African Journal of Integrated Health Vol 7: N° 2; December 2017 P. 49-56

RESEARCH ARTICLE

ANTIBACTERIAL ACTIVITY OF METHANOL EXTRACTS FROM SIX CAMEROONIAN EDIBLE PLANTS *CAMELLIA SINENSIS, MANGIFERA INDICA, MORINGA OLEIFERA, ANANAS COMOSUS, TRIUMPHETTA PENTANDRA* AND *ARTOCARPUS HETEROPHYLLUS* AGAINST MDR GRAM-NEGATIVE PHENOTYPES

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ABSTRACT

Background: After six decades of antimicrobial use, pathogenic bacteria of human and animal origin have reached alarming levels of antibiotics resistance. The present study aimed at investigating the *in vitro* antibacterial activity of methanol extracs from six Cameroonian edible plants (*Camellia sinensis*, *Mangifera indica*, *Artocarpus heterophyllus, Moringa oleifera, Ananas comosus* and *Triumphetta pentandra*) against a panel of 29 multi-drug resistant (MDR) Gram-negative bacteria.

Method: Extracts were subjected to qualitative chemical screening of their secondary metabolite contents according to the standard methods. Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) determination on the tested bacteria were conducted using modified rapid *p*-iodonitrotetrazolium chloride (INT) colorimetric assay.

Results: Phytochemical assays revealed that all tested crude extracts contained alkaloids, polyphenols, triterpenes and sterols. Other classes of secondary metabolites were selectively distributed. Extracts showed antibacterial activities with minimum inhibitory concentrations ranging from 32-1024 µg/mL on the majority of the 29 tested Gram-negative bacterial strains. The leaves' extract of *C. sinensis* inhibited the growth of 86.20% of the tested bacterial strains. The lowest minimal inhibitory concentation value (32µg/mL) was recorded with the bark of *M. indica* against *Pseudomonas aeruginosa* PA01 strain whilst the best MBC value (512 µg/mL) was obtained with the extract from *C. sinensis*against *Klebsiella pneumoniae* K2 strain.

Conclusion: The results of the present work provide baseline information on the possible use of different parts of *C. sinensis*, *M. indica*, *A. heterophyllus*, *M. oleifera*, *A. comosus* and *T. pentandra* in the treatment of selected bacterial infections including multidrug resistant phenotypes.

INTRODUCTION

Mortality associated with infectious diseases is a serious blow to the economy of developing countries where they are the leading cause of death and a major public health problem [1]. The ever increasing number of hospitalized or deceased people with an infection would be linked to the emergence of resistance to the antibiotics to which they are commonly exposed within the microorganisms responsible for these diseases [2]. In Cameroon particularly, the study carried out by Marbou and Kuete [3] in the locality of Mbouda (Bamboutos) showed a prevalence of multi-resistance of enteric bacteria of 79.4% in HIV-positive patients and 29.7 % in seronegative patients. This resistance is most often due to inappropriate use of available antibiotics [4]. Medicinal plants constitute an important source of new candidates for therapeutic compounds, in regards to the chemical diversity found in several species [5].

In Cameroon, several medicinal plants are used as herbal medicines to treat infectious diseases [6]. The present work was therefore designed to investigate the antibacterial potential of some commonly edible and medicinal plants namely *Camellia sinensis* Linn. *Mangifera indica* Linn. (Anacardiaceae), *Artocarpus heterophyllus*Lam. (Moraceae), *Moringa oleifera* Lam. (Moringaceae), *Ananas comosus* (L.) MERRILL. (Bromeliaceae) and *Triumphetta pentandra*A.Rich. (Tiliaceae) against Gram-negative bacteria including MDR phenotypes.

MATHERIALS AND METHODS

Plant material and extraction

The plant materials used in this work were collected in March 2015 in two Regions of Cameroon and included leaves and bark of *Mangifera indica*, stem of *Triumphetta pentandra* collected at Koung-khi division (West Region); leaves of *Camellia sinensis* and *Artocarpus heterophyllus* collected at Menoua division (West Region); fruits of *Ananas comosus*, and seeds of *Moringa oleifera* were collected at Mungo division (Littoral Region). The plants were identified at the National Herbarium (Yaounde, Cameroon) where voucher specimens were deposited under the reference numbers (Table 1). Each plant sample was air dried and the powder (300 g) was extracted with methanol (MeOH, 1 L) for 48 h at room temperature. The extract was then concentrated under reduced pressure to give residues which constituted the crude extract. All extracts were then kept at 4°C until further use.

