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Antibacterial and antibiotic-potentiation activity of *Coffea arabica* and six other Cameroonian edible plants against multidrug-resistant phenotypes

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Abstract

Background: Medicinal plants have always played an important role in human health. Many plants are traditionally used as drugs against microbial infections. In this study, a panel of seven methanol extracts from Cameroonian edible was assessed for their antibacterial potentiality against multidrug-resistant Gram-positive and Gram-negative bacteria.

Methods: The microdilution technique using a 96-well plate was used to assess the minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of the crude extracts, as well as their potential to improve the antimicrobial activity of certain families of antibiotics. Phytochemical screening of the extracts was carried out according to the standard methods.

Results: The most detected classes of pharmaceuticals were tannins, triterpenes, polyphenols, and steroids. *Coffea arabica* bark extract inhibited all 20 tested MDR bacteria strains; *Coffea arabica* leaf and seeds extracts, *Adansonia digitata* bark extract, *Sechium edule* leaf extract, all inhibited 95% (19/20) of the strains tested, *Beilschmeidia louisii* stem extract inhibited the growth of 85% (17/20) of the tested bacteria, while *Hyphaene therbaica* displayed 70% (14/20) bacterial inhibition. The MIC values of the plant extracts ranged from 256 to 2048 µg/mL. However, the best MIC value (256 µg/mL) was obtained with *B. louisii* stem extract against *E. coli* AG102 and *S. aureus* MRSA12. The leaf extract of *S. edule* improved the anti-bacterial activities of kanamycin, tetracycline, and Cloxacillin against the MDR strain *P. stuartii* 29916 by up to 16 times; furthermore, this extract improved the antibacterial effect of tetracycline, Cloxacillin, kanamycin, and doxycycline by 16 folds against the MDR strain *E. coli* AG100ATET; the bark extract of *C. arabica* improved the activities of ofloxacin, chloramphenicol the activities of ofloxacin, chloramphenicol, and doxycycline toward all the tested MDR Gram positive and Gram-negative bacteria with improvement activity factor (IAF) ranging from 2 to 16, while the leaf extract of *B. louisii* increased up to 8-fold the activity of Cloxacillin against *P. aeruginosa* PA 124.

Conclusion: *Coffea arabica*, *Adansonia digitata*, *Sechium edule,* and *Beilschmeidia louisii* are the explorable sources of antibacterial agents usable alone or in combination with conventional antibiotics to tackle diseases caused by resistant bacterial phenotypes.

Keywords: Bacterial infections; Cameroon; edible plants; Multidrug resistance; Antibiotic-potentiation.

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Background

The discovery of antibiotics has revolutionized modern medicine and saved countless human lives; however, microbial infections continue to be a serious threat to human life because the current set of conventional antibiotics is rapidly depleting due to the spread of multidrug-resistant (MDR) bacteria [1]. The first comprehensive analysis of the global impact of antimicrobial resistance (AMR) estimates resistance itself caused 1.27 million deaths in 2019 more deaths than HIV/AIDS or malaria, and that antimicrobial-resistant infections played a role in 4.95 million deaths [2]. Considering this public health problem, investigating new antimicrobial agents has become a top priority to tackle microbial infections that involve multi-drug resistant pathogens. Natural medicines have been used to boost health since immemorial times and the success of modern medical science largely depends on drugs originally obtained from natural resources. Considerable efforts have been made by scientists in the two last decades to discover natural products to combat various types of drug resistance, such as cancer or microbial drug resistance [3-17]. Several antimicrobial molecules have been discovered in natural products for the treatment and control of infectious diseases [18]. Plants constitute a deep well for searching for novel antimicrobial agents. Moreover, the huge variety of plant-derived compounds provides very diverse chemical structures that may provide novel mechanisms of antimicrobial action [19] and suppress the beta-lactamase expressed and/ or the pump efflux respectively expressed and overexpressed by MDR pathogens. Several studies on medicinal plants and their isolated compounds have highlighted their interesting antibacterial potential against drug-sensitive and drug-resistant bacteria strains of Escherichia *coli*, *Pseudomonas stuartii, Staphylococcus aureus, Providencia stuartii, Klebsiella pneumoniae and Enterobacter aerogenes* [20-26]. The African flora is rich in botanicals which are traditionally used for the treatment of infectious diseases. The current work aimed at investigating the antibacterial effects of the methanol extract from seven Cameroonian edible plants, *Sechium edule* (Jacq.) Sw. (Cucurbitaceae), *Raphanus sativus* L (Brassicaceae), *Hyphaene thebaica (L.) Mart.* (Palmae), *Coffea Arabica* Linn (Rubiaceae), *Adansonia digitata* L (Malvaceae), *Eleusina coracana* (L) Gaerth (Poaceae), *Beislschmiedia louisii* Robyns & Wilczek (Lauraceae). The study was also extended to evaluate the synergistic activity of the plant extracts when combined with some classes of conventional antibiotics.

Methods

Plant samples and extraction

The seven plants used in this study were collected in October 2019 in the Coastal and Western regions of Cameroon and were subsequently identified at the National Herbarium (Yaoundé, Cameroon) where voucher specimens were deposited. The reference voucher numbers of all the identified plants as identified in the Cameroon national herbarium are shown in Table S1 (Supplementary file). For each plant part extracted, the powder was soaked in methanol (1:3 w/v) for 48 h at room temperature. The extract obtained was collected by filtration using Whatman filter paper N°1 and concentrated under reduced pressure using a rotary evaporator (BÜCHI R-200) at 65°C. The extracts were dried until complete evaporation of the residual solvent and stored in dark sterile bottles at 4°C for future use.

Preliminary Phytochemical Investigations

Detection of main classes of antibacterial secondary metabolites such as alkaloids (Dragendorff's and Mayer's tests), flavonoids (Aluminum chloride test), saponins (Foam test), triterpenes (Liebermann-Burchard test), phenolics: anthraquinones (Borntrager's test), polyphenols (Ferric chloride test), tannins (Gelatin test) and terpenoids: sterols (Salkowski's test) were investigated according to described phytochemical methods [26, 19].

Chemicals and culture media

p-Iodonitrotetrazolium chloride (INT) was used for colorimetric detection of living bacteria and dimethyl sulfoxide (DMSO) for extracts and antibiotics dissolution. Twelve conventional antibiotics including Ciprofloxacin (CIP), Erythromycin (ERY), Tetracycline (TET), Kanamycin (KAN), Doxycycline (DOX), Chloramphenicol (CHL), Ofloxacin (OFL), Flucloxacillin (FLU), Thiamphenicol (THI), Streptomycin (STR), gentamycin (GEN) and azithromycin (AZI) were used. The Mueller Hinton Agar (MHA) and Mueller Hinton Broth (MHB) were used as culture media respectively for bacterial growth and for the determination of minimal inhibitory concentrations (MIC) and minimal bactericidal concentrations (MBC).

Microorganisms

The tested microorganisms included various strains of Gram-positive bacteria, Staphylococcus aureus, and a panel of Gram-negative bacteria. Gram-negative bacteria included MDR isolates (laboratory collection) and reference strains of *Escherichia coli* (ATCC8739, AG100, AG100ATet, AG102, ATCC10536), *Enterobacter aerogenes* (ATCC13048, EA27), *Klebsiella pneumoniae* (KP55, KP63, K24), *Providencia stuartii* (NEA16, PS299645) and *Pseudomonas aeruginosa* (PA01, PA124). The strains of *Staphylococcus aureus* used were as follows: a reference strain obtained from American Type Culture Collection (ATCC) (ATCC 25923), 1 methicillin-sensitive *S. aureus* (MSSA1), 4 methicillin-resistant *S. aureus* (MRSA) strains (MRSA3, MRSA6, MRSA9, MRSA12 (obtained from the culture collection of the Laboratory of Microbiology, Graduate School of Pharmaceutical Sciences, The University of Tokyo, Japan, and provided by Dr. Dzoyem of the University of Dschang) [27,28].

Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) determination assays

The MIC and MBC of each tested crude extracts on bacteria were performed using the rapid INT colorimetric assay [29] with some modifications as previously described [19]. Samples were dissolved in DMSO/MHB. The final concentration of DMSO was lower than 2.5%. Twofold dilutions of samples were made in 96-well microplates and the tested bacterial concentration was 1.5 x 10^6 colony forming unit (CFU)/mL. The microplates were incubated at 37°C for 18 h. Wells containing MHB, 100 µL of inoculum, and DMSO to a final concentration of 2.5% served as a negative control. The MIC of each sample was detected after 18h incubation at 37°C, following the addition (40 µL) of 0.2mg/mL of INT and incubation at 37°C for 30 minutes as the lowest sample concentration that prevented the color change of the medium and

exhibited complete inhibition of microbial growth [29]. 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 MHB. These preparations were further incubated at 37◦C for 48h. The MBC was regarded as the lowest concentration of a sample, which did not induce a color change after the addition of INT as mentioned above [29]. The plant extract was considered to have strong activity if MIC<100 µg/mL, significant activity if 100≤MIC≤512 µg/mL, moderate activity if 512<MIC≤2048 µg/mL, and weak activity if MIC>2048 µg/mL. Moreover, a plant extract was considered to have a bactericidal effect if MBC/MIC≤4 and a bacteriostatic effect if MBC/MIC>4 [30].

Antibiotic-Potentiation assays

To evaluate the antibiotic-resistance modulating activity of extracts, a preliminary assay was performed to determine the MICs of antibiotics in the absence and presence of these extracts using the broth microdilution method as previously described [20, 29]. The MDR bacteria strain *P. aeruginosa* PA124 was used for preliminary assays and samples were tested at various subinhibitory concentrations (MIC/2, MIC/4, MIC/8, and MIC/16). Results allowed the selection of MIC/2 and MIC/4 as subinhibitory concentrations for further experiments on the following selected bacteria, *E. coli* (ATCC 10536 and AG100ATET), *E. aerogenes* (ATCC 13048 and EA 27), *K. pneumoniae* (Kp55 and Kp 63), *P. stuartii* (ATCC 29916 and NEA16), and *S. aureus* (ATCC 25923 and MRSA9). Briefly, after serial dilution of the antibiotic, the extract was added to each well at its subinhibitory concentration and the bacterial inoculation was done; the MIC was further determined. Rows receiving antibiotic dilutions without extracts were used for the determination of the MICs of the antibiotics.

