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# Chemical Composition and Antimicrobial Activity of Various Crude Extracts of Ginger (*Zingiber officinale* Roscoe.)

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**The aims of this study were to test the antibacterial activity and chemical composition of various crude extracts of ginger (*Zingiber officinale* Roscoe.). The extract was obtained using 50% aqueous - ethanol extraction solution to extract *Zingiber officinale*. The extract was prepared and evaluated for antimicrobial activity against six bacterial strains by determining minimum inhibitory concentration (MIC). The results revealed that the 50% aqueous - ethanol extract is potent in inhibiting bacterial growth of both gram-positive and gram negative bacteria. The chemical composition of *Zingiber officinale* was analyzed by gas chromatography/mass spectroscopy (GC/MS). Results of the present study sign the interesting assurance of designing a potentially active antibacterial agent from *Zingiber officinale*.**

**Key words:** *Zingiber officinale*, Chemical Composition, GC-MS, Antibacterial.

Plants and herbs consumed by humans may contain thousands of different chemicals like phenolic acid and flavonoid components. The effect of dietary phenolics is of great current interest due to their antioxidative and possible anticarcinogenic activities[1]. Phenolic acids and flavonoids also function as reducing agents, free radical scavengers, and quenchers of singlet oxygen formation [2]. Antioxidant compounds that scavenge free radicals help protect against degenerative diseases[3]. Phenolic components play important roles in the control of cancer and other human diseases. For example, ginger has long been used in traditional medicine as a cure for some ailments including inflammatory diseases[4]. It was found that flavonoids reduce blood-lipid and glucose, and enhance human immunity[5]. Flavonoids are also a kind of natural antioxidant substances capable of scavenging free superoxide radicals, thus displaying anti-aging properties and reducing the risk of cancer. At present, flavonoids are extracted, among other sources, from ginkgo leaves[6], kudzu root[7], lotus leaves[8] and ginger rhizomes and leaves[9]. Ginger is an important horticultural crop in tropical Southeast Asia. It produces a pungent, aromatic and bioactive rhizome that is valued all over the world either as a spice or herbal medicine. Ginger is known as a resource with high phenolic contents, wide availability and low price[10], and therefore, it can serve as a cheap and important food material. Ginger is a natural food component with many active phenolic compounds such as gingerol and shagaol, and it has been shown to have anti-cancer and antioxidant effects[11]. Gingerol may reduce nausea caused by motion sickness or pregnancy and may also relieve migraines[12].

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*Zingiberaceae* is among the plant families that are widely distributed throughout the tropics, particularly in Southeast Asia. It is an important natural resource that provides man with many useful products for food, spices, medicines, dyes, perfume and aesthetics[13]. Thailand is a country of high plant biodiversity as a result of its geographical position in the tropics and the climatic variation between north and south. There are 200 species of *Zingiberaceae* belonging to 20 genera found in Thailand. In recent years, several reports have been published concerning the composition and/or the biological properties (antimicrobial, antioxidant, anticancer and a stimulated effect on the immune system) of *Zingiberaceae* extracts[14-18]. These studies have emphasized the existence of marked chemical differences among oils extracted from different species or varieties. These variations are likely to influence the antimicrobial activity of the oil and are generally a function of three factors: genetically determined properties, the age of the plant and the environment.

In Asia, rhizomes of ginger varieties (family *Zingiberaceae*) have been widely used as spices in food or condiments[19]. The rhizomes are usually eaten raw or cooked as vegetables and used for flavouring foods. Traditionally, leaves of *Elettariopsis latiflora* (*Zingiberaceae*) have been used to relieve flatulence, to improve appetite and as an antidote to poisons[20]. In Japan, leaves of *Alpinia zerumbetare* sold after drying as an herbal tea, and are commonly used to flavour noodles and to wrap rice cakes in celebrations. In another study the diuretic and anti-ulcerogenic properties of *A. zerumbet* leaves have been reported[21].