Preliminary phytochemical investigations

The major phytochemical classes such as alkaloids (Dragendorff's and Mayer's tests), triterpenes (Libermann Burchard's test), flavonoids (Aluminum chloride test), anthraquinones (Borntrager's test), polyphenols (Ferric chloride test), sterols (Salkowski's test), coumarins (Lacton test), saponins (Foam test) and tannins (Gelatin test) (Table 2) were investigated according to the commonly described phytochemical methods [7-9].

Bacterial strains and culture media

The studied microorganisms included sensitive and resistant strains of *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Enterobacter aerogenes*, *Enterobacter cloacae*, *Escherichia coli* and *Providencia stuartii* obtained from the American Type Culture Collection (ATCC) as well as clinical strains. Their bacterial features were previously reported [10-12]. Nutrient agar was used for the activation of the tested Gram-negative bacteria while the Mueller Hinton Broth was used for antibacterial assays [13].

Chemicals for antimicrobial assays

Chloramphenicol (CHL), (Sigma–Aldrich, St Quentin Fallavier, France) was used as reference antibiotic (RA). *P-Iodonitrotetrazolium* chloride (INT) was used as microbial growth indicator [14, 15].

Bacterial susceptibility determination

The MIC determinations on the tested bacteria were conducted using rapid INT colorimetric assay according to previously described methods [14] with some modifications [16, 17]. The test samples and RA were first of all dissolved in DMSO/Mueller Hinton Broth (MHB). The final concentration of DMSO was lower than 2.5% and does not affect the microbial growth [18, 16]. The solution obtained was then added to Mueller Hinton Broth, and serially diluted two folds (in a 96-wells microplate). One hundred microliters (100 µL) of inoculum 1.5×10^6 CFU/mL prepared in appropriate broth was then added [19, 17]. The plates were covered with a sterile plate sealer, then agitated to mix the contents of the wells using a plate shaker and incubated at 37°C for 18 h. The assay was repeated thrice. Wells containing adequate broth, 100 µL of inoculum and DMSO to a final concentration of 2.5% served as negative control. The MIC of samples was detected after 18 h incubation at 37°C, following addition (40 µL) of 0.2 mg/mL of INT and incubation at 37°C for 30 min. Viable bacteria reduced the yellow dye to pink. MIC was defined as the sample concentration that prevented the color change of the medium and exhibited complete inhibition of microbial growth [14]. The MBC was determined by adding 50 µL aliquots of the preparations, which did not show any growth after incubation during MIC assays, to 150 µL of adequate broth. These preparations were incubated at 37°C for 48 h. The MBC was regarded as the lowest concentration of extract, which did not produce a color change after addition of INT as mentioned above [19, 17].

RESULTS

The results of the phytochemical screening (Table 2) showed that all the tested plant extracts contain alkaloids, polyphenols, triterpenes and sterols. The other classes of secondary metabolites were selectively distributed. Also, the extracts from *Mangifera indica* and *Ananas comosus* contain all the classes of screened secondary metabolites.The results summarized in Table 3 showed that the tested extracts displayed selective antibacterial activities. The best activity was recorded with *Camellia sinensis* extract,

with MIC values ranging from 64 to 1024 µg/mL against 25/29 (89.65%) tested bacteria. MIC values below or equal to 1024 µg/mL were also recorded with the leaves and barks from *Mangifera indica*, *Artocarpus heterophyllus*, *Ananas comosus*, *Triumphetta pentandra* and *Moringa oleifera* extracts respectively against 22/29 (75.86%), 21/29 (72.41%), 19/29 (65.51%), 12/29 (41.37%), 10/29 (34.48%) and 6/29 (20.68%) tested bacteria. The lowest MIC value (32 µg/mL) was recorded with the extract from bark of *M. indica* against *P.aeruginosa* PA01. Extract from *C. sinensis* also displayed the best spectrum of bactericidal effect with a ratio MBC/MIC ≤ 4 obtained on six tested bacterial strains.

DISCUSSION

Chemical composition of the tested plant extracts. Phytochemical screening revealed the presence of several classes of secondary metabolites such as alkaloids, polyphenols, flavonoids, anthraquinones, coumarins, saponins, tannins, triterpenes and steroids. Several molecules belonging to these classes were found active on pathogenic microorganisms [16].