The effects of the combination were estimated by calculating the improvement activity factors (IAF) of each combination using the following formula:

$$IAF = \frac{MIC\ antibiotic\ alone}{MIC\ combination}.$$

MIC of antibiotic alone / MIC of combination. Each assay was also performed in triplicate. Extract and antibiotic were considered to have potentiation, indifferent, or antagonistic effects if IAF≥2, IAF=1, or IAF≤0.5 respectively [31].

Results

Qualitative phytochemical composition of the tested plant extracts.

The results of the phytochemical screening (Table 1) revealed the presence of all the probed phytochemicals in *Sechium edule* and *Coffea arabica* leaves extracts except anthocyanin and saponins respectively. The classes of secondary metabolites were selectively distributed in other tested plant extracts. Moreover, results showed that tannins, triterpenes, polyphenols, and Steroids were the most represented metabolites in the tested extracts.

Antibacterial activity of the assessed botanicals extracts

Seventeen plant extracts as well as the chloramphenicol used as the positive control were assessed for their antibacterial activity against a panel of MDR bacteria made up of 14 Gram-negative and 06 Gram-positive overexpressing efflux pumps as the main mechanism of resistance. The obtained results (Table 2) showed that the bark extract of *Coffea arabica* inhibited the growth of all (20/20, 100%) of the tested bacteria, with significant antibacterial activity (512 µg/ml) against the strains AG100, PA01, NEA16, EA27, ATCC13048, KP63, K24, and MRSA3; the seeds extract of *Coffea arabica* showed a 95% (19/20) antibacterial spectrum, with significant antibacterial activity (512 µg/ml) against the strains AG102, AG100, PA01, PA124, NEA16, K24, MRSA3, and MRSA 12; the leaf extract of *Coffea arabica* displayed a 95% (19/20) antibacterial spectrum with significant antibacterial activity (512 µg/ml) against the strains ATCC10536, PA01, PA124, ATCC29916, and NEA16; the bark extract of *Adansonia digitata* showed 95% (19/20) antibacterial spectrum with significant antibacterial activity (512 µg/ml) against the strains AG100ATET, PA01, PA124, and Kp63; the leaf extract of *Sechium edule* displayed 95% (19/20) antibacterial spectrum with significant antibacterial activity (512 µg/ml) against the strains ATCC13048 and MRSA3; the stem extract of *Beilschmeidia louisii* displayed a 85% (17/20) antibacterial spectrum with significant antibacterial activity (512 µg/ml) against the strains AG100 and MRSA 12, while its root extract displayed a 75% (15/20) antibacterial spectrum with significant antibacterial activity (512 µg/ml) against the strains AG100ATET and Kp63; the trunk extract of *Beilschmeidia louisii* showed a 65% (13/20) antibacterial spectrum with significant antibacterial activity (512 µg/ml) against the strains ATCC8739, AG102, ATCC 25923 and MRSA 12; the skin extract of *Beilschmeidia louisii* showed a 55% (11/20) antibacterial spectrum; the seeds extract of showed a 55% (11/20) antibacterial spectrum with significant antibacterial activity (256-512 µg/ml) against the strains AG102, MRSA 12, and ATCC 25923; the leaf extract of *Beilschmeidia louisii* showed a 50% (10/20) antibacterial spectrum with significant antibacterial activity (512 µg/ml) against the strain MRSA 12; the fruits extract of *Hyphaene therbaica* displayed a 70% (14/20) antibacterial spectrum with no significant activity. The other plant extracts i.e fruits and stem extracts of Sechium *edule,* the leaf extract of *Raphanus sativus,* and seeds extract of Eleusina *coracana* showed a less than 50% antibacterial spectrum of activity toward the tested bacteria. The fruit extract of *Raphanus sativus* showed no antibacterial activity. Globally, the best MBC values (512 µg/ml) were obtained with *Beilschmeidia louisii* seeds extract against *E. coli* AG102 and *S. aureus* MRSA12, *Coffea arabica* leaf extract against *S. aureus* ATCC25923, and *Coffea arabica* bark extract against *P. aeruginosa* PA01 *and E. aerogenes* EA27.

Antibiotic-resistance modulation activity of extracts

The plant extracts at MIC/2, MIC/4, MIC/8, and MIC/16 were first tested in combination with 12 antibiotics: ERY, GEN, THI, OFL, CHL, CIP, FLU, CLO, TET, KAN, DOX, and AZI against *P. aeruginosa* PA124 strains. It appears that the best potentiating concentrations were obtained at MIC/2 and MIC/4 as shown in Tables S2 to S7 (supplementary materials). Tables 3 to 11 show the improvement activity factors (IAF) of selected plant extracts at the best sub-inhibitory concentrations (MIC/2 and MIC/4) against *P. aeruginosa* PA124: *Sechium edule* leaf extract, *Adansonia digitata* bark extract, *coffea arabica* leaf extract, *coffea arabica* leaf, seeds, and bark extracts, *Beilschmeidia louisii* leaf extract**,** *Beilschmeidia louisii* trunk and stem extract, and *Hyphaene therbaica* ***fruits*** extract. *Sechium edule* leaf extract at MIC/2 and MIC/4, selectively increased antibiotics activities with improvement activity factor (IAF) varying from 2 to 16. However, the best increase in activity was observed at MIC/2 with potentiation of 5/12 of the antibiotics against 100% of the tested MDR bacteria strains. *Adansonia*

digitata bark extract at MIC/2, improved the antibacterial activities of 6/12 of the tested MDR bacterial strains with the improvement activity factor ranging from 2 to 16 against over 70% of the strains used. However, cases of indifference (IAF=1) and antagonism (IAF≤0.5) were also observed at MIC/4. *Coffea arabica* leaf extract at MIC/2, improved the activity of 5/12 of the tested antibiotics tested against more than 60% of the studied bacteria with the best improvement of activity obtained with Gentamycin against *S. Aureus strain ATCC2592*; Chloramphenicol, Ofloxacin, and Ciprofloxacin against *P. aeruginosa* PA124. At MIC/4, this plant extract antagonized Flucloxacillin, Cloxacillin, Tetracycline, Kanamycin, Doxycycline, and Azithromycin against all the tested bacteria strains. The Improvement effect of *Coffea arabica* seeds extract at CMI/2 was observed for 5/12 of the tested antibiotics including Thiamphenicol, Ofloxacin, Chloramphenicol, Ciprofloxacin and Cloxacillin against over 50% of bacterial strains with the improvement activity ranging from 2 to 16. Furthermore, the best-modulated effect of the extract was found at CMI/2 in association with gentamycin against *P. aeruginosa* PA124. At the sub-inhibitory concentration MIC/2, *Coffea arabica* bark extract selectively potentiated all antibiotics against more than 60% of the bacteria tested. The best potentiating activity was observed on chloramphenicol and the IAF values varied between 2 and 16. *Beilschmeidia louisii* leaf extract at MIC/2, selectively increased the activity of all the tested antibiotics with the best IAF of 8 with Cloxacillin activity against *P. aeruginosa*. However, the activities of 9/12 of the tested antibiotics were increased by the extract at MIC/2 by over 80%. Both the trunk and the bark extracts of *Beilschmeidia louisii* selectively increase all the antibiotics activities at MIC/2 with IAF varying between 2 and 4. The trunk extract and the bark extracts increased the activities of 10/12 and 9/12 of tested antibiotics respectively, against more than 60% of the bacteria tested. Certain cases of antagonisms were also noted at MIC/2 with Ofloxacin, Azithromycin, Ciprofloxacin, and Gentamycin against *K. pneumoniae, S. aureus,* and *P. aeruginosa.* The fruit extract of *Hyphaene therbaica* strongly increased the activity of Chloramphenicol and Gentamycin against 90 and 70% of the bacteria strains respectively. However, the best improvement was noted at CMI/2 with Ofloxacin activity towards *P. Stuartii* NEA16 strain with an IAF of 8.

