Evaluation of Antimicrobial Activity of the Methanol Extracts from 8 Traditional Medicinal Plants

Chang-Geun Kang¹, Dae-Sik Hah², Chung-Hui Kim³, Young-Hwan Kim⁴, Euikyung Kim¹ and Jong-Shu Kim¹

¹Department of Pharmacology & Toxicology, College of Veterinary Medicine, Gyeongsang National University (Institute of Animal Science), Jinju 660-701
²Gyeongnam Livestock Promotion Institute Middle-branch, Changwon 541-703
³Department of Animal Science and Biotechnology, Gyeongnam National University of Science and Technology, Jinju 660-758
⁴Department of Microbiology & Immunology, College of Veterinary Medicine, Gyeongsang National University (Institute of Animal Science), Jinju 660-701, Korea

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The methanol extract of 12 medicinal plants were evaluated for its antibacterial activity against Gram-positive (5 strains) and Gram-negative bacteria (10 strains) by assay for minimum inhibitory concentration (MIC) and minimum bacterial concentration (MBC). The antibacterial activity was determined by an agar dilution method (according to the guidelines of Clinical and Laboratory Standard Institute). All the compounds (12 extracts) of the 8 medicinal plants (leaf or root) were active against both Gram-negative and Gram-positive bacteria. Gram-negative showed a more potent action than Gram positive bacteria. The MIC concentrations were various ranged from 0.6 µg/ml to 5000 µg/ml. The lowest MIC (0.6 µg/ml) and MBC (1.22 µg/ml) values were obtained with extract on 4 and 3 of the 15 microorganisms tested, respectively.

Key words: Antimicrobial activity, traditional medicinal plants, minimum inhibitory concentration (MIC), minimum bacterial concentration (MBC), methanol extract, agar dilution method.

INTRODUCTION

From ancient times, traditional medicinal plants have been known to possess diverse biological activity as antimicrobial, analgesics, anticancer, antipyretic, and antihypertensive activity and an important source of many biological active compounds (Inatain et al., 1996; Alma et al., 2003; Andrade et al., 2007; Webster et al., 2008). Medicinal plants have been used extensively by a large proportion of the world for their health care and remedy of diseases during the 2000 years and these data have revealed a high degree of correlation between traditional medicinal plants uses and laboratory analysis (Kumar and Roy, 1972; Singh et al., 2008). Phytotherapy is based on the use of biological active components contained in plants (Hostettman, 1998; Garza et al., 2007). The most interesting area of application for medicinal plant extracts is the inhibition of growth and reduction in numbers of the more serious pathogens (Okolo et al., 1995; Kuete et al., 2007; Kotzekidou et al., 2008). Recent several studies have been focused on growing interest in plants as a significant source of new pharmaceuticals (Locher et al., 1995; Rabe and Staden, 1997; Rates, 2001).

The 8 traditional medicinal plants used in this study were chosen based on either traditional and ethnobotanical usage suggestive of antibacterial or previous studies that have demonstrated anti-inflammation (Kim et al., 2004), anti-infection (Ming et al., 2006), antioxidant (Wu et al., 2010), anti-obesity (Miyata et al., 2010), analgesic and anti-fever activity (Cha et al., 1998). However, a little information exists regarding the antimicrobial activity of these medicinal plants. Therefore, the purpose of present study was to screen the antimicrobial activity of 8 different medicinal plants.

MATERIALS AND METHODS

Plant materials and extracts preparation. The medicinal plants were obtained from the Research Institute of Traditional Medicinal Plants of Gyeongnam (Hamyang, the province of Gyeongnam in south-western Korea). The plants obtained from Institute included: Sedum kamschatnicum (SK: root or leaf), Geum japonicum (GJ), Geranium sibiricum (GS), Saururus chinensis (SC: root or leaf), Agrimonia pilosa (AP: root or leaf), Houttuynia cordata (HC:...
root or leaf), *Perilla frutescens* (PF), *Agastache rugosa* (AR). The plants with their common names are listed in Table 1.