A lot of extraction methods and analytical methods as spectrophotometry, high performance liquid chromatography, capillary electrophoresis, gas chromatography (GC) with flame ionization detection (FID), gas chromatography-mass spectrometry (GC-MS) are developed for plant active compounds study. The combination of an ideal separation technique (GC) with the best identification technique (MS) made GC/MS an ideal technique for qualitative and quantitative for volatile and semi-volatile compounds. In addition, the use of a proper extraction method is needed.

This study aimed to evaluate the antimicrobial activity of 50% ethanolic and methnol extracts of *Zingiber officinale* extracts and identify the active compounds of *Zingiber officinale* extract. The assessment might provide a basis for searching the potent active compounds for the antimicrobial related search and improve the therapeutic application of *Zingiber* species.

## MATERIALS AND METHODS

### Preparation of extracts

The Fresh Ginger (*Zingiber officinale*) roots, was purchased from a local market at Riyadh, Saudi Arabia. About 100 g of ginger were crushed in a mortar. Exactly 10 g of *Zingiber officinale* powder were soaked in 100 ml of 50%ethanol water with agitation at 40°C. The EtOH:$H_20$ extract was then filtered, evaporated under steam of nitrogen using sample concentrator model Techne DB.3 (Techne, UK). Exactly other 10 g of powder were extracted by Soxhlet unit with methanol. Aliquot of the extracts was resolved individually in 50% ethanol/water and methanol respectively, to a final concentration of 1.0 mg/mL.

### Analysis and identification of compounds

The identification of compounds of *Zingiber officinale* extract was carried out by gas chromatography mass spectrometry (GC/MS) series Agilent 7890 with Ion-trap series 240 (Agilent Technologies, USA) (Agilent Technologies, J&W Scientific Products, Palo Alto,CA, USA), equipped with an Agilent Technologies capillary DB-5MS column (30 m length; 0.25 mm i.d.; 0.25µm film thickness), GC inlet was split/splitless injector used in the splitless mode, inlet temperature was 250°C.

The carrier gas was He and was used at 1 mL $min^{-1}$ flow rate. The oven temperature program was as follows: 2 min at 100°C ramped from 100 to 150°C at 5°C $min^{-1}$ and 1 min at 200°C. then ramped from 200 to 260°C at 5°C $min^{-1}$, total run time 40 min. Filament delay, 4 min; ionization voltage 70 eV; emission current 10A; scan rate 1 scan/s; mass range 70-500 m/z; ion source temperature 200°C all Agilent, Santa Clara, CA). Identification of components was assigned by matching their mass spectra with Wiley and NIST library data, standards of the main components and comparing their Kovats Retention Indices (KRI) with reference libraries[22, 23] and from the literature. The component concentration was obtained by semi-quantification by peak area integration from GC peaks and by applying the correction factors.

**Microorganisms**

The organisms which are used for the antimicrobial activity evaluation were obtained from the Microbiology laboratory, Department of life science, faculty of science, King Saud University. They were; *Bacillus subtilis* IMG 22, *Staphylococcus aureus* ATCC 2491, *Proteus vulgaris* FMC1, *Escherichia coli* ATCC 25912, *Pseudomonas aeruginosa* DSM 50071, *Klebsiella pneumonia* FMC 5, and *Listeria monocytogenes* SCOOT A. They were maintained as pure cultures in respective specific agar slants at 4°C.

**Culture medium and inoculum**

The tested original strains are activated formerly with the corresponding medium slant. Cell suspensions were prepared by inoculation of each bacterium into 10 ml of sterile saline solution in a test tube by inoculation loop and then vortexed and oscillated into the bacterial suspension standby. Incubation was performed at 37 °C for 24 h. Muller Hinton Agar (MHA) (Difco, USA) was prepared and cooled to 45 °C. Bacterial suspension was added into MHA to give a final concentration of 107 CFU/ml and plated out.