Antibacterial activity of the tested extracts. Differences in antibacterial activities were noted between the extracts. Several molecules belonging to the detected classes of secondary metabolites were found active on pathogenic microorganisms [20, 21]. The presence of such metabolites in the studied plant extracts can provide a preliminary explanation on their antibacterial activities. Differences were observed in the antibacterial activities of the extracts. These could be due to the differences in their chemical composition as well as in the mechanism of action of their bioactive constituents [20]. According to Kuete [6], Kuete and Efferth [22], the antibacterial activity of a plant extract is considered significant when MIC values are below 100 µg/mL, moderate when 100 ≤ MIC ≤ 625 µg/mL and weak when MIC > 625 µg/mL. Consequently, the activity (MIC of 32 and 64 µg/mL) observed with bark of *M. indica* and leaves of *C. sinensis* extracts against *P. aeruginosa* PA01 and *K. pneumoniae* K2 respectively can be considered important. Antibacterial activity of mango extracts upon Gram-positive, Gram-negative bacteria and *Candida albicans* yeasts was also demonstrated [23, 24] and it is thought that the antibacterial activity of mango extract is due to the presence of gallotannin and mangiferin [25]. Different extracts of *C. sinensis* having antimicrobial activity was reported against Gram-positive, Gram-negative and fungi [26, 27] and it is thought that its antibacterial activity is due to the presence of Catechin which particularly affects the membrane fluidity in both, hydrophilic and hydrophobic regions of lipid bilayers of the microorganism [28], or by inhibiting the action of DNA polymerases [29]. In addition, numerous research groups have sought to elucidate the antibacterial mechanisms of action of selected flavonoids as this study confirms the presence in many extracts including *C. sinensis*. The activity of quercetin, for example has been at least partially attributed to inhibition of DNA gyrase. The present study provides additional data on the ability of this plant to fight MDR bacteria.

Dzotam *et al.* [30] demonstrated that the methanol extract from the leaves of *M. oleifera* have moderate activities against sensitive and MDR bacteria. The weak activity observed with the methanolic seed extract in this work can be explained by the difference in the phytochemical composition of both parts [20]. The weak antibacterial activities of the methanol extract of *T. pentandra* stem bark is being reported here for the first time and it is validating the low inhibitory potential of the plant as documented Dzotam *et al.* [31]. It has been demonstrated that the acetone extract from fruits, and also methanol, ethyl acetate and aqueous methanol extracts from leaves of *A. heterophyllus* exhibits antibacterial activity against the strains MSSA, MRSA [32], *Pseudomonas aeruginosa, Bacillus subtilis, Bacillus thuringiensis, Escherichia coli, and Proteus mirabilis* [33]. This is in accordance with the present study, as we also found that the methanol extract from leaves of this plant showed activity against *E. coli*, and *P. aeruginosa* strains. It is thought that the antibacterial activity of jackfruit extract is due to the presence of artocarpesin and, certainly, related flavonoids which could be useful in the treatment of infections produced by MRSA and many other pathogens [32]. MIC values ranging from 100-512 µg/mL have recently been proposed as significantly active when samples tested are edible parts of plants [65]. Therefore, the obtained results for the majority of the tested extracts could be considered as important in the fight against bacterial infections involving MDR phenotypes [6, 13, 34-36].

CONCLUSIONS

The present work provides supportive information on the antibacterial activities of the tested edible plants and suggests that the extracts from different parts of these can be used as potential leads to discover new antibacterials to control some bacterial infections, especially those involving MDR bacterial species.