Table 1 also provides a description of the parts of the plants used and extraction yields (% W/W, dry base) of the plants. Each voucher specimen was deposited in the same Research Institute. The identification of the plants material was conducted entirely in the same Research Institute. The plant materials (leaf and root) were air dried under shade and cut into small pieces and stored at 4°C until use. Each plant materials 300 g were extracted with 80% 900 ml methanol in a shaking incubator at 37°C for 12 hr. The residue was re-extracted under the same condition three times. The extracts obtained were pooled and filtered. The combined methanol specimen was evaporated to dryness using a vacuum rotary evaporator and weighted (9.97 to 49.46%; W/W, dry base) to determine the yield of soluble constituents. The extract obtained was subject to evaluate the antimicrobial test were performed.

**Table 1.** Plants extract sources and extraction yields of each plants by 80% methanol.

| Pharmacopeia scientific name | Common name | Korean name | Yield | Plant part used |
|-----------------------------|-------------|-------------|-------|----------------|
| *Sedum kamtschaticum*       | Stonecrop   | Gilin weed  | 49.46 ± 1.8<sup>a</sup> | R               |
| *Sedum kamtschaticum*       | Stonecrop   | Gilin weed  | 26.65 ± 1.3<sup>b</sup> | L               |
| *Geranium sibiricum*        | Siberian geranium | Ilijeol     | 41.45 ± 1.3<sup>b</sup> | L               |
| *Perilla frutescens*        | Chinese Basil | Deulggae    | 23.47 ± 2.2<sup>c</sup> | L               |
| *Geum japonicum*            | Geum macrophyllum | BamnnMoo 41.45 ± 1.3<sup>b</sup> | L               |
| *Saururus chinensis*         | Spalthum Chinense Lour | Sambback glass | 40.17 ± 1.1<sup>c</sup> | R               |
| *Saururus chinensis*         | Spalthum Chinense Lour | Sambback glass | 29.22 ± 1.4<sup>c</sup> | L               |
| *Agrimonia pilosa*          | Hairy Agrimony | Sunhaek weed | 32.96 ± 1.5<sup>a</sup> | L               |
| *Agrimonia pilosa*          | Hairy Agrimony | Sunhaek weed | 9.97 ± 1.2<sup>c</sup> | R               |
| *Houttuynia cordata*        | Chameleon   | Uaesung weed | 32.02 ± 1.6<sup>c</sup> | L               |
| *Houttuynia cordata*        | Chameleon   | Uaesung weed | 14.92 ± 2.4<sup>c</sup> | R               |
| *Agastache rugosaia*        | Wrinkled giant hyssop | Baechoghang | 11.94 ± 2.3<sup>c</sup> | L               |

<sup>1</sup>: % W/W, dry base.
<sup>2</sup>: Plant parts used are indicated as follows; L-leaf, R-root.
<sup>3</sup>: Means ± SD with different superscript in the same column are significantly different (p < 0.01).

**Microbial strains.**  The bacterial test strains used in this study were *Salmonella typhimurium* (ATCC 14028), *Pseudomonas aeruginosa* (ATCC 9027), *E. coli* (ATCC 31165), *Salmonella enteritidis* (ATCC 4931), *Klebsiella pneumoniae* (ATCC 13883), *E. coli O157 :H7* (ATCC 43894), *Enterobacte aerogenes* (ATCC 29010), *Shigella dysenteriae* (ATCC 29026), *Bacillus subtilis* (ATCC 31091), *Bacillus cereus* (ATCC 11778), *Staphylococcus epidermidis* (ATCC 1228), and *Staphylococcus aureus* (ATCC 29213), all of them obtained from the American Type Culture Collection (ATCC) and *Proteus mirabilis* (CDC S 17), *Proteus vulgaris* (CDC 527 C), and *Listeria monocytogenes* (EGD) were kindly provided by Department of Microbiology, College of Veterinary Medicine, Gyeongsang National University, Korea. The bacterial strains were maintained on agar slant at 4°C in the same above-mentioned laboratory where the antimicrobial tests were performed.

**Culture media.** Nutrient Agar (NA) containing Bromocresol purple was used for the activation of Bacillus species while NA was used for the other bacteria for minimum bactericidal concentration (MBC). Mueller Hinton Agar (MHA) was used for minimum inhibitory concentration (MIC).

**Agar dilution method assays:** (According to the guidelines of Clinical and Laboratory Standard Institute).

Evaluation of the antimicrobial activity of medicinal plants extracts was conducted according to the agar dilution method with some modification (Pottumarthy et al., 2006). Gentamycin (Sigma) and bacteria-free solvent were used as a positive and negative control, respectively.