Discussion

The increasing incidence of deaths due to multidrug-resistant microorganisms is a call for concern in the public health sector. Extensive research is being done on plants to discover new antimicrobial compounds that could directly or indirectly tackle MDR microorganisms [32]. Bioactive phytochemicals provide an alternative source for the screening of new active ingredients against MDR bacterial infections. The results of the phytochemicals. The results of the phytochemical screening carried out on the tested extracts indicated the presence of at least one of the phytopharmaceuticals classes in each of the seventeen plant extracts investigated. Globally, tannins, triterpenes, polyphenols, and steroids were the most represented class of secondary metabolites. The antibacterial activities of plants are mainly attributed to the various classes of bioactive chemicals they contain [33]. Based on the antibacterial activity classification scale established by Tamokou et al [30], the bark, leaf, and seed extracts of *Coffea arabica, Adansonia digitata* bark extract, *Sechium edule* leaf extract, and Beilschmeidia *louisii* stem, root, trunk, and leaf extracts were found to be significantly active against at least one tested MDR bacterial strain, with MIC values ranging from 256 to 512 μg/ml. The study carried out by Runti et al [34], revealed the antibacterial activity of Coffea *arabica* extract against three Gram-positive cocci *S. aureus* ATCC25923*, S. epidermidis* ATCC12228 *and E. faecalis* ATCC29212*,* and two Gram-negative bacilli *E. coli* ATCC25922 *and S. enterica* ATCC14028*.* Furthermore, *Coffea arabica* extract showed interesting antibacterial activity toward clinically important pathogenic bacteria *Enterococcus faecalis* MTCC439*, P. aeruginosa* MTCC1035*, Salmonella* typhi MTCC531*, Shigella flexneri*. Aissaoui et al [34, 35] showed the very strong and interesting antibacterial activity of *Coffea arabica* n-butanol extract against *Citrobacter freundii A*TCC8090 and *Staphylococcus aureus* ATCC6538. Results from all these studies are strongly in accordance with our study which highlighted the significant anti-MDR bacteria activity of the various parts of *Coffea arabica*. Phytochemical study of the latter revealed the presence of the following antibacterial pharmaceuticals: ferulic acid, rutin, catechin, gallic acid, caffeic acid, quercetin, chlorogenic acid [36] and p-coumaric acid which could disrupt bacterial cell membranes and bind to bacterial genomic DNA to inhibit cellular functions, ultimately leading to cell death [37]. Flavonoid compounds (rutin, catechin, quercetin) revealed by the reversed-phase HPLC of *Coffea arabica* extract [37] corroborates our phytochemicals screening on this plant extract, which indicated the presence of flavonoids. In our study, *Adansonia digitata* extract was found to be significantly active against *E. coli* AG100ATET, P. *aeruginosa* PA01 and PA124, and *K. pneumoniae* Kp63. These findings are in accordance with those of Bashir et al [38] in which the leaf and stem bark extracts of *Adansonia digitata* displayed significant antibacterial activity against the clinical isolates *E. coli*, *S. aureus,* and *S. typhi.* Furthermore, the study carried out by Seukep et al [39], already showed the antibacterial effect of *Adansonia digitata* against MDR bacterial strains including *E. coli* 10536, *E. aerogenes* EA 298, *K. pneumoniae* K2, and *P. stuartii* PS299645. Seukep et al [39] also detected the presence of flavonoids, saponins, steroids, and triterpenes in *Adansonia digitata* extract, confirming the results obtained in our study. Among the tested plant extracts, *Sechium edule* leaf extract had also shown significant activity against S. *aureus* MRSA3. Looking to previous studies on the antibacterial activity of Sechium *edule,* those of Ordonez et al [40] indicate that both fluid extract and seeds tincture of *Sechium edule* have very good antimicrobial efficacy against clinical strains of methicillin-resistant *S. aureus*, methicillin-sensitive *S. aureus*, methicillin-sensitive coagulase-negative *S. aureus*, and methicillin-resistant coagulase-negative *S. aureus.* Various parts extracts of *Beilschmeidia louisii* displayed significant activities against the tested MDR bacteria in this work. Our findings are in accordance with those of Fankam et al [41], who investigated the antibacterial activity of another species from *Beilschmeidia* genus, *Beilschmiedia obscura* (fruits), against the references strains, *Escherichia coli ATCC8739 and ATCC10536, Enterobacter aerogenes ATCC13048, Klebsiella pneumoniae ATCC11296, and Providencia stuartii ATCC29916; and the clinical isolates of Escherichia coli, Enterobacter aerogenes, Klebsiella pneumoniae, Enterobacter cloacae, Pseudomonas aeruginosa, and Providencia stuartii.* Furthermore, *Beilschmiedia louisii* roots and leaves extracts showed potent antiparasitic activity against *Trypanosoma brucei brucei;* and the endiandric acid derivatives beilschmiedol B and beilschmiedol C isolated from the same botanical, showed potent anti- trypanosomal activity against the *Plasmodium falciparum* chloroquine-resistant strain Pf3D7 [42].

The use of natural products derived from plants has been seen as an alternative to antibiotics. Apart from substances with direct antimicrobial activity, substances have been identified

that can act as adjuvants by modifying the effectiveness of antimicrobial agents [43, 44]. In this work, plant extracts have been explored for their potential to boost the antibacterial activity of certain classes of conventional antibiotics against MDR bacteria overexpressing efflux pumps. The panel of antibiotics was made up of ERY, GEN, THI, OFL, CHL, CIP, FLU, CLO, TET, KAN, DOX, and AZI. Among assessed plant extract, the leaf of *S. edule* potentiated up to 16 times the anti-bacterial activities of kanamycin, tetracycline, and Cloxacillin against the MDR strain *P. stuartii* 29916. Furthermore, the same plant extract improved 16 times the antibacterial effect of tetracycline, Cloxacillin, kanamycin, and doxycycline toward the MDR strain E. *coli* AG100ATET. The bark extract of *C. arabica* improved the activities of ofloxacin, chloramphenicol, and doxycycline toward all the tested MDR Gram + and Gram - bacteria with IAF ranging from 2 to 16. According to Okusa and Duez [45], such effects may be due to the presence of alkaloids, flavonoids, terpenoids and tannins in these extracts. The leaf extract of *B. louisii* increased up to 8 times the activity of Cloxacillin against *P. aeruginosa* PA 124. The study by Fankam et al [41] highlighted that, extract from a plant of the same genus, *B. obscura* found its activity significantly modulated in presence of phenylalanine arginine β-naphthylamide (PAβN) against the MDR bacteria *K. pneumoniae* KP55. Adding to our finding, one could hypothesize that, plant species from *Beilschmeidia genus* are interesting sources of natural molecules to tackle multidrug resistance caused by the overexpression of efflux pumps. The indifferent effects (IAF=1) obtained with some cases of antibiotic-plant extracts combination indicate that extract has no direct or indirect inhibitory effect on the bacteria and could not modulate the antibacterial activity of an antibiotic. The cases of antagonisms observed could be due to negative interaction between the phytochemicals and antibiotics' pharmacophores [46].

Table 1. Phytochemical composition of the plant extracts

Phytochemical classes	Plants extracts																
	SeL	**SeS**	**SeF**	**RsF**	**RsL**	**EcS**	**HtF**	**CaL**	**CaG**	**CaB**	**AdB**	**BlL**	**BlS**	**Blt**	**BlR**	**Blst**	**Blsk**
Alkaloïds	+	-	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-
Flavonoïds	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Saponins	+	+	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
Tannins	+	+	-	-	+	+	+	+	+	-	+	+	-	-	-	-	-
Triterpens	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-
Polyphenols	+	+	-	-	+	+	+	+	+	-	+	+	-	-	-	-	-
Anthraquinones	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+
Anthocyanin	-	-	-	+	+	+	+	+	-	+	+	-	-	-	+	-	-
Steroïds	+	+	-	+	+	+	+	+	+	+	+	+	-	-	+	-	-

(-): absent ; (+): present; SeL : *Sechium edule* (Leaf), SeS : *Sechium edule* (Stem), SeF : *Sechium edule* (Fruits), RsF*: Raphanus sativus*(fruits), RsL : *Raphanus sativus* (Leaf), EcS : *Eleusina coracana* (Seeds), HtF : *Hyphaene therbaica* (Fruits), CaL:*Coffea arabica* (Leaf), CaS :*Coffea arabica* (Seeds), CaB :*Coffea arabica* (Bark), AdB : A*dansonia digitata*(Bark), BlL : *Beilschmeidia louisii* (Leaf), BlS: *Beilschmeidia louisii* (Seeds); Blt: *Beilschmeidia louisii* (Trunk); BlR : *Beilschmeidia louisii* (Root); Blst : *Beilschmeidia louisii* (Stem), and Blsk: *Beilschmeidia louisii* (Skin).

Table 2. MIC and MBC of the plant extracts against MDR bacteria strains (μg/mL)

Bacterial strains	CaL			CaS			CaB			AdB			SeL			Sest		
	CMI	**CMB**	**R**	**CMI**	**CMB**	**R**	**C MI**	**CMB**	**R**	**CMI**	**CMB**	**R**	**CMI**	**CMB**	**R**	**CMI**	**CMB**	**R**
E. coli																		
AG102	1024	-	nd	**512**	1024	2	1024	1024	1	1024	-	nd	2048	-	nd	-	-	nd
AG100 ATET	1024	2048	2	1024	-	nd	2048	-	nd	**512**	1024	2	1024	-	nd	-	-	nd
ATCC10536	**512**	**512**	1	1024	1024	1	1024	1024	1	1024	2048	2	1024	1024	1	-	-	nd
AG100	1024	2048	2	**512**	1024	2	**512**	1024	2	2048	-	nd	2048	-	nd	1024	1024	1
ATCC8739	2048	-	nd	1024	2048	2	1024	2048	2	2048	-	nd	1024	-	nd	2048	-	nd
P. aeruginosa																		
PA01	**512**	2048	4	**512**	1024	2	**512**	512	1	**512**	1024	2	2048	-	nd	-	-	nd
PA124	**512**	2048	4	**512**	2048	4	1024	2048	2	**512**	2048	4	1024	-	nd	1024	-	nd
P. stuartii																		
NEA16	**512**	2048	4	**512**	1024	2	**512**	2048	4	1024	-	nd	1024	2048	2	-	-	nd
ATCC29916	**512**	1024	2	2048	-	nd	1024	-	nd	1024	-	nd	2048	-	nd	-	-	nd
E. aerogenes																		
EA27	2048	-	nd	1024	-	nd	**512**	512	1	1024	2048	2	1024	-	nd	1024	1024	1
ATCC13048	**512**	2048	4	1024	-	nd	**512**	2048	4	1024	2048	2	**512**	2048	4	2048	-	nd
K. pneumoniae																		
KP55	**512**	1024	2	-	-	nd	1024	2048	2	-	-		-	-	nd	-	-	nd
KP63	2048	-	nd	1024	-	nd	**512**	1024	2	**512**	1024	2	1024	-	nd	-	-	nd
K24	**512**	2048	4	**512**	1024	2	**512**	2048	4	1024	2048	2	2048	-	nd	2048	-	nd
S. aureus																		
MSSA1	2048	-	nd	2048	-	nd	1024	2048	2	1024	-	nd	1024	1024	1	-	-	nd
MRSA3	1024	2048	2	**512**	2048	4	**512**	1024	2	1024	2048	2	**512**	512	1	-	-	nd
MRSA6	-	-	nd	2048	-	nd	1024	2048	2	2048	-	nd	1024	1024	1	-	-	nd
MRSA9	1024	2048	2	2048	-	nd	1024	1024	1	1024	2048	2	1024	-	nd	-	-	nd
MRSA12	**512**	2048	4	**512**	2048	4	2048	-	nd	1024	2048	2	1024	-	nd	1024	-	nd
ATCC25923	**512**	**512**	1	1024	1024	1	1024	-	nd	2048	-	nd	2048	-	nd	-	-	nd