Table 1. Plants used in the present study and evidence of their bioactivities

Species (family); Voucher Number*	Traditional uses	Parts used traditionally	Bioactive or potentially bioactive components	Bioactivity of crude extract or derived compounds
***Mangifera indica* Linn.(Anacardiaceae); 18646/HNC**	Anti-syphilitic, vulnerary, anti-emetic, antiinflammatory, cough, hiccup, hyperdipsia, burning sensation, hemorrhages, haemoptysis, haemorrhoids, wounds, ulcers, diarrhoea, dysentery, pharyngopathy, scorpion string, wounds, ulcers, anorexia, dyspepsia [37].	Leaves, flowers, barks, roots, stones and fruits.	Carotenoids (provitamin A compound, beta-carotene, lutein and alphacarotene), polyphenols [38] such as quercetin, kaempferol, gallic acid, caffeic acid, catechins, tannins and mangiferin [39].	Mangiferin: Anticancer (breast, renal, colon and leukemia cancer cell lines [40, 41]); Antidiabetic [42]; antimalarial [43]; methanol and aqueous extracts: *Sa*, *Sp*, *Pa*, *Ca*, and *Ef* [44]; *Se*, *Lm*, *Ec* [45]; ethanol and benzene extracts: *Pv*, *Pf*, *Sfx*, *Kp*, and *St* [24]; anti-amoebic [46].
***Camellia sinensis* Linn.(Theaceae); 43103/HNC**	Aiding digestion, blood purification, ensuring regularity, lowering body temperature, strengthening teeth and bones, boost immune system, enhance heart function, suppress aging, deter food poisoning, fights virus, and lowers blood sugar levels [47].	Leaves, stem bark and roots.	Polyphenols (catechins and their derivatives), methylxanthines (caffeine, theophylline and theobromine), carbohydrates, proteins, free amino acids, vitamins (vitamin C and carotenoids), volatile compounds, lipids, chlorophylls, saponins and inorganic elements (fluorine, manganese and aluminium) [48, 47].	Methanolic extract of leaves: antioxidant activity. These antioxidant properties are beneficial for several chronic diseases related with oxidative stress, including cancer, cardiovascular and neurodegenerative diseases [49].
***Artocarpus heterophyllus* Lam.(Moraceae); 43993/HNC**	Sprains, fractures, diabetes, laxative effect of abdomen, increase the breast milk production in nursing mothers, anemia, asthma, wound healing, ulcers, dermatitis, and diarrhea and cough [50].	Bark, roots, leaves, and fruit	Coumarin, alkaloid, terpenoid, saponin [33]; 5, 7,2′,4′-tetrahydroxy-6-(3-methylbut-3-nyl) flavone or artocarpesin [32].	Methanol and water extracts: *Bs* and *Pf* [51]; ethanol, n-butanol, water, chloroform, and ethyl acetate extracts: antioxidant, hypoglycemic, and hypolipidemic activities [52]; methanol, aqueous methanol and ethyl acetate extracts: antioxydant and antimicrobial (*Ps*, *Bs*, *Bt*, *Ec*, and *Pm*) [33]; hydroalcoholic extracts: *Sp* and *Ec* [53]; *n*-hexane, acetone and methanol: MSSA and MRSA [32].
***Triumphetta pentandra* A.Rich. (Tiliaceae); 9014/SRF/Cam**	Induce fertility and implantation of the fetus [54, 55].	Leaves, stems and roots	Triumfettamide, triumfettoside, heptadecanoic acid, β-sitosterol glucopyranoside, friedeline, lupeol, betuline, maslinic acid, 2-hydroxyoleanolicacid and the mixture of stigmasterol and bsitosterol [56, 57].	Methanolic extract of leaves: *Ec*, *Ea*, *Kp*, *Ece*, *Pst* and *Pa* [31].
***Moringa oleifera* Lam.(Moringaceae); 49178/HNC**	Dental caries, syphilis, typhoid, diarrhea, epilepsy, purgative, prostate cancer, water purification [58]; fever, HIV-AIDS [59].	Leaves, flowers, seeds and barks	4-(4'-O-acetyl-α-L-rhamnopyranosyloxy)benzylisothiocyanate, 4-(-L-rhamnopyranosyloxy)benzylisothiocyanate, niazimicin, pterygospermin, benzylisothiocyanate and 4-(α-L-rhamnopyranosyloxy)benzylglucosinolate[60].	Aqueous and ethanol extracts of seeds against*Sa*, *Vc*, *Ec*, *Se*, *Lv* and *On*[61]; methanol extract of leaves against*Ec*, *Ea*, *Kp*, *Ece*, *Pst* and *Pa* [30].
***Ananas comosus* (L.) MERRILL. (Bromeliaceae); 18648/HNC**	Root and fruit are either eaten or applied topically as an anti-inflammatory and digestive. It is also used as an antiparasitic (antihelmintic) agent, and the root decoction is used to treat diarrhoea [62]; boosting fertility through sperm quality [63].	Fruit, root, leaves and stem	Bromelain, malic acid [63]; alkaloids, flavonoids, tannins, phytosterol, glycoside, phenols [64].	Bromelain and pineapple enzymes: meat tenderizing properties [63]; ethanolic extract: antidiabetic [64].