**Inoculation preparation:** At least four well isolated colonies of the same type from a culture agar plate were selected and touched the top of colony with a loop and transferred to a tube containing 4 ml of a suitable broth such as tryptic soy broth (TSB). The suspension was incubated at 37°C and the size was adjusted to the 0.5 MacFarland standard turbidity (NCCLS, 1999), approximately 1.5 × 10<sup>7</sup> CFU/ml.

**Preparation of antimicrobial plates:** The diluted methanol extracts were added to the melted and cooled medium in a ratio of 1 part extract sample agent to 9 parts medium.
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(2 ml of plant extract to 18 ml of Mueller Hinton agar for each petri dishes plate) with most susceptibility test. Gentamycin (0.62–5 µg/ml) was used as control for the 15 microorganisms assay. The reference antibiotic and its concentration were chosen because they are often employed as first line antibiotic in the respective bacterial infections.

**Inoculation of test organisms:** Full each well of multiple-inoculator with inoculums test organisms and dip the tip of multiple-inoculator on Mueller Hinton Agar plates and incubate at 37°C for 24 hr. At least three repetitions were run for each assay.

**Minimum inhibitory concentration (MIC) and Minimum bactericidal concentration (MBC):** The MIC value of the extract was determined as the lowest concentration that completely inhibited bacterial growth after 48 hr of incubation at 37°C. For the determination of MBC, a portion of liquid (5 µl) from each plates well that exhibited no growth were taken and then incubating 37°C for 24 hr. The lowest concentration that revealed no visible bacterial growth after sub-culturing was taken as MBC. Positive and negative cultures were also prepared.

**RESULTS AND DISCUSSION**

The methanol extracts from the root or leaf of 8 traditional medicinal plants showed various degrees of the inhibition against 15 bacterial strains using the agar dilution method (Table 2). The antibacterial activity of the methanol extracts tested was found mainly against Gram negative bacteria. In agreement with this finding, Nikaido (1996) reported that the Gram negative bacteria have hydrophilic out membrane owing to the consist of lipopolysaccharide molecular, thus, small hydrophilic molecules pass the outer membrane, on the other hand, this outer membrane have property passing the lipophilic compounds and macromolecules and permeating outer membrane of the microorganisms is prerequisite condition for any solute having antibacterial activity. Thus, despite methanol extracts used in this study are limited solubility in water, it penetrate the outer membrane of Gram negative bacteria and disturbed cellular function, metabolism, and loss of cellular constituents, leading their death. Similar results have also been reported in other previous studies (Rajeshwar et al., 2005; Kuete et al., 2007). In contrast, other reports did not consistent with our results (Rabe and Staden, 1997; Rezende et al., 2006). This difference may be due probably to the composition of samples used and the extraction process (water or solvents). Most microorganisms tested, except 5 strains, were found to be susceptible to the methanol extracts with MICs 0.6-5000 µg/ml and its growth was completely inhibited by the extracts. The *S. aureus* was found to be the most resistant microorganism against methanol extracts and was inhibited by only 7 of 12 extracts tested followed by *S. enteritidis* which were inhibited by 10 of 12 extracts and *P. aeruginosa*, *S. epidermidis* and *L. monocytogenes* were inhibited by 11 of 12 extracts (Table 2, 3). This result was agreed

| Microorganisms              | Methanol extracts |
|-----------------------------|-------------------|
|                            | SK-R² | SK-L | GJ | GS | SC-R | SC-L | AP-L | AP-R | HC-L | HC-R | PF | AR | RA³ |
| Gram-negative bacteria      |        |      |    |    |      |      |      |      |      |      |    |    |     |
| *S. typhimurium*            | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *E. coli*                   | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *P. aeruginosa*             | +      | +    | +  | +  | +    | +    | +    | +    | -    | +    | +  | +  |     |
| *S. enteritidis*            | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *K. pneumoniae*             | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *E. coli-O 157:H7*          | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *E. aerogenes*              | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *P. mirabilis*              | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *S. dysenteriae*            | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *P. ulgaris*                | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| Gram-positive bacteria      |        |      |    |    |      |      |      |      |      |      |    |    |     |
| *B. subtilis*               | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *S. epidermidis*            | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *S. aureus*                 | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *L. monocytogenes*          | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |
| *B. cereus*                 | +      | +    | +  | +  | +    | +    | +    | +    | +    | +    | +  | +  |     |