CaL:*Coffea arabica* (Leaf), CaS :*Coffea arabica* (Seeds), CaB :*Coffea arabica* (Bark), AdB : *Adansonia digitata* (Bark), SeL : *Sechium edule* (Leaf), Sest : *Sechium edule* (Stem), MIC: minimal inhibitory concentration, MBC: minimal bactericidal concentration; *E. coli : Escherichia coli, P. aeruginosa : Pseudomonas aeruginosa, P. stuartii : Providencia stuartii, K. pneumoniae : Klebsiella pneumoniae, S. aureus : Staphylococcus aureus.*

Table 2. *continued.*

Bacterial strains	SeF			HtF			Blst			BlR			Blsp			Blsk		
	CMI	**CMB**	**R**	**CMI**	**CMB**	**R**	**CMI**	**CMB**	**R**	**C MI**	**CMB**	**R**	**CMI**	**CMB**	**R**	**CMI**	**CMB**	**R**
E. coli																		
AG102	2048	-	nd	1024	2048	2	1024	-	nd	1024	-	nd	**512**	1024	2	-	-	nd
AG100 ATET	1024	1024	1	-	-	nd	1024	-	nd	5**12**	-	nd	-	-	nd	-	-	nd
ATCC10536	-	-	nd	-	-	nd	-	-	nd	1024	-	nd	1024	-	nd	1024	-	nd
AG100	-	-	nd	1024	2048	2	**512**	1024	2	-	-	nd	1024	-	nd	1024	-	nd
ATCC8739	2048	-	nd	1024	1024	1	1024	-	nd	1024	-	nd	**512**	-	nd	1024	-	nd
P. aeruginosa																		
PA01	-	-	nd	1024	2048	2	-	-	nd	1024	-	nd	1024	-	nd	1024	-	nd
PA124	1024	-	nd	2048	-	nd	1024	-	nd	1024	-	nd	-	-	nd	-	-	nd
P. stuartii																		
NEA16	-	-	nd	1024	2048	2	1024	-	nd	1024	-	nd	1024	-	nd	-	-	nd
ATCC29916	-	-	nd	1024	2048	2	1024	-	nd	1024	-	nd	-	-	nd	1024	-	nd
E. aerogenes																		
EA27	-	-	nd	-	-	nd	-	-	nd	1024	-	nd	1024	-	nd	1024	-	nd
ATCC13048	2048	-	nd	1024	-	nd	1024	-	nd	-	-	nd	-	-	nd	1024	-	nd
K. pneumoniae																		
KP55	2048	-	nd	-	-	nd	1024	-	nd	1024	-		1024	-	nd			nd
KP63	1024	-	nd	2048	-	nd	1024	-	nd	**512**	1024	2	-	-	nd	1024	-	-
K24	-	-	nd	2048	-	nd	1024	-	nd	1024	-	nd	1024	-	nd	-	-	nd
S. aureus																		
MSSA1	-	-		-	-	nd	1024	-	nd	-	-	nd	-	-	nd	1024	-	nd
MRSA3	-	-	nd	2048	-	nd	1024	-	nd	1024	-	nd	1024	-	nd	1024	-	nd
MRSA6	-	-	nd	-	-	nd	1024	-	nd	-	-		-	-	nd	-	-	nd
MRSA9	-	-	nd	1024	2048	2	1024	-	nd	1024	-	nd	1024	-	nd	1024	-	nd
MRSA12	-	-	nd	2048	-	nd	**512**	-	nd	1024	-	nd	**512**	-	nd	-	-	nd
ATCC25923	1024	-	nd	1024	-	nd	1024	-	nd	-	-	nd	**512**	-	nd	-	-	nd

Table 2. *end.*

Bacterial strains	**BIL**			**BIS**			**RsF**			**RsL**			**EcS**			**ATB (CHL)**		
	CMI	**CMB**	**R**	**CMI**	**CMB**	**R**	**CMI**	**CMB**	**R**	**CMI**	**CMB**	**R**	**C MI**	**CMB**	**R**	**CMI**	**CMB**	**R**
E. coli																		
AG102	1024	-	nd	**256**	**512**	2	-	-	nd	-	-	nd	-	-	nd	64	256	4
AG100 ATET	-	-	nd	1024	-	nd	-	-	nd	-	-	nd	-	-	nd	32	64	2
ATCC10536	-	-	nd	-	-	nd	-	-	nd	-	-	nd	-	-	nd	32	64	2
AG100	1024	-	nd	1024	-	nd	-	-	nd	-	-	nd	-	-	nd	128	256	2
ATCC8739	-	-	nd	1024	-	nd	-	-	nd	-	-	nd	-	-	nd	32	128	4
P aeruginosa																		
PA01	-	-	nd	-	-	nd	-	-	nd	-	-	nd	-	-	nd	32	64	2
PA124	1024	-	nd	-	-	nd	-	-	nd	-	-	nd	-	-	nd	128	256	2
P. stuartii																		
NEA16	-	-	nd	-	-	nd	-	-	nd	-	-	nd	-	-	nd	64	256	4
ATCC29916	-	-	nd	1024	-	nd	-	-	nd	-	-	nd	-	-	nd	64	128	2
E. aerogenes																		
EA27	1024	-	nd	1024	-	nd	-	-	nd	2048	-	nd	-	-	nd	256	-	nd
ATCC13048	1024	-	nd	-	-	nd	-	-	nd	-	-	nd	-	-	nd	16	64	4
K. pneumoniae																		
KP55	-	-	nd	-	-	nd	-	-	nd	-	-	nd	2048	-	nd	32	64	2
KP63	1024	-	nd	1024	-	nd	-	-	nd	-	-	nd	-	-	nd	32	128	4
K24	1024	-	nd	-	-	nd	-	-	nd	-	-	nd	-	-	nd	64	128	2
S. aureus																		
SSA1	-	-	nd				-	-	Nd	-	-	nd	-	-	nd	128	256	2
RSA3	1024	-	nd	1024	-	nd	-	-	Nd	-	-	nd	-	-	nd	64	256	4
RSA6	-	-	nd	-	-	nd	-	-	Nd	-	-	nd	-	-	nd	64	128	2
RSA9	1024	-	nd	1024	-	nd	-	-	Nd	-	-	nd	-	-	nd	64	256	4
RSA12	512	-	nd	**256**	**512**	2	-	-	Nd	-	-	nd	-	-	nd	128	256	2
TCC25923	-	-	nd	512	1024	2	-	-	Nd	-	-	nd	2048	-	nd	16	64	4

Table 3. Antibiotic-resistance modulatory activity *Sechium edule* leaf extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (μg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. Stuartii*		*S. Aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**64(4)**	**32(8)**	**64(4)**	**128(2)**	**64(4)**	**128(2)**	**128(2)**	**165(16)**	**32(8)**	**64(4)**	**16(16)**	**100%**
	CMI/4	**128(2)**	**64(4)**	256(1)	256(1)	**128(2)**	256(1)	256(1)	**64(4)**	**64(4)**	**128(2)**	**32(8)**	**63.63%**
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	**1(4)**	**0.25(16)**	**2(2)**	**1(4)**	**1(4)**	**2(2)**	**1(4)**	**0.25(16)**	**1(4)**	**1(4)**	**0.5(8)**	**100%**
	CMI/4	**2(2)**	**1(4)**	4(1)	4(1)	**2(2)**	4(1)	**2(2)**	**1(4)**	**2(2)**	**2(2)**	**2(2)**	**72.72%**
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**O.25(8)**	**0.5(4)**	**1(2)**	**0.5(4)**	**1(2)**	**0.5(4)**	**0.125(16)**	**0.25(8)**	**0.25(8)**	**0.5(4)**	**100%**
	CMI/4	**1(2)**	**0.5(4)**	**1(2)**	2(1)	1(2)	2(1)	**1(2)**	**0.5(4)**	**0.5(4)**	**0.5(4)**	**1(2)**	**81.81%**
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.125(16)**	**0.5(4)**	**0.25(8)**	**0.5(4)**	**0.5(4)**	**0.5(4)**	**0.25(8)**	**0.5(4)**	**1(2)**	**0.5(4)**	**100%**
	CMI/4	**1(2)**	**0.5(4)**	2(1)	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	**2(1)**	**1(2)**	**81.81%**
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.125(16)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	**1(2)**	**0.125(16)**	**0.5(4)**	**0.25(8)**	**0.125(16)**	**100%**
	CMI/4	2(1)	**0.5(4)**	2(1)	2(1)	**1(2)**	2(1)	2(1)	**0.5(4)**	**1(2)**	**0.5(4)**	**0.5(4)**	**54.54%**
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.25(8)**	**0.25(8)**	**1(2)**	**0.5(4)**	**0.5(4)**	**0.5(4)**	**1(2)**	**0.5(4)**	**0.5(4)**	**0.25(8)**	**0.125(16)**	**100%**
	CMI/4	**0.5(4)**	**0.5(4)**	2(1)	**1(2)**	1(2)	**1(2)**	2(1)	**1(2)**	**1(2)**	**0.5(4)**	**0.5(4)**	**81.81%**