**Antibacterial susceptibility studies**

Disc diffusion method was used for antibacterial susceptibility test[24]. Filter paper discs of 5.0 mm diameter were prepared and sterilized by autoclaving. Each of the prepared discs was found to absorb a maximum volume of 0.052 mg/ml. Therefore, 1000 mg/ml /2 mg/ml solution of each of the extract was prepared by dissolving 1.0g (1000 mg) of the extracts in 2 mls of the suitable solvents. The test extract was placed on the filter paper disc in different concentrations (1000, 500 and 250 mg/ml) and then allowed to dry. The alcoholic extracts were reconstituted in Di-Methyl Sulphoxide (DMSO). Then 500 mg/ml and 250 mg/ml solution of the extract were prepared from the original 1000 mg/ml concentration by double dilution procedure. The cultures were enriched in sterile nutrients broth for 6 - 8 h at 37°C using sterile cotton swabs; the cultures were aseptically swabbed on the surface of sterile Muller-Hinton plates using an ethanol dipped and flamed forceps, the antibiotic discs were aseptically placed on the upper layer of the seeded MHA plates sufficiently separated from each other to keep away from overlapping of inhibition zones. The plates were incubated in an upright position at 37°C for 24 h. The diameters of the zones of inhibition appearing around the discs were measured to the nearest millimeter (mm) and the results were recorded. Discs less than 7 mm diameter are considered as having no antibacterial activity. Diameter between 7 and 12 were considered as moderate active and those with > 12 mm were considered as highly active. Streptomycin (10 ?g/disc) was used as positive control and negative control was prepared using respective solvent. All of the susceptibility tests were performed in triplicate and expressed as average value.Inhibition zones when present were measured in millimeter (Table 2).

**Antimicrobial activity assay**

The Antimicrobial activities were determined by Kirby Bauer Disc diffusion method described by Bauer *et al.* 1966[25]. The extracts were prepared and the sterile blotting paper disc (5 mm) was soaked in the diluted extract in two different final concentrations (50 µl and 100 µl/disc). The prepared disc were dried in controlled temperature (at 37 °C overnight) to remove excess of solvent and used for study.

**Determination of Minimum Inhibitory Concentrations (MIC)**

The antimicrobial activity of the *Zingiber officinale* extract, that shows antimicrobial activity, were determined using microdilution broth method as described by Brantner and Grein, 1994[26]. Different antibiotics [Ampicillin, amikacin, gentamicin, kanamycin, and tetracycline (10-32 µg/ml)] were used as reference standards (CLSI, 2011). The *Zingiber officinale* extract solution was prepared to obtain final concentrations of 0.25-2.0 mg/ ml for antibacterial testing. One microliter of an overnight culture of each bacterial strain, containing approximately 104 CFU, was applied onto a 96-well microtiter plate in the presence of MHB. The microtiter plates were incubated at 35 °C for 18 h. Observations were performed at least in replicate and results were expressed as the lowest concentration of plant extracts that produced a complete suppression of colony growth, MIC.

## RESULTS AND DISCUSSION

With the increase in the incidence of resistance to antibiotics, alternative natural products of plants could be of interest. Some plant

extracts and phytochemicals are known to have antimicrobial properties, which could be of great importance in the therapeutic treatments. In the last years, various studies have been conducted in different countries, demonstrating the efficacy of this type of treatment[27]. These ginger are a rich source of fiber and protein. The fiber may be further classed as gum (gel fiber) and neutral detergent fiber. The protein fraction contains the amino acid 4-hydroxyisoleucine, which has been proven to stimulate insulin production. Whole *Zingiber officinale* also contain 4.8% saponins. *Zingiber officinale* saponins are of steroidal nature (type furostanolsaponins) with diosgenin as the principal steroidal saponin.