²: SK-R; Sedum kamtschaticum root, SK-L; Sedum kamtschaticum leaf, GJ; Geum japonicum, GS; Geranium sibiricum, SC-R; Saururus chinensis root, SC-L; Saururus chinensis leaf, AP-R; Agrimonia pilosa root, AP-L; Agrimonia pilosa leaf, HC-R; Houttuynia cordata root, HC-L; Houttuynia cordata leaf, PF; Perilla frutescens, AR; Agastache rugosa.
³: RA, reference antibiotics (Gentamycin), -; no inhibition.
with observation of the Dormann and Deans (2000) and Kotzekidou et al. (2008). The other results, however, did not in accord in the reports of Al-Bakri and Afifi (2007), Kuete et al. (2007) and Kotzekidou et al. (2008). This discrepancy may be also due to the difference of samples used and the extraction process. The antimicrobial spectra of the SK-R, SK-L, GJ, GS, SC-R, SC-L, AP-L, AP-R, HC-L, HC-R and AR were showed selective activity at 93, 86 and 73% against the tested pathogens, respectively (Table 2). Similar results were showed selective activity at 93, 86 and 73% against the corresponding microorganisms (Table 4). This data was supported by the other previous studies (Dordevic et al., 2007, 2008). The results of Table 3 showed that the MIC values varied from 0.6~5000 µg/ml for the methanol extracts from leaves or root of 8 medicinal plants. The known antibacterial mechanisms of medicinal plants against microorganisms were inhibit cell wall synthesis (Cowan, 1999; Marcucci et al., 2001), accumulate in bacterial membranes causing energy depletion (Conner, 1993), or interfere the permeability of cell membrane which had a consequence a permeability increase and loss of cellular constituents, membrane disruption and changes the structure and function of key cellular constituents, resulting in mutation, cell damage, and death (Kim et al., 1995). Lin and Tang (2007) reported that phenolic and flavonoids contents in various fruits and vegetables help immune-modulator organs, killing the microorganisms. Medicinal plants used in the present study were known to possess various phenolic and flavonoids contents (Cha et al., 1997; Wu et al., 2010). Although, antibacterial mechanisms of medicinal plants

### Table 3. Minimum inhibition concentration (µg/ml) for the methanol extracts from leaves or root of 8 medicinal plants