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 3. *continued and end.*

Antibiotics	Extracts concentration	MIC (μg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. pneumoniae*		*P. Stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.25(8)**	**0.5(4)**	1(1)	**0.5(4)**	**1(2)**	**1(2)**	**0.25(8)**	**1(2)**	**0.5(4)**	2(1)	**90.91%**
	CMI/4	**1(2)**	**0.5(4)**	**1(2)**	2(1)	**1(2)**	2(1)	2(1)	**0.5(4)**	2(1)	**1(2)**	4(0.5)	**54.54%**
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.125(16)**	**0.5(4)**	1(1)	1(1)	**0.5(4)**	**0.5(4)**	**0.125(16)**	**0.5(4)**	**0.5(4)**	4(0.5)	**90.91%**
	CMI/4	2(1)	**0.5(4)**	**1(2)**	2(1)	2(1)	**1(2)**	**1(2)**	**0.25(8)**	**1(2)**	**1(2)**	8(0.25)	**63.63%%**
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.125(16)**	**1(2)**	**0.5(4)**	**0.5(4)**	2(1)	**1(2)**	**0.125(16)**	**0.5(4)**	**0.5(4)**	**0.5(4)**	**90.91%**
	CMI/4	**1(2)**	**0.5(4)**	2(1)	**1(2)**	**1(2)**	4(0.5)	2(1)	**0.125(16)**	**1(2)**	**1(2)**	2(1)	**63.63%%**
KAN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.125(16)**	**1(2)**	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	**0.125(16)**	**1(2)**	**0.5(4)**	4(0.5)	**90.91%**
	CMI/4	1(1)	**0.5(4)**	2(1)	**1(2)**	**1(2)**	2(1)	2(1)	**0.25(8)**	2(1)	**1(2)**	8(0.5)	**54.54%**
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.125(16)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	**1(2)**	**0.25(8)**	**0.5(4)**	**0.5(4)**	2(1)	**90.91%**
	CMI/4	1(1)	**0.5(4)**	2(1)	2(1)	**1(2)**	2(1)	2(1)	**0.5(4)**	**1(2)**	**1(2)**	**4(0.5)**	**54.54%**
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	**0.5(4)**	2(1)	**1(2)**	**0.125(16)**	**0.5(4)**	**0.5(4)**	4(0.5)	**81.81%**
	CMI/4	**1(2)**	**1(2)**	2(1)	2(1)	**1(2)**	4(0.5)	2(1)	**0.5(8)**	**1(2)**	**1(2)**	4(0.5)	**54.54%**

Table 4. Antibiotic-resistance modulatory activity of *Adansonia digitata* bark extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**64(4)**	**128(2)**	256(1)	**64(4)**	**32(8)**	**64(4)**	256(1)	**64(4)**	**64(4)**	**64(4)**	**64(4)**	**81.81%**
	CMI/4	**128(2)**	256(1)	512(0.5)	**128(2)**	**64(4)**	**128(2)**	512(0.5)	**128(2)**	**128(2)**	**128(2)**	**128(2)**	**72.72%**
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	4(1)	**2(2)**	8(0.5)	**2(2)**	4(1)	**2(2)**	4(1)	**2(2)**	**1(4)**	4(1)	**1(4)**	**54.54%**
	CMI/4	8(0.5)	**2(2)**	8(0.5)	4(1)	8(0.5)	4(1)	8(0.5)	4(1)	**1(4)**	8(0.5)	**2(2)**	18.18%
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	2(1)	2(1)	2(1)	2(1)	**1(2)**	**0.25(8)**	**1(2)**	**1(2)**	**0.5(4)**	**63.63%**
	CMI/4	2(1)	2(1)	4(0.5)	4(0.5)	4(0.5)	4(0.5)	2(1)	**0.5(4)**	2(1)	2(1)	**1(2)**	18.18%
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.5(4)**	2(1)	**1(2)**	**0.125(16)**	**0.5(4)**	4(0.5)	**0.25(8)**	**1(2)**	2(1)	**0.25(8)**	**72.72%**
	CMI/4	2(1)	**1(2)**	4(0.5)	2(1)	**0.25(8)**	**1(2)**	8(0.25)	**1(2)**	4(0.5)	4(0.5)	**0.5(4)**	45.45%
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	**0.5(4)**	**0.5(4)**	2(1)	4(0.5)	2(1)	**0.125(0.16)**	**1(2)**	**0.5(4)**	**63.63%**
	CMI/4	2(1)	2(1)	4(0.5)	**0.5(4)**	**1(2)**	4(0.5)	8(0.25)	4(0.5)	**0.25(8)**	2(1)	2(1)	27.27%
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.25(8)**	2(1)	**0.5(4)**	2(1)	**0.5(4)**	**1(2)**	2(1)	**0.125(0.16)**	**1(2)**	**0.25(8)**	**72.72%**
	CMI/4	2(1)	**0.5(4)**	4(0.5)	**1(2)**	2(1)	**1(2)**	2(1)	4(0.5)	**0.25(8)**	2(1)	**0.5(4)**	45.45%

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 4. *continued and end.*

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**1(2)**	**1(2)**	2(1)	**0.5(4)**	4(0.5)	2(1)	2(1)	**0.5(4)**	2(1)	4(0.5)	36.36%
	CMI/4	4(0.5)	**1(2)**	2(1)	4(0.5)	**1(2)**	8(0.125)	4(0.5)	4(0.5)	**1(2)**	4(0.5)	8(0.125)	27.27%
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	4(0.5)	**1(2)**	**0.5(4)**	**0.25(8)**	**1(2)**	**1(2)**	2(1)	2(1)	2(1)	**1(2)**	**54.54%**
	CMI/4	4(0.5)	8(0.125)	2(1)	**1(2)**	**0.5(4)**	2(1)	2(1)	4(0.5)	2(1)	4(0.5)	2(1)	18.18%
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**1(2)**	4(0.5)	**1(2)**	**0.25(8)**	4(0.5)	4(0.5)	2(1)	2(1)	2(1)	4(0.5)	27.27%
	CMI/4	4(0.5)	2(1)	8(0.125)	2(1)	**1(2)**	8(0.125)	8(0.125)	2(1)	4(0.5)	2(1)	8(0.125)	9.09%
KAN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	4(0.5)	2(1)	**0.5(4)**	**0.25(8)**	2(1)	4(0.5)	2(1)	**0.125(16)**	1(2)	2(1)	45.45%
	CMI/4	2(1)	8(0.125)	4(0.5)	**1(2)**	**1(2)**	4(0.5)	8(0.125)	4(0.5)	**0.5(4)**	4(0.5)	4(0.5)	27.27%
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	2(1)	2(1)	2(1)	**1(2)**	**1(2)**	2(1)	2(1)	**1(2)**	**1(2)**	2(1)	45.45%
	CMI/4	2(1)	4(0.5)	4(0.5)	4(0.5)	2(1)	2(1)	4(0.5)	4(0.5)	2(1)	2(1)	4(0.5)	0%
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	**1(2)**	**0.5(4)**	**1(2)**	2(1)	**1(2)**	**0.125(16)**	**1(2)**	2(1)	**72.72%**
	CMI/4	2(1)	2(1)	4(0.5)	2(1)	2(1)	2(1)	4(0.5)	2(1)	**0.5(4)**	2(1)	4(0.5)	9.09%

Table 5. Antibiotic-resistance modulatory activity of *Coffea arabica* leaf extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**64(4)**	256(1)	256(1)	**128(2)**	**32(8)**	**64(4)**	256(1)	**128(2)**	**128(2)**	**128(2)**	**16(16)**	**72.72%**
	CMI/4	**128(2)**	512(0.5)	512(0.5)	256(1)	**128(2)**	**128(2)**	512(0.5)	256(1)	256(1)	256(1)	**32(8)**	36.36%
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	4(1)	**0.5(4)**	8(0.5)	4(1)	**2(2)**	**2(2)**	4(1)	**2(2)**	**2(2)**	**2(2)**	**0.5(4)**	18.18%
	CMI/4	8(0.5)	**1(4)**	8(0.5)	8(0.5)	4(1)	4(1)	8(0.5)	4(1)	4(1)	4(1)	2(1)	9.09%
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	4(0.5)	2(1)	8(0.25	**0.25(8)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	**72.72%**
	CMI/4	2(1)	8(0.25)	4(0.5)	8(0.25	**0.5(4)**	2(1)	2(1)	2(1)	2(1)	2(1)	**1(2)**	18.18%
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	1(2)	4(0.5)	2(1)	2(1)	4(0.5)	4(0.5)	4(0.5)	**1(2)**	**0.125(16)**	4(0.5)	**0.5(4)**	36.36%
	CMI/4	2(1)	8(0.25)	4(0.5)	4(0.5)	8(0.25)	8(0.25)	8(0.25)	2(1)	**0.25(8**	8(0.25)	**1(2)**	18.18%
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	4(0.5)	2(1)	**0.5(4)**	**0.25(8)**	2(1)	4(0.5)	**1(2)**	**1(2)**	**1(2)**	**0.125(16)**	**63.63%**
	CMI/4	2(1)	≥8	4(0.5)	**1(2)**	**1(2)**	4(0.5)	8(0.25)	2(1)	2(1)	2(1)	**0.5(4)**	27.27%
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	2(1)	**0.5(4)**	**0.25(8)**	**1(2)**	**1(2)**	0.5(4)	**1(2)**	**0.125(16)**	**81.81%**
	CMI/4	2(1)	**1(2)**	4(0.5)	2(1)	**1(2)**	**1(2)**	2(1)	2(1)	1(2)	2(1)	**0.25(8)**	45.45%