*(HNC): Herbier National du Cameroun; (SRF/Cam):Société des Réserves Forestières du Cameroun; *Sa: Streptococcus aureus; Vc: Vibrio cholerae; Ec: Escherichia coli; Se: Salmonella enteretidis; Lv: Litopenaeus vannmaei; On: Oreochromis nicoticus; Bs: Bacillus subtilis; St: Salmonella typhi; Bc: Bacillus cereus; Ef: enterococcus faecalis; Sf: Stapylococcus faecalis; Pv: Proteus vulgaris; HIV-AIDS:Human Immunodeficiency Virus- Acquired Immuno Deficiency Syndrom.Pf:Pseudomonas fluorescens; Sfx:Shigella flexneri;Kp:Klebsiella pneumonia; Sp: Streptococcus pneumoniae;Pa: Pseudomonas aeruginosa; Ca: Candida albicans; Lm: Listeria monocytogenes; Ea: Enterobacter aerogenes; Psp: Proteus spp.; Mc: Moraxella catarrhalis; Asp: Acinetobacter spp.; Pst: Providencia Stuartii; Ece: Enterobacter cloaceae; Bt: Bacillus thuringiensis; Pm:Proteus mirabilis; MSSA: Methicillin Sensitive Staphylococcus Aureus; MRSA: Methicillin Resistant Staphylococcus Aureus.*

LIST OF ABBREVIATIONS

A. comosus: *Ananas comosus*
A. heterophyllus: Artocarpus heterophyllus
ATCC:American Type Culture Collection
C. sinensis: *Camellia sinensis*
CFU: colony forming unit
CHL: Chloramphenicol
DMSO: dimethyl sulfoxide
E. aerogenes: Enterobacter aerogenes
E. cloacae: Enterobacter cloacae
E. coli: Escherichia coli
NHC: National Herbarium of Cameroon
INT: *p*-iodonitrotetrazolium chloride
K. pneumoniae: Klebsiella pneumoniae
M. oleifera: Moringa oleifera
M. indica: *Mangifera indica*
MBC: minimal bactericidal concentration
MDR: multidrug resistant
MDR: multi-drug resistant
MHB: Mueller Hinton Broth
MIC: minimal inhibitory concentration
MRSA: methicillin-resistant staphylococcus aureus
P. aeruginosa: Pseudomonas aeruginosa
P. stuartii: Providencia stuartii
RA: reference antibiotic
T. pentandra: *Triumphetta pentandra*

ACKNOWLEDGEMENTS

Authors are thankful to the Cameroon National Herbarium specially Mr. NGANSOP T. Eric for identification of plants, and Mr. Nangwat Claude for language editing.

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Table 2. Phytochemical composition of the plant extracts

Extracts	***Mangifera indica***		***Camellia sinensis***	***Artocarpus heterophyllus***	***Triumphetta pentandra***	***Moringa oleifera***	***Ananas comosus***
Parts used	**Leaves**	**Bark**	**Leaves**	**Leaves**	**Stem**	**Seeds**	**Peel**
Yield* (%)	**5.36**	**4.26**	**5.8**	**5.11**	**2.33**	**1.36**	**2.37**
Alkaloids	+	+	+	+	+	+	+
Polyphenols	+	+	+	+	+	+	+
Flavonoids	+	+	+	+	-	+	+
Anthraquinones	+	+	-	-	-	+	+
Coumarins	+	+	-	-	-	+	+
Tannins	+	+	+	+	+	-	+
Triterpenes	+	+	+	+	+	+	+
Sterols	+	+	+	+	+	+	+
Saponins	+	+	+	-	+	-	+

(-): Absent; (+): Present; * yield calculated as the ratio of the mass of the obtained methanol extract/mass of the plant powder.

Table 3. Minimal inhibitory concentration (MIC), minimal bactericidial concentration (MBC) in µg/mL of methanol extracts from the studied plants and chloramphenicol.