| Microorganisms       | Methanol extracts |
|----------------------|-------------------|
|                      | SK-R<sup>a</sup> | SK-L | GJ | GS | SC-R | SC-L | AP-L | AP-R | HC-L | HC-R | PF | AR | RA<sup>b</sup> |
| Gram-negative bacteria |                   |      |    |    |      |      |      |      |      |      |    |    |              |
| *S. typhimurium*     | 9.76 156.2         | 78.12 | 12.2 | 156.2 | 78.12 | 0.6 | 1250 4.88 | 312.5 1250 | 156.2 0.31 |
| *E. coli*            | 9.76 156.2         | 78.12 | 9.76 | 312.5 | 78.12 | 0.6 | 1250 9.76 | 1250 156.2 | 156.2 0.62 |
| *P. aeruginosa*      | 39.0 156.2         | 2500 0.6 | 156.2 | 1250 4.88 | 2500 9.76 | 1250 5000 | - | - | 1250 156.2 | 1250 156.2 |
| *S. enteritidis*     | 78.12 156.2         | 78.12 | 625 | 1250 1250 | 1250 1250 | - | - | - | 1250 156.2 | 1250 156.2 |
| *K. pneumoniae*      | 78.12 78.12         | 78.12 | 4.88 | 39 | 1250 4.88 | 1250 9.76 | 312.5 312.5 | 1250 156.2 | 156.2 0.62 |
| *E. coli-O157:H7*    | 19.53 156.2         | 1250 | 1250 | 4.88 | 1250 9.76 | 1250 78.1 | 1250 78.1 | 1250 78.1 | 1250 156.2 | 1250 156.2 |
| *E. aerogenes*       | 9.76 156.2          | 1250 | 625 | 0.6 | 0.6 | 1250 0.6 | 78.12 4.88 | 4.88 78.1 | 156.2 156.2 | 156.2 156.2 |
| *P. mirabilis*       | 4.88 156.2          | 78.12 | 0.6 | 0.6 | 1250 0.6 | 78.12 4.88 | 2.44 1.22 | 1250 1250 | 1250 1250 | 1250 1250 |
| *S. dysenteriae*     | 9.76 156.2          | 1250 | 625 | 0.6 | 0.6 | 1250 0.6 | 19.53 1.22 | 1.22 19.53 | 0.6 0.6 | 0.6 0.6 |
| *P. vulgaris*        | 156.2 78.12        | 78.12 | 4.88 | 19.53 | 1250 9.76 | 156.2 156.2 | 9.76 4.88 | 156.2 0.31 |
| Gram-positive bacteria |              |      |    |    |      |      |      |      |      |      |    |    |              |
| *B. subtilis*        | 156.2 9.76         | 625 | 4.88 | 1250 | 1250 | 156.2 | 1250 19.53 | 2500 1250 | 1250 1250 | 1250 156.2 | 156.2 0.62 |
| *S. epidermidis*     | 312.5 9.76         | 1250 | 9.76 | 2500 | 625 | 78.12 | 1250 1250 | 1250 2500 | 156.2 156.2 | 156.2 156.2 |
| *S. aureus*          | 1250 78.12        | 2500 | 78.1 | 2500 | - | 156.2 | - | - | 5000 | - | 2.5 | |
| *L. monocytogenes*   | 78.12 156.2        | 78.12 | 0.6 | 0.6 | 1250 4.88 | 312.5 19.53 | 156.2 2500 | - | - | 2500 2500 | 2.5 |
| *B. cereus*          | 1250 156.2        | 156.2 | 39 | 78.12 | 1250 9.76 | 312.5 1250 | 312.5 1250 | 1250 1250 | 1250 1250 | 1250 1250 | 1250 1250 | 0.62 |

<sup>a</sup> SK-R: Sedum kamtschaticum root, SK-L: Sedum kamtschaticum leaf, GJ: Geum japonicum, GS: Geranium sibiricum, SC-R: Saururus chinensis root, SC-L: Saururus chinensis leaf, AP-R: Agrimonia pilosa root, AP-L: Agrimonia pilosa leaf, HC-R: Houttuynia cordata root, HC-L: Houttuynia cordata leaf, PF: Perilla frutescens, AR: Agastache rugosa.<br>
<sup>b</sup> RA: reference antibiotics (Gentamycin), (-): no inhibition.

Minimum bactericidal effects were exhibited with various degrees in all the methanol extracts. These effects were also observed on 15/15 microorganisms for SK-R, SK-L, GS, SC-R, and AR. The AR had only eleven (11/15) bactericidal potency. Mims et al. (1993) reported that the value of the lowest MBC obtained was not more four times higher than that of MIC’s on the corresponding pathogens, It seems possible that the sample tested was possessed the antimicrobial activity. The lowest MBC (1.22 µg/ml) was obtained in this study. This value not more than four times greater than that of the MIC’s on the corresponding microorganisms (Table 4). This data was supported by the other studies (Meyer and Lall, 2007; Kuete et al., 2007, 2008).
Table 4. Minimum bactericidal concentration (µg/ml) for the methanol extracts from leaves or root of 8 medicinal plants