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 5. *continued and end.*

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)										Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**1(2)**	**1(2)**	4(0.5)	**0.25(8)**	**0.25(8)**	2(1)	2(1)	**1(2)**	4(0.5)	2(1)	45.45%
	CMI/4	4(0.5)	2(1)	2(1)	8(0.25)	**1(2)**	**1(2)**	4(0.5)	4(0.5)	2(1)	8(0.25)	4(0.5)	18.18%
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	2(1)	**1(2)**	**1(2)**	**0.25(8)**	2(1)	**1(2)**	2(1)	**1(2)**	2(1)	4(0.5)	45.45%
	CMI/4	4(0.5)	4(0.5)	2(1)	2(1)	**0.5(4)**	4(0.5)	2(1)	4(0.5)	2(1)	4(0.5)	8(0.25)	9.09%
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	≥8	4(0.5)	8(0.25)	4(0.5)	4(0.5)	4(0.5)	**0.5(4)**	4(0.5)	**1(2)**	0.5(4)	27.27%
	CMI/4	4(0.5)	≥8	8(0.25)	8(0.25)	8(0.25)	8(0.25)	8(0.25)	**1(2)**	8(0.25)	2(1)	2(1)	9.09%
KAN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	0.5(4)	2(1)	**1(2)**	**1(2)**	4(0.5)	4(0.5)	**0.5(4)**	**0.5(4)**	4(0.5)	4(0.5)	**54.54%**
	CMI/4	2(1)	1(2)	4(0.5)	2(1)	2(1)	8(0.25)	8(0.25)	1(2)	1(2)	8(0.25)	8(0.25)	27.27%
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	4(0.5)	2(1)	**1(2)**	**0.5(4)**	**1(2)**	2(1)	2(1)	**0.5(4)**	**1(2)**	2(1)	**54.54%**
	CMI/4	2(1)	8(0.25)	4(0.5)	2(1)	**1(2)**	2(1)	4(0.5)	4(0.5)	**1(2)**	2(1)	4(0.5)	18.18%
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.5(4)**	2(1)	**1(2)**	**1(2)**	**1(2)**	**2(1)**	**1(2)**	**0.5(4)**	4(0.5)	4(0.5)	**63.63%**
	CMI/4	2(1)	**1(2)**	4(0.5)	2(1)	2(1)	2(1)	4(0.5)	**1(2)**	**1(2)**	8(0.25)	4(0.5)	27.27%

Table 6. Antibiotic-resistance modulatory activity of *Coffea arabica* seeds extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (μg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aerug-inosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**64(4)**	256(1)	256(1)	**64(4)**	**32(8)**	**128(2)**	256(1)	**64(4)**	256(1)	**128(2)**	**16(16)**	**63.63%**
	CMI/4	**128(2)**	512(0.5)	512(0.5)	**64(4)**	**64(4)**	256(1)	512(0.5)	**128(2)**	512(0.5)	256(1)	**32(8)**	45.45%
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	4(1)	**2(2)**	8(0.5)	8(0.5)	4(1)	**2(2)**	4(1)	**2(2)**	**1(4)**	**2(2)**	**2(2)**	**54.54%**
	CMI/4	8(0.5)	4(1)	8(0.5)	16(0.25)	8(0.5)	4(1)	8(0.5)	4(1)	2(2)	4(1)	4(1)	9.09%
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	4(0.5)	2(1)	4(0.5)	2(1)	4(0.5)	**1(2)**	4(0.5)	**0.5(4)**	**1(2)**	**0.25(8)**	45.45%
	CMI/4	2(1)	8(0.25)	4(0.5)	8(0.25	4(0.5)	8(0.25)	2(1)	8(0.25)	**1(2)**	2(1)	**0.5(4)**	18.18%
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	2(1)	2(1)	**1(2)**	4(0.5)	4(0.5)	4(0.5)	**0.25(8)**	4(0.5)	4(0.5)	**0.125(16)**	36.36%
	CMI/4	2(1)	4(0.5)	4(0.5)	2(1)	8(0.25)	8(0.25)	8(0.25)	**1(2)**	8(0.25)	8(0.25)	**1(2)**	18.18%
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	4(0.5)	2(1)	**0.5(4)**	**0.5(4)**	4(0.5)	4(0.5)	**1(2)**	**0.5(4)**	**1(2)**	**0.5(4)**	**63.63%**
	CMI/4	2(1)	4(0.5)	4(0.5)	**1(2)**	**1(2)**	8(0.25)	8(0.25)	2(1)	**1(2)**	2(1)	2(1)	27.27%
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	4(0.5)	2(1)	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	**1(2)**	**0.25(8)**	**1(2)**	**0.25(8)**	**81.81%**
	CMI/4	2(1)	8(0.25)	4(0.5)	2(1)	**1(2)**	**1(2)**	2(1)	2(1)	**0.5(4)**	2(1)	**0.5(4)**	36.36%

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 6. *continued and end.*

Antibiotics	Extracts concentration	MIC (μg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	4(0.5)	**1(2)**	4(0.5)	**1(2)**	**1(2)**	2(1)	4(0.5)	4(0.5)	**1(2)**	**1(2)**	45.45%
	CMI/4	4(0.5)	8(0.25)	2(1)	8(0.25)	4(0.5)	2(1)	4(0.5)	8(0.25)	8(0.25)	2(1)	4(0.5)	0%
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	4(0.5)	**1(2)**	2(1)	**0.5(4)**	**0.5(4)**	**1(2)**	4(0.5)	4(0.5)	**0.5(4)**	**1(2)**	**54.54%**
	CMI/4	4(0.5)	4(0.5)	2(1)	2(1)	**1(2)**	**1(2)**	2(1)	8(0.25)	8(0.25)	**1(2)**	2(1)	27.27%
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	4(0.5)	4(0.5)	4(0.5)	4(0.5)	4(0.5)	4(0.5)	**1(2)**	4(0.5)	**1(2)**	**1(2)**	27.27%
	CMI/4	4(0.5)	8(0.25)	8(0.25	8(0.25	8(0.25)	8(0.25)	8(0.25)	2(1)	8(0.25)	2(1)	2(1)	0%
KAN	0	2	2	2	2	2	2	2	2	2	2	2(2)	
	CMI/2	**1(2)**	4(0.5)	2(1)	2(1)	**1(2)**	4(0.5)	4(0.5)	**1(2)**	0.5(4)	2(1)	**1(2)**	45.45%
	CMI/4	2(1)	8(0.25)	4(0.5)	4(0.5)	2(1)	8(0.25)	8(0.25)	2(1)	2(1)	4(0.5)	4(0.5)	0%
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	4(0.5)	2(1)	2(1)	2(1)	**0.5(4)**	2(1)	**0.5(4)**	**1(2)**	**1(2)**	2(1)	45.45%
	CMI/4	2(1)	4(0.5)	4(0.5)	4(0.5)	4(0.5)	**1(2)**	4(0.5)	**1(2)**	2(1)	2(1)	4(0.5)	18.18%
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	4(0.5)	4(0.5)	2(1)	2(1)	4(0.5)	4(0.5)	4(0.5)	**1(2)**	27.27%
	CMI/4	2(1)	2(1)	4(0.5)	4(0.5)	4(0.5)	4(0.5)	4(0.5)	8(0.25)	8(0.25)	8(0.25)	2(1)	0%

Table 7. Antibiotic-resistance modulatory activity of *Coffea arabica* bark extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100 ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC 29916	ATCC 25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**128(2)**	**64(4)**	**64(4)**	**64(4)**	**128(2)**	**128(2)**	256(1)	**32(8)**	**64(4)**	**64(4)**	**16(16)**	**90.90%**
	CMI/4	256(1)	**128(2)**	**128(2)**	**128(2)**	256(1)	256(1)	512(0.5)	**64(4)**	**128(2)**	**128(2)**	**64(4)**	**72.72%**
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	**1(4)**	**0.5(8)**	**2(2)**	4(1)	4(1)	**2(2)**	**2(2)**	**0.5(8)**	**2(2)**	**2(2)**	**2(2)**	27.27%
	CMI/4	**2(2)**	**1(4)**	4(1)	8(0.5)	8(0.5)	4(1)	4(1)	**1(4)**	4(1)	4(1)	4(1)	18.18%
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	**1(2)**	**1(2)**	**1(2)**	2(1)	**1(2)**	**0.5(4)**	**0.5(4)**	**0.5(4)**	**81.81%**
	CMI/4	2(1)	2(1)	4(0.5)	2(1)	2(1)	2(1)	4(0.5)	4(0.5)	**1(2)**	**1(2)**	2(1)	18.18%
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**0.5(4)**	**1(2)**	2(1)	**0.5(4)**	**1(2)**	**0.25(8)**	**0.5(4)**	2(1)	2(1)	**1(2)**	**72.72%**
	CMI/4	4(0.5)	**1(2)**	2(1)	4(0.5)	**1(2)**	2(1)	**0.5(4)**	**1(2)**	4(0.5)	4(0.5)	2(1)	36.36%
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	**0.25(8)**	**0.5(4)**	**1(2)**	**0.5(4)**	**1(2)**	**0.5(4)**	**0.25(8)**	**100%**
	CMI/4	**1(2)**	**1(2)**	2(1)	2(1)	**1(2)**	**1(2)**	2(1)	**1(2)**	2(1)	**1(2)**	**0.5(4)**	72.72%
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**0.5(4)**	2(1)	2(1)	**0.5(4)**	4(0.5)	**0.5(4)**	2(1)	**1(2)**	**0.25(8)**	**72.72%**
	CMI/4	**1(2)**	2(1)	**1(2)**	4(0.5)	4(0.5)	**1(2)**	8(0125)	1(2)	4(0.5)	2(1)	1(2)	45.45%

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 7. *continued and end.*

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	2(1)	**1(2)**	**1(2)**	2(1)	**0.5(4)**	**0.5(4)**	**1(2)**	2(1)	**72.72%**
	CMI/4	**1(2)**	2(1)	2(1)	4(0.5)	2(1)	2(1)	4(0.5)	2(1)	**1(2)**	2(1)	4(0.5)	18.18%
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**0.5(4)**	2(1)	2(1)	2(1)	**0.5(4)**	**1(2)**	**1(2)**	2(1)	**0.5(4)**	**1(2)**	**54.54%**
	CMI/4	4(0.5)	**1(2)**	4(0.5)	4(0.5)	4(0.5)	**1(2)**	2(1)	2(1)	4(0.5)	**1(2)**	2(1)	27.27%
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.5(4)**	2(1)	2(1)	**0.5(4)**	**1(2)**	4(0.5)	**1(2)**	**1(2)**	**1(2)**	4(0.5)	**63.63%**
	CMI/4	2(1)	**1(2)**	4(0.5)	4(0.5)	**1(2)**	2(1)	8(0.25)	2(1)	2(1)	2(1)	8(0.25)	18.18%
KAN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	2(1)	4(0.5)	**1(2)**	**1(2)**	**0.5(4)**	4(0.5)	**72.72%**
	CMI/4	2(1)	**1(2)**	**1(2)**	2(1)	2(1)	4(0.5)	8(0.25)	2(1)	2(1)	**1(2)**	8(0.25)	27.27%
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	2(1)	**0.5(4)**	**1(2)**	**0.5(4)**	4(0.5)	**90.90%**
	CMI/4	**1(2)**	**1(2)**	**1(2)**	2(1)	2(1)	2(1)	4(0.5)	**1(2)**	2(1)	**1(2)**	8(0.25)	45.45%
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**0.5(4)**	**0.5(4)**	2(1)	**1(2)**	**1(2)**	2(1)	**1(2)**	**0.5(4)**	**1(2)**	4(0.5)	**63.63%**
	CMI/4	4(0.5)	**1(2)**	**1(2)**	4(0.5)	2(1)	2(1)	4(0.5)	2(1)	**1(2)**	2(1)	8(0.25)	27.27%