Bacterial strains		**Tested samples, MIC and MBC and MBC/MIC ratio**											
		M. indica (leaves)			*M. indica (bark)*			*C. sinensis*			*A. heterophyllus*		
		MIC	*MBC*	*R*	*MIC*	*MBC*	*R*	*MIC*	*MBC*	*R*	*MIC*	*MBC*	*R*
Escherichia coli	ATTC8739	-	-	-	256	-	-	512	1024	2	512	-	-
	ATCC10536	512	-	-	256	-	-	512	-	-	512	-	-
	AG100	1024	-	-	-	-	-	512	-	-	1024	-	-
	AG100A	1024	-	-	-	-	-	512	1024	2	512	-	-
	AG102	1024	-	-	1024	-	-	256	1024	4	1024	-	-
	AG100ATet	1024	-	-	-	-	-	256	-	-	1024	-	-
	MC4100	1024	-	-	1024	-	-	1024	-	-	512	-	-
	W3110	1024	-	-	1024	-	-	1024	-	-	-	-	-
Enterobacter aerogenes	ATCC13048	512	-	-	512	-	-	512	1024	2	1024	-	-
	EA-CM64	-	-	-	-	-	-	-	-	-	-	-	-
	EA3	1024	-	-	512	-	-	1024	-	-	512	-	-
	EA27	512	-	-	512	-	-	1024	-	-	512	-	-
	EA289	-	-	-	512	-	-	512	-	-	512	-	-
	EA294	-	-	-	-	-	-	1024	-	-	-	-	-
	EA298	-	-	-	-	-	-	512	-	-	-	-	-
Klebsiella pneumoniae	ATCC11296	-	-	-	-	-	-	512	-	-	512	-	-
	K2	1024	-	-	1024	-	-	**64**	512	8	-	-	-
	K24	1024	-	-	1024	-	-	512	-	-	-	-	-
	KP55	1024	-	-	1024	-	-	-	-	-	1024	-	-
	KP63	1024	-	-	512	-	-	256	-	-	1024	-	-
Providencia stuartii	ATCC29916	512	-	-	1024	-	-	512	-	-	-	-	-
	ATCC299645	1024	-	-	-	-	-	512	-	-	-	-	-
	PS2636	512	-	-	512	-	-	-	-	-	512	-	-
	NEA16	512	-	-	512	-	-	1024	1024	1	512	-	-
Enterobacter cloacae	BM47	512	-	-	512	-	-	1024	-	-	512	-	-
	BM67	1024	-	-	512	-	-	256	1024	4	1024	-	-
	ECCI69	-	-	-				512	-	-	-	-	-
Pseudomonas aeruginosa	PA01	1024	-	-	**32**	256	8	512	-	-	-	-	-
	PA124	1024	-	-	512	-	-	1024	-	-	512	-	-
Escherichia coli	ATTC8739	-	-	-	1024	-	-	-	-	-	4	16	4
	ATCC10536	-	-	-	-	-	-	-	-	-	4	128	32
	AG100	-	-	-	-	-	-	1024	-	-	8	64	8
	AG100A	512	-	-	512	-	-	1024	-	-	64	-	-
	AG102	512	-	-	-	-	-	1024	-	-	64	256	4
	AG100ATet	-	-	-	-	-	-	-	-	-	128	-	-
	MC4100	-	-	-	-	-	-	1024	-	-	8	64	8
	W3110	-	-	-	-	-	-	1024	-	-	8	256	32
Enterobacter aerogenes	ATCC13048	1024	-	-	1024	-	-	1024	-	-	8	64	8
	EA-CM64	-	-	-	-	-	-	-	-	-	128	-	-
	EA3	-	-	-	-	-	-	1024	-	-	32	256	8
	EA27	-	-	-	-	-	-	1024	-	-	128	-	-
	EA289	-	-	-	-	-	-	-	-	-	256	-	-
	EA294	-	-	-	-	-	-	-	-	-	8	128	16
	EA298	-	-	-	-	-	-	-	-	-	32	64	2
Klebsiella pneumoniae	ATCC11296	1024	-	-	1024	-	-	-	-	-	64	-	-
	K2	1024	-	-	-	-	-	-	-	-	32	128	s
	K24	1024	-	-	-	-	-	-	-	-	128	256	2
	KP55	1024	-	-	-	-	-	-	-	-	64	128	2
	KP63	-	-	-	-	-	-	-	-	-	64	256	4
Providencia stuartii	ATCC29916	-	-	-	1024	-	-	-	-	-	128	-	-
	ATCC299645	1024	-	-	1024	-	-	1024	-	-	64	256	4
	PS2636	1024	-	-	-	-	-	1024	-	-	128	-	-
	NEA16	-	-	-	-	-	-	-	-	-	32	256	8
Enterobacter cloacae	BM47	-	-	-	-	-	-	-	-	-	256	-	-
	BM67	1024	-	-	-	-	-	1024	-	-	128	-	-
	ECCI69	-	-	-	-	-	-	-	-	-	>256	256	-
Pseudomonas aeruginosa	PA01	-	-	-	-	-	-	1024	-	-	32	-	-
	PA124	-	-	-	-	-	-	-	-	-	256	-	-

R: MIC/MBC; -: MIC > 1024 µg/mLfor the plant extracts and > 256 µg/mL for chloramphenicol