg/mL) followed by *S. angustifolia* (42.08 µg/mL) were presented the lowest inhibition. The inhibiting values of our five extracts of plants are very weak compared with the substances of references. Indeed, the best inhibition obtained by *D. erecta* (7.88 µg/mL) is four times lower than that of the ascorbic acid (1.8 µg/mL).

Table 2: Capacity antioxidant values of the methanolic extracts

Samples	FRAP (mmol EAA/g)	IC_{50} (µg/mL)
D. erecta	15.03^{c}±0.3	7.88^{c}±1.74
G. arborea	16.23^{bc}±0.27	43.49^{a}±9.96
S. angustifolia	16.81^{b}±0.12	42.08^{a}±1.14
T. grandis	11.7^{e}±0.81	33.96^{b}±8.18
V. doniana	16.86^{b}±0.17	32.91^{b}±1.62
Gallic acid	18.46^{a}±1.51	0.60^{d}±0.01
Quercetin	13.19^{d}±2.17	0.93^{d}±0.02
Ascorbic acid	5.86^{f}±0.51	1.8^{d}±0.43

The values represent the mean and standard deviation for three independent samples. Different letters in the same column (or line) mean significant differences ($p\leq0.05$)

Table 3: Summary table of the diameters (mm) of inhibition zones

Bacterial strains	*D. erecta*	*G. arborea*	*T. grandis*	*V. doniana*	*S. angustifolia*	A (10 µg/d)	C (5 µg/d)	G (10 µg/d)	Co (25 µg/d)
Bacillus cereus ATCC9144	8	11	10	9	9	-	25	18	24
Citrobacter freundii	R	R	R	R	R	ND	ND	ND	ND
Escherichia coli (isolate)	R	R	R	R	R	26	33	28	28
Escherichia coli ATCC 25922	10	11	9.5	10	8	19	23	20	ND
Klebsiella pneumoniae	9	8	10	9	9	ND	ND	ND	ND
Pantoea sp.	8	10	10	10	10	ND	ND	ND	ND
Proteus mirabilis ATCC35659	8	8	8	8	8	-	27	20	29
Pseudomonas aeruginosa	8	8	8	8	8	ND	ND	ND	ND
Shigella flexneri	R	R	R	R	R	18	31	34	30
Salmonella typhi (fish)	8	8	8	8	8	22	31	20	ND
Salmonella typhi (salad)	8	8	8	8	8	ND	ND	ND	ND
Staphylococcus aureus ATCC 25923	8	8	10	9	8	-	30	20	ND
Staphylococcus aureus (isolate)	R	8	R	9	9	16	31	27	35
Staphylococcus épidermidis	22.33	8	9	9	R	-	24	18	ND
Streptococcus agalactiae (isolate)	8	9	9	R	R	ND	ND	ND	ND
Vibrio cholera (water)	R	R	R	R	R	8	31	19	ND
Vibrio cholera (salad)	R	R	R	R	R	ND	ND	ND	ND

D. *erecta*: *Duranta erecta*; G. *arborea*: *Gmelina arborea*; T. *grandis*: *Tectona grandis*; V. *doniana*: *Vitex doniana*; S. *angustifolia*: *Stachytarpheta angustifolia*; R: Resistant; ND: no determined; A: Ampicillin; C: Ciprofloxacin; G: Gentamycin; Co: Cotrimoxazole

Concerning the antibacterial activity, the diameters of inhibitions zones are varied from 8 to 22.33 mm at a concentration of 25 µg/mL (Table 3). No inhibition zones diameter was found for the following bacterial strains *Citrobacter freundii*, *Escherichia coli* (clinic), *Shigella flexneri, Vibrio cholerae* (water) and *Vibrio cholerae* (salad). Just as *Proteus mirabilis* ATCC35659, *Pseudomonas aeruginosa*, *Salmonella typhi* (fish) and *Salmonella typhi* (salad) did not present interesting diameters of inhibitions. An extract is active if it induces an inhibition zones superior at 3 mm around the disc (Schulz *et al*., 1995). Taking account of this consideration, we can say that our extracts were active on the following species: *Bacillus cereus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pantoea* sp., *Staphylococcus aureus* ATCC25922 and *Staphylococcus épidermidis*. *Pantoea* sp., was most sensitive to the extracts. The best inhibition zones are been obtained by *D. erecta* extract on *Staphylococcus épidermidis*, followed by *T. grandis* on *Bacillus cereus* ATCC9144. This best activity was obtained on the Gram-positive bacteria which are very rich in peptidoglycane (50 to 80% of the lining); consist of several layers of peptidoglycane and having a significant reticulation (Corvec, 2009). One of the peptidoglycanes roles is to ensure the rigidity and the solidity lining of the bacterial as well as the protection of the cytoplasmic membrane against osmotic lysis. Particularly, *Bacillus* and *Staphylococci* are accused in the infections of the urinary tract, pneumonia, toxi-infections, whitlow, furuncle and visceral infections (Singleton, 2004). The inhibition zones given by antibiotics show that the majority of the bacterial strains are sensitive to the Ciprofloxacin, Cotrimoxazol and Gentamicin. These results show that these three antibiotics present a broad activity spectrum. Only the extract of *D. erecta* gave an inhibition zone of 22.33 mm at a concentration of 25 µg/mL. Extract of *D. erecta* is thus active on *Staphylococcus épidermidis*.