Table 8. Antibiotic-resistance modulatory activity of *Beilschmeidia louisii* leaf extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**128(2)**	**128(2)**	**64(4)**	**64(4)**	**128(2)**	**128(2)**	**128(2)**	**128(2)**	**64(4)**	**64(4)**	256(1)	**90;90%**
	CMI/4	256(1)	256(1)	**128(2)**	**128(2)**	256(1)	256(1)	256(1)	256(1)	**128(2)**	**128(2)**	256(1)	45.45%
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	**1(4)**	**1(4)**	**2(2)**	**2(2)**	**2(2)**	4(1)	**1(4)**	**2(2)**	**1(4)**	**2(2)**	**1(4)**	**90;90%**
	CMI/4	**2(2)**	**2(2)**	4(1)	4(1)	4(1)	8(0.25)	**2(2)**	4(1)	**2(2)**	4(1)	**1(4)**	**54.54%**
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	**0.5(4)**	2(1)	**1(2)**	**81.81%**
	CMI/4	**1(2)**	2(1)	2(1)	2(1)	2(1)	2(1)	**1(4)**	2(1)	**1(2)**	4(1)	**1(2)**	36.36%
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	**1(2)**	2(1)	2(1)	**81.81%**
	CMI/4	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	2(1)	4(0.5)	4(0.5)	27.27%
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	2(1)	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	**0.5(4)**	**1(2)**	**0.5(4)**	2(1)	**81.81%**
	CMI/4	**1(2)**	2(1)	4(0.5)	2(1)	2(1)	2(1)	**1(2)**	**1(2)**	2(1)	**1(2)**	4(0.5)	36.36%
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	2(1)	**90.90%**
	CMI/4	**1(2)**	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	4(0.5)	9.09%

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 8. *continued and end.*

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	2(1)	**1(2)**	2(1)	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**81.81%**
	CMI/4	**1(2)**	2(1)	2(1)	4(0.5)	2(1)	4(0.5)	**1 (2)**	2(1)	2(1)	2(1)	2(1)	18.18%
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	2(1)	**1(2)**	**1(2)**	**0.5(4)**	**0.5(4)**	**1(2)**	**0.5(4)**	**0.25(8)**	**81.81%**
	CMI/4	2(1)	2(1)	4(0.5)	4(0.5)	2(1)	2(1)	**1(2)**	**1(2)**	2(1)	**1(2)**	**0.5(4)**	36.36%
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	**0.5(4)**	**1(2)**	2(1)	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	**81.81%**
	CMI/4	2(1)	2(1)	4(0.5)	**1(2)**	2(1)	4(0.5)	**1(2)**	2(1)	2(1)	2(1)	**1(2)**	27.27%
KAN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	2(1)	**1(2)**	2(1)	2(1)	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	**72.72%**
	CMI/4	**1(2)**	2(1)	4(0.5)	2(1)	4(0.5)	4(0.5)	2(1)	2(1)	2(1)	2(1)	**1(2)**	18.18%
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	2(1)	**0.5(4)**	**1(2)**	**1(2)**	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	**90.90%**
	CMI/4	**1(2)**	2(1)	4(0.5)	2(1)	2(1)	2(1)	**1(2)**	**1(2)**	2(1)	2(1)	2(1)	27.27%
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	2(1)	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	**63.63%**
	CMI/4	2(1)	2(1)	4(0.5)	4(0.5)	2(1)	4(0.5)	4(0.5)	**1(2)**	2(1)	2(1)	2(1)	9.09%

Table 9. Antibiotic-resistance modulatory activity of *Beilschmeidia louisii* trunk extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**128(2)**	**128(2)**	**64(4)**	**64(4)**	**128(2)**	**128(2)**	**64(4)**	**128(2)**	**128(2)**	256(1)	256(1)	**81.81%**
	CMI/4	256(1)	256(1)	**128(2)**	**128(2)**	256(1)	256(1)	**128(2)**	256(1)	256(1)	512(0.5)	256(1)	27.27%
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	**1(4)**	**0.5(8)**	1(4)	**2(2)**	**2(2)**	4(1)	**2(2)**	**1(4)**	4(1)	**2(2)**	**1(4)**	**81.81%**
	CMI/4	**2(2)**	1(4)	4(1)	4(1)	4(1)	8(0.5)	4(1)	**2(2)**	8(0.5)	4(1)	**1(4)**	36.36%
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	2(1)	2(1)	2(1)	4(0.5)	**72.72%**
	CMI/4	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	**1(2)**	4(0.5)	4(0.5)	4(0.5)	8(0.25)	9.09%
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	4(0.5)	2(1)	4(0.5)	**72.72%**
	CMI/4	4(0.5)	2(1)	2(1)	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	4(0.5)	4(0.5)	8(0.25)	18.18%
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	4(0.5)	**1(2)**	**0.25(8)**	**0.5(4)**	2(1)	**1(2)**	4(0.5)	**72.72%**
	CMI/4	**1(2)**	**1(2)**	2(1)	2(1)	8(0.25)	2(1)	**0.5(4)**	**1(2)**	4(0.5)	2(1)	8(0.25)	36.36%
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	2(1)	4(0.5)	2(1)	0.5(4)	4(0.5)	2(1)	4(0.5)	45.45%
	CMI/4	**1(2)**	2(1)	2(1)	2(1)	4(0.5)	4(0.5)	4(0.5)	1(2)	8(0.25)	4(0.5)	8(0.25)	18.18%

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 9. *continued and end.*

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)										Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	2(1)	**0.5(4)**	**63.63%**
	CMI/4	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	4(0.5)	4(0.5)	2(1)	4(0.5)	4(0.5)	2(1)	18.18%
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.5(4)**	2(1)	**1(2)**	2(1)	4(0.5)	**0.5(4)**	**0.5(4)**	4(0.5)	2(1)	**1(2)**	**54.54%**
	CMI/4	2(1)	**1(2)**	4(0.5)	2(1)	4(0.5)	4(0.5)	**1(2)**	**1(2)**	4(0.5)	4(0.5)	4(0.5)	27.27%
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	2(1)	4(0.5)	**0.5(4)**	**1(2)**	**1(2)**	2(1)	**1(2)**	**72.72%**
	CMI/4	**1(2)**	**1(2)**	2(1)	2(1)	4(0.5)	8(0.25)	**1(2)**	2(1)	2(1)	4(0.5)	2(1)	27.27%
KAN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**0.5(4)**	**0.5(4)**	4(0.5)	2(1)	**0.5(4)**	**1(2)**	**1(2)**	2(1)	**1(2)**	**72.72%**
	CMI/4	**1(2)**	**1(2)**	**1(2)**	**1(2)**	8(0.25)	4(0.5)	**1(2)**	2(1)	2(1)	4(0.5)	2(1)	45.45%
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	**0.5(4)**	**0.5(4)**	2(1)	4(0.5)	**1(2)**	**81.81%**
	CMI/4	**1(2)**	**1(2)**	**1(2)**	**1(2)**	2(1)	2(1)	**1(2)**	**1(2)**	4(0.5)	4(0.5)	**1(2)**	**63.63%**
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**1(2)**	**0.5(4)**	**1(2)**	4(0.5)	2(1)	2(1)	**0.5(4)**	2(1)	4(0.5)	2(1)	36.36%
	CMI/4	4(0.5)	2(1)	**1(2)**	2(1)	8'0.25)	4(0.5)	4(0.5)	**1(2)**	4(0.5)	4(0.5)	4(0.5)	18.18%

Table 10. Antibiotic-resistance modulatory activity of *Beilschmeidia louisii* stem extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100A TET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**64(4)**	**128(2)**	**64(4)**	**64(4)**	**128(2)**	**128(2)**	256(1)	256(1)	**128(2)**	**128(2)**	256(1)	**72.72%**
	CMI/4	**128(2)**	256(1)	**128(2)**	**128(2)**	256(1)	256(1)	512(0.5)	512	256(1)	256(1)	256(1)	27.27%
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	**1(4)**	**0.5(8)**	**1(4)**	**2(2)**	**2(2)**	**2(2)**	**1(4)**	**1(4)**	**2(2)**	**2(2)**	**1(4)**	**54.54%**
	CMI/4	**2(2)**	**1(4)**	4(1)	4(1)	4(1)	4(1)	**2(2)**	**2(2)**	4(1)	4(1)	**1(4)**	18.18%
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	2(1)	**0.5(4)**	**1(2)**	2(1)	**81.81%**
	CMI/4	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	4(0.5)	**1(2)**	2(1)	4(0.5)	9.09%
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	2(1)	2(1)	**0.5(4)**	**1(2)**	2(1)	2(1)	2(1)	**54.54%**
	CMI/4	2(1)	2(1)	2(1)	**1(2)**	4(0.5)	4(0.5)	**1(2)**	2(1)	4(0.5)	4(0.5)	2(1)	18.189%
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	2(1)	**0.25(8)**	**1(2)**	**1(2)**	**0.5(4)**	2(1)	**81.81%**
	CMI/4	2(1)	**1(2)**	2(1)	2(1)	2(1)	4(0.5)	**0.5(4)**	2(1)	2(1)	**1(2)**	4(0.5)	27.27%
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	**1(2)**	2(1)	**1(2)**	2(1)	**1(2)**	2(1)	**1(2)**	**1(2)**	**72.72%**
	CMI/4	**1(2)**	2(1)	2(1)	2(1)	4(0.5)	2(1)	4(0.5)	2(1)	4(0.5)	2(1)	2(1)	9.09%