| Microorganisms         | Methanol extracts |
|------------------------|-------------------|
|                        | SK-R<sup>a</sup> | SK-L | GJ | GS | SC-R | SC-L | AP-L | AP-R | HC-L | HC-R | PF | AR | RA<sup>b</sup> |
| Gram-negative bacteria  |                   |      |    |    |      |      |      |      |      |      |    |    |            |
| S. typhimurium         | 78.1             | 156.2 | 625 | 9.76 | 2500 | 625 | 2.44 | 5000 | 78.12 | 2500 | >5000 | 1250 | 0.62 |
| E. coli                | 78.1             | 78.12 | 312.5 | 78.12 | 2500 | 625 | 4.88 | 5000 | 156.2 | 2500 | >5000 | 1250 | 1.25 |
| P. aeruginosa          | 156.2            | 78.12 | 5000 | 2.44 | 1250 | 5000 | 39.0 | >5000 | 156.2 | 5000 | nt | nt | 0.62 |
| S. enteritidis         | 312.5            | 156.2 | 625 | 2500 | >5000 | 5000 | 5000 | 5000 | nt | nt | 5000 | 5000 | 2.5 |
| K. pneumoniae          | 312.5            | 625 | 1250 | 78.12 | 625 | 5000 | 39 | 2500 | 78.12 | 2500 | 2500 | 1250 | 1.25 |
| E. coli-O 157:H7       | 156.2            | 5000 | 2500 | 39 | 1250 | >5000 | 5000 | 4.88 | 2500 | 78.12 | 5000 | 625 | 5000 | 2.5 |
| E. aerogenes           | 78.12            | 5000 | 2500 | 1.22 | 2.44 | 2500 | 2.44 | 1250 | 39 | 39 | 1250 | 2500 | 1.25 |
| P. mirabilis           | 39               | 1250 | 312.5 | 1.22 | 1.22 | 5000 | 1.22 | 312.5 | 19.57 | 9.76 | >5000 | 9.76 | 1.25 |
| S. dysenteriae         | 156.2            | 2500 | 5000 | 2.44 | 1.22 | 5000 | 2.44 | 312.5 | 4.88 | 9.76 | 156.2 | 9.76 | 1.25 |
| P. vulgaris            | 625              | 625 | 625 | 78.12 | 625 | 78.12 | 1250 | 1250 | 78.12 | 39 | 1250 | 0.62 |
| Gram-positive bacteria  |                   |      |    |    |      |      |      |      |      |      |    |    |            |
| B. subtilis            | 625              | 78.12 | 2500 | 39 | 5000 | 2500 | 625 | 5000 | 5000 | >5000 | 500 | 5000 | 2.5 |
| S. epidermidis         | 1250             | 78.12 | 5000 | 156.2 | >9000 | 2500 | 1250 | 2500 | >5000 | 500 | 5000 | 2.5 |
| S. aureus              | 2500             | 1250 | >5000 | 1250 | >5000 | nt | 39 | nt | nt | nt | nt | 5 |
| L. monocytogenes       | 625              | 625 | 1250 | 2.44 | 2.44 | 5000 | 19.53 | 2500 | 312.5 | 2500 | 500 | 5000 | 5 |
| B. cereus              | 2500             | 625 | 625 | 625 | 625 | 1250 | 5000 | 625 | 2500 | 2500 | 500 | 5000 | 2.5 |

<sup>a</sup>: SK-R; Sedum kamtschaticum root, SK-L; Sedum kamtschaticum leaf, GJ; Geum japonicum, GS; Geranium sibiricum, SC-R; Saururus chinesis root, SC-L; Saururus chinesis leaf, AP-L; Agrimonia pilosa root, AP-R; Agrimonia pilosa leaf, HC-R; Houttuynia cordata root, HC-L; Houttuynia cordata leaf, PF; Perilla frutescens, AR; Agastache rugosa.<br>
<sup>b</sup>: RA; reference antibiotics (Gentamycin), nt; not tested because the MIC was not determined.

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used in this study against various microorganisms were not fully illustrate, we suggest that one of the mechanisms above mentioned play an important role in their antibacterial activity. From these findings, we suggest that plant extracts used in this study may be become source for discovery of novel antibiotics agent from plant sources. But we also should consider the other reports that determination of MIC values and antibacterial activity were influenced by technical methods in each laboratory and bacterial inherent virulence and susceptibility and the result of in vitro should not apply directly to clinical field without in vivo study (Nikaido, 1996). Thus, it is important to keep in mind that in vitro and in vivo research must be conducted to evaluate the biological effects and the application in clinics of using different compounds formulations. Also, it is necessary that we must be consider the methods of plant extract because traditionally plant extract were prepared with water such as poultices, decoction and infusions. The plant extracts, However, used in current study were extracted with methanol.

In conclusion, We found that the methanol extracts from the 8 medicinal plants (leaf or root) had significant antimicrobial activity, Especially, GS, SC-R and AP-L which have the lowest MIC (0.6 µg/ml) on 7 microorganisms strains and showed antibacterial activity against all of the 15 microorganisms used in present study and would be interesting source for discovery of novel antibiotics agent from plant sources.
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