Five genus of Verbenaceae species from Burkina Faso folk medicine have been studies, in order to confirm their uses. The studies are concerning polyphenolic compounds contents and their antibacterial and antioxidant activities, through methanolic extracts (Table 4). The polyphenolic investigations show in a general way, that there is not great variation on the level of each group of compounds, namely the totals phenolic, the total flavonoids, total flavonols and the tannins contents. These five species are poor in polyphenolic compounds. Totals phenolics are varied from 9.44±0.06 (*V. doniana*) to 12.81±0.94 (*T. grandis*) mg

Table 4: Results of polyphenolic quantification

Species	Total phenolics (mg GAE/ 100 mg)	Total flavonoids (mg QE/ 100 mg)	Total flavonols (mg QE/ 100 mg)	Tannins (mg TAE/ 100 mg)
D. erecta	12.53^{a}±1.03	5.98^{bc}±0.20	3.82^{a}±1.08	6.21^{ab}±0.18
G. arborea	10.11^{b}±0.44	8.72^{a}±0.27	3.76^{ab}±0.80	6.11^{ab}±0.19
S. angustifolia	10.21^{b}±0.29	4.93^{c}±0.47	3.48^{bc}±0.52	6.44^{a}±0.15
T. grandis	12.81^{a}±0.94	7.60^{ab}±2.70	2.25^{abc}±0.09	5.97^{b}±0.05
V. doniana	9.44^{b}±0.06	5.10^{c}±0.20	2.35^{c}±0.06	6.43^{ab}±0.27

The values represent the mean and standard deviation for three independent samples. Different letters in the same column (or line) mean significant differences ($p \leq 0.05$)

GAE/g of extract. The best content is obtained by *T. grandis*, followed by *D. erecta* (12.53±1.03). The lowest value is obtained by *V. doniana* (9.44±0.06 mg.GAE/g of extract). The best content in totals flavonoids are been obtained by *G. arborea* (8.72±0.27 mg.QE/g) followed of *T. grandis* (7.60±2.70 mg.QE/g of extract). The lowest value are been presented by *S. angustifolia*<*V. doniana* with 4.93±0.47 and 5.10±0.20 mg.QE/g of extract, respectively. *D. erecta*≥*G. arborea*≥*S. angustifolia* are presented the best content in total flavonols, respectively. The lowest content are been obtained by *T. grandis* and *V. doniana*. All species are presented the high content in tannins compared at the total phenolic content.

DISCUSSION

While trying to understand the chemical group of compounds implied in this antioxidant activity, we realize that the tannins contents are there for some things. For each extract the tannins contents are with more half of the polyphenolic contents. We note that the capacity reductive of the Fe (III) in Fe (II) is in the order of the tannin contribution on the polyphenolics contents. Indeed, *Vitex doniana* which presented strongest antioxidant activity has the strongest tannin content (6.43 mg TAE/100 mg extract), which is with more half of the polyphenolic contents (9.44 mg/100 mg extract). Follow of *S. angustifolia* and *G. arborea* which are presented the best antioxidant activities, respectively. We note that flavonoids are not responsible for these irons reducing activity.

According to former results, it was difficult to establish a very clear correlation between the rate of flavonoids and the reduction. Sometimes a good correlation was shown (Lamien-Meda *et al*., 2008), sometimes a bad correlation as in this case. These observations could be explained by several possibilities:

- The compounds existing in the extracts have large molecular weights or are heterosidic (Manzi *et al*., 2004)
- The majority of the flavonoids are not antioxidants (Gursoy *et al*., 2009)
- Under estimate of the flavonoids by the method of $AlCl_3$ (Meda *et al*., 2005)