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 10. *continued and end.*

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)										Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100A TET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	**1(2)**	2(1)	**63.63%**
	CMI/4	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	4(0.5)	4(0.5)	2(1)	4(0.5)	2(1)	4(0.5)	18.18%
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.5(4)**	2(1)	**1(2)**	2(1)	**0.5(4)**	**1(2)**	**0.5(4)**	**1(2)**	**0.5(4)**	**1(2)**	**81.81%**
	CMI/4	2(1)	**1(2)**	4(0.5)	2(1)	4(0.5)	**1(2)**	2(1)	**1(2)**	2(1)	**1(2)**	2(1)	36.36%
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	1(2)	**1(2)**	**1(2)**	**1(2)**	2(1)	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**90.9%**
	CMI/4	**1(2)**	2(1)	2(1)	2(1)	2(1)	4(0.5)	2(1)	2(1)	2(1)	2(1)	2(1)	9.09%
KAN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**0.5(4)**	**0.5(4)**	**0.5(4)**	2(1)	2(1)	**1(2)**	**1(2)**	2(1)	**1(2)**	**1(2)**	**63.63%**
	CMI/4	4(0.5)	**1(2)**	**1(2)**	**1(2)**	4(0.5)	4(0.5)	2(1)	2(1)	4(0.5)	2(1)	2(1)	27.27%
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**0.5(4)**	**0.5(4)**	2(1)	**1(2)**	**0.5(4)**	**0.5(4)**	**1(2)**	2(1)	**1(2)**	**81.81%**
	CMI/4	**1(2)**	**1(2)**	**1(2)**	**1(2)**	4(0.5)	2(1)	**1(2)**	**1(2)**	2(1)	4(0.5)	2(1)	54.54%
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**1(2)**	**0.5(4)**	**1(2)**	2(1)	2(1)	2(1)	**0.5(4)**	**1(2)**	2(1)	**1(2)**	**54.54%**
	CMI/4	4(0.5)	2(1)	**1(2)**	2(1)	4(0.5)	4(0.5)	4(0.5)	**1(2)**	2(1)	4(0.5)	2(1)	18.18%

Table 11. Antibiotic-resistance modulatory activity of *Hyphaene therbaica* fruits extract and Improvement Activity

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
CHL	0	256	256	256	256	256	256	256	256	256	256	256	
	CMI/2	**128(2)**	**64(4)**	**128(2)**	**64(4)**	**128(2)**	**128(2)**	**64(4)**	**128(2)**	**128(2)**	256(1)	**64(4)**	**90.9%**
	CMI/4	256(1)	**128(2)**	256(1)	**128(2)**	256(1)	256(1)	**128(2)**	256(1)	256(1)	512(0.5)	**128(2)**	36.36%
THI	0	4	4	4	4	4	4	4	4	4	4	4	
	CMI/2	**1(4)**	**2(2)**	4(1)	8(0.5)	**2(2)**	4(1)	**2(2)**	**1(4)**	4(1)	**2(2)**	4(1)	**54.54%**
	CMI/4	**2(2)**	4(1)	8(0.5)	4(1)	4(1)	8(0.5)	4(1)	**2(2)**	8(0.5)	4(1)	8(0.5)	18.18%
ERY	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**1(2)**	2(1)	2(1)	**1(2)**	**1(2)**	0.5(4)	2(1)	2(1)	2(1)	0.5(4)	**54.54%**
	CMI/4	2(1)	2(1)	4(0.5)	4(0.5)	2(1)	2(1)	1(2)	4(0.5)	4(0.5)	4(0.5)	1(2)	18.18%
GEN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	**1(2)**	4(0.5)	2(1)	**0.5(4)**	**72.72%**
	CMI/4	4(0.5)	2(1)	2(1)	2(1)	2(1)	2(1)	1(2)	2(1)	4(0.5)	4(0.5)	**1(2)**	18.18%
OFL	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	2(1)	2(1)	4(0.5)	**1(2)**	**0.25(8)**	**0.5(4)**	2(1)	**1(2)**	**0.5(4)**	**63.63%**
	CMI/4	**1(2)**	**1(2)**	4(0.5)	4(0.5)	8(0.25)	2(1)	**0.5(4)**	**1(2)**	4(0.5)	2(1)	**1(2)**	45.45%
CIP	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	2(1)	**1(2)**	2(1)	4(0.5)	2(1)	**0.5(4)**	4(0.5)	2(1)	**0.5(4)**	45.45%
	CMI/4	**1(2)**	2(1)	4(0.5)	2(1)	4(0.5)	4(0.5)	4(0.5)	**1(2)**	8(0.25	4(0.5)	**1(2)**	27.27%

IAF : Improvement Activity Factor; MIC : Minimal inhibitory Concentration ; ERY: Erythromycin; GEN: Gentamycin; THI: Thiamphenicol; OFL: Ofloxacin; CHL: Chloramphenicol; CIP: Ciprofloxacin. FLU: Flucloxacillin; CLO: Cloxacillin; TET : Tetracycline ; KAN : Kanamycin ; DOX : Doxycycline ; AZI: Azithromycin ; values in bold represent Improvement Activity Factor ≥ 2.

Table 11. *continued and end.*

Antibiotics	Extracts concentration	MIC (µg/mL) and IAF (in bracket)											Improvement effects (%)
		E. coli		*E. aerogenes*		*K. Pneumoniae*		*P. stuartii*		*S. aureus*		*P. aeruginosa*	
		ATCC10536	AG100ATET	EA27	ATCC13048	KP55	KP63	NEA16	ATCC29916	ATCC25923	MRSA9	PA124	
FLU	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**1(2)**	**1(2)**	2(1)	**1(2)**	2(1)	2(1)	**1(2)**	2(1)	2(1)	2(1)	45.45%
	CMI/4	**1(2)**	2(1)	2(1)	4(0.5)	2(1)	4(0.5)	4(0.5)	2(1)	4(0.5)	4(0.5)	4(0.5)	9.09%
CLO	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**1(2)**	**0.5(4)**	2(1)	2(1)	2(1)	4(0.5)	**0.5(4)**	**0.5(4)**	4(0.5)	2(1)	2(1)	36.36%
	CMI/4	2(1)	**1(2)**	4(0.5)	4(0.5)	4(0.5)	4(0.5)	**1(2)**	**1(2)**	4(0.5)	4(0.5)	4(0.5)	27.27%
TET	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	**1(2)**	**1(2)**	2(1)	4(0.5)	**0.5(4)**	**1(2)**	**1(2)**	2(1)	2(1)	**63.63%**
	CMI/4	**1(2)**	**1(2)**	2(1)	2(1)	4(0.5)	8(0.25)	**1(2)**	2(1)	2(1)	4(0.5)	4(0.5)	27.27%
KAN	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	2(1)	2(1)	4(0.5)	2(1)	**0.5(4)**	**1(2)**	**1(2)**	2(1)	2(1)	45.45%
	CMI/4	**1(2)**	**1(2)**	4(0.5)	4(0.5)	8(0.25)	4(0.5)	**1(2)**	2(1)	2(1)	4(0.5)	4(0.5)	27.27%
DOX	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	**0.5(4)**	**0.5(4)**	2(1)	**1(2)**	**1(2)**	**1(2)**	**0.5(4)**	**0.5(4)**	2(1)	4(0.5)	2(1)	**63.63%**
	CMI/4	**1(2)**	**1(2)**	4(0.5)	2(1)	2(1)	2(1)	**1(2)**	**1(2)**	4(0.5)	4(0.5)	2(1)	36.36%
AZI	0	2	2	2	2	2	2	2	2	2	2	2	
	CMI/2	2(1)	**1(2)**	**1(2)**	**1(2)**	4(0.5)	2(1)	2(1)	**0.5(4)**	2(1)	4(0.5)	2(1)	36.36%
	CMI/4	4(0.5)	2(1)	2(1)	2(1)	8(0.25)	4(0.5)	4(0.5)	**1(2)**	4(0.5)	4(0.5)	4(0.5)	9.09%

Conclusion

Generally, findings from the current study demonstrate that, among the studied plants, *Coffea arabica*, *adansonia digitata*, *Sechium edule,* and *Beilschmeidia louisii* are explorable sources of antibacterial agents against bacterial infections involving resistant phenotypes. Furthermore, some of these plants could be further investigated for natural substances to restore the antibacterial activity of some classes of antibiotics.

Additional file

Supplementary file. Table S1. Plants' names, family, and references numbers. Table S2-S7. Preliminary potentiating of

antibiotics by plant extracts against P. aeruginosa PA124. Available at: https://www.investchempharma.com/imcp68-ngwaneu-et-al-supplementary-file/

Abbreviations

AZI: azithromycin
CHL: chloramphenicol
CIP: ciprofloxacin
CLO: Cloxacillin
DMSO: dimethylsulfoxide
DOX: doxycycline
ERY: erythromycin
FLU: fluconazole
GEN: gentamycin
HNC: Herbier National du Cameroun
INT: p-iodonitrotetrazolium chloride
KAN: kanamycin
OFL: ofloxacillin
TET: tetracycline
THI : thiamphenicol

Authors' Contribution

SLMN, BENW carried out the study; ATM and VK designed the experiments. PN, LYM, FA, INB prepared the data and wrote the manuscript; VK supervised the work and provided the facilities for antibacterial assays; all authors read and approved the final manuscript.

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Conflict of interest

The authors declare no conflict of interest

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