These observations are in conformity with those of Meda *et al.* (2005) which showed a bad correlation between the anti-DPPH and flavonoids honey activity. According to Cai *et al.* (2006) in fact the flavanols present a better anti-DPPH activity, whereas the method used in this study underestimates these types of flavonoids according to Chang *et al.* (2002). But our results corroborate with those of Coulidiati (2010) and Méda (2010), which showed that the antioxydant activities are related to tannins. Other searchers showed that there was a bond between totals phenolic and antioxydant activities (Djeridane *et al*., 2006; Lamien-Meda *et al*., 2008; Amaral *et al*., 2009; Zhang and Wang, 2009; Ciz *et al*., 2010; Cèspedes *et al*., 2010). Concerning the radical scavenging activity, phenolic and flavonols content can justify these activities. Thus according to Surveswaran *et al.* (2007) which evaluated the correlation between antioxidant activity and totals phenolic of 133 species of medicinal plants of Indiana, found a significant correlation include $R^2 = 0.89$ and $R^2 = 0.97$. They could show the implication of the phenolic and tanins compounds in 83 of the species of plants of their study. Other searchers highlighted the action of certain secondary metabolites on the antioxidant capacity. Thus, the verbascoside which are known to possess antioxidant is isolated in the following species: *G. arborea*, *T. grandis* and *Stachytarpheta* genus (Dhakulkar *et al*., 2005; Penido *et al*., 2006; Singh *et al*., 2010). The verbascoside protects the destruction oxidative of hemoglobin, inhibits the aldolase reductase as well as the lipidic peroxidation. It also presented an immunomodulatrice activity, immunosuppressive properties and apparently reinforced the anti-tremor effect of the L-DOPA (Ghisalberti, 2000). Cirsimaritin and 12S, 16S/R-Dihydroxy-ent-labda-15, 16-olide (isolated from *Vitex* genus), exhibited scavenging activity (IC_{50}: 22.14±1.74 to 33.06±1.68 mg/mL) in the anti-oxidant assay (Nyiligira *et al*., 2008). *Duranta repens* compounds content (coumarinolignoids, repenins A-D, durantin, cleomiscosin) which are potent scavenging activities against DPPH radical, with IC_{50} values in the range 0.420 to 0.625 mM. The activities of these plants could be justified by the secondary metabolites of these species.

While trying to understand, the reason of this strong inhibition of the extract of *Duranta erecta*, we realize that only its total flavonols content is highest. We did not meet former studies on the biological

activities of this plant, in particular those antimicrobial. The species of Verbenaceae whose their antibacterial activities are elucidated are *Lippia* genus and *Lantana* genus. For example, it was shown that the following compounds identified in the two *genus* have antimicrobial activities: acetate ursulic, verbascoside, elemol, 1, 8-cineol, camphor and the *p*-cymene (Ghisalberti, 2000; Pascual *et al*., 2001; Bassolé *et al*., 2003; Mevy *et al*., 2007). The verbascoside was detected in the following genus and species: *Stachytarpheta*, *Gmelina arborea* and *Tectona grandis* (Dhakulkar *et al*., 2005; Penido *et al*., 2006; Singh *et al*., 2010). More particularly, certain searchers showed that the furanonaphthoquinones (detected in *Lantana* genus) are very active on the Gram-positive bacteria (Ghisalberti, 2000).

According to Maregesi *et al*. (2008) the Gram-positive bacteria were more sensitive than Gram-negative bacteria. They tested themselves 147 extracts of plants on six bacterial strains of which *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* at a concentration of 1000 µg/mL. None positive result was not found with the Verbenaceae species, such as *Stachytarpheta jamaicensis* (L.) Vahl (leaves).

The polyphenols (flavonoids) are likely to contribute to the antibacterial activities. Thus it was evaluated the contribution of polyphenols to the inhibitions of the growth of *B. cereus, S. aureus* and *E. coli* which was 0.92, 0.93 and 0.88, respectively (Shan *et al.,* 2007). Although the extract of *G. arborea* was rich in flavonoids (8.72 mg/100 mg extract), it did not show a good antibacterial activity so than *D. erecta* flavonoid (5.98 mg/100 mg extract) extract. Such an observation is identical to that of Sirikhansaeng *et al.* (2008) which noted a bad contribution of the flavonoids. Also it was shown a bad diffusion of the flavonoids on the agar. It should be noted that the antibacterial activities of the flavonoids seem to be discussed (Cushnie and Lamb, 2005). In this study, weak inhibitions can be related to the low content of polyphenolic compounds. Also the phenolic compounds in particular the tannins are suitable for precipitation during the reactions of oxidation and that could be a factor of toxicity with respect to the micro-organisms (Bakasso, 2009). The antibacterial activity highlighted would confirm the therapeutic use of the five species in traditional medicine in the treatments of affection of respiratory tracks, teeth of babies, diarrhea, dysentery, painful rules, chicken pox, small pox and evil of chronic stomach (Nacoulma, 1996; Agunu *et al*., 2005; Penido *et al*., 2006; Awah *et al*., 2010). Taking account of the effectiveness of the extract of *Duranta erecta* on *Staphylococcus épidermidis*, we could exploit this plant for the search for new molecules, especially those directed in the treatment of the whitlows, otitises, the bacillary dysenteries and the urinary infections.

CONCLUSION

Antibacterial and antioxidant activities were investigated against polyphenolic compounds, using methanolic extract. The results obtained in this study showed an interesting antibacterial activity of *Duranta erecta* particularly on *Staphylococcus épidermidis*, among the five species of Verbenaceae family. This plant also presented the best antioxidant capacity. The results show that tannins content was implied in the ferric reducing activity, while phenolic and flavonol contents are responsible to the radical scavenging activity. In a general way, antioxydant activities found are superior or equal to 7 µg/mL. That shows that these species are not very good antioxidant inhibitor. These results give further support to the therapeutical uses of theses Verbenaceae species. Further investigation will be conducted on *Duranta erecta* species for the isolation and identification of active principles through bioassay-guided.

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