The 50% aqueous-ethanol extract of *Zingiber officinale* was screened for their antimicrobial activity at three different concentration (50,250 and 1000 µg/ml) against *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumonia* and *Listeria monocytogenes*. The results showed that the growth of *B. cereus* and *S. aureus* was inhibited at a MIC value of 72.5 and 41.25µg/ml respectively, followed by *E. coli, P. vulgaris* and *K. pneumonia,* while *Ps. aeruginosa* showed highest MIC value of 89.25µg/ml. The poor activity of the 50 % ethanol/water extract against most bacterial strains investigated in this study is in agreement with previous reports[28,29]. This could be due to the insolubility of the active compounds in water or the hot water could have caused denaturation of the active compounds. It is also observed from the results that the ethanol/water extract had wide antibacterial activity (Table 1) against both gram positive and gram negative bacteria *S. aureus* and *S. typhi*, respectively, (Table 2). The activity of the extracts against the Gram negative bacteria is noteworthy as these bacteria are known to exhibit high degree of resistance to conventional antibiotics[30]. The few variations in results between the disc diffusion and MIC results can be due to the different susceptibility of the bacterium to the plant extract, the rate of growth of bacteria, solvents used to extract the plant compounds and the rate of extract diffusion[31].

**Table 1.** Mean inhibition zone diameter (mm) of 50% aqueous-ethanol and methanolic of *Zingiber officinaleon* tested microorganisms by disc diffusion method with respect to various concentrations in µg/ml.

| | Eth./$H_2O$ Extract (µg/ml) | | | Eth. Extract (µg/ml) | | |
|---|---|---|---|---|---|---|
| Bacteria | 250 | 500 | 1000 | 250 | 500 | 1000 |
| *Bacillus subtilis* | 7.0 | 8.5 | 9.0 | 6.0 | 6.0 | 7.0 |
| *Staphylococcus aureus* | 6.0 | 7.0 | 8.0 | - | - | 6.0 |
| *Proteus vulgaris* | 4.0 | 5.0 | 6.5 | - | - | - |
| *Escherichia coli* | 6.0 | 7.0 | 9.5 | 6.0 | 6.0 | 7.5 |
| *Pseudomonas aeruginosa* | 6.0 | 7.0 | 8.0 | - | - | - |
| *Bacillus subtilis* | 7.0 | 8.5 | 9.0 | 6.0 | 6.0 | 7.0 |

**Table 2.** Minimal inhibitory concentration (MIC) of 50% ethanolic extract of ginger (*Zingiber officinale*) roots against different strains. (µg/ml)

| Bacteria | MIC |
|---|---|
| *Bacillus subtilis* | 62.50 |
| *Staphylococcus aureus* | 31.25 |
| *Proteus vulgaris* | 31.25 |
| *Escherichia coli* | 62.50 |
| *Pseudomonas aeruginosa* | 31.25 |
| *Klebsiella pneumonia* | 62.50 |
| *Listeria monocytogenes* | 31.25 |

**Antibacterial activity of Ethanol and Ethanol/Water extracts**

Tha antibacterial activity of ginger with two types of extracts against different organisms is shown in table #. All the ethanolic extracts showed varying diameter zone of inhibition with the different test organisms. The concentration of 1000 mg/ml is the most effective and gave the widest inhibition zone of 9.5 mm. *Escherichia coli, Klebsiella pneumonia* and *Bacillus subtilis* were sensitive with ethanolic and ethanol/$H_2O$ extracts of ginger with 1000 mg/ml concentration.

Pseudomonas aeruginosa and Proteus vulgaris were mild sensitive with ethanolic extracts of ginger but there was no inhibition with the etanol/$H_2O$ extract. The MIC of ethanolic extract of ginger roots against different organisms is shown in Table 2. The MIC of ginger extract against the test isolates ranged from 31.25- 62.5 mg/mL. The MIC results of different extracts were gotten from the extrapolation diameter zone of inhibition of the concentration. For this reason the MIC of etanol/$H_2O$ extract was

**Table 3.** Identified compounds of 50% aqueous-ethanol extract of *Zingiber officinale*

| # | Retention Time (min.) | Compound name | Mol. wt. | Molecular Formula | % of Total |
|---|---|---|---|---|---|
| 1 | 10.462 | Vanillin | 152 | $C_8H_8O_3$ | 0.45 |
| 2 | 11.077 | β-Caryophyllen | 204 | $C_{15}H_{24}$ | 9.248 |
| 3 | 11.897 | α-Caryophyllene | 204 | $C_{15}H_{24}$ | 0.856 |
| 4 | 12.873 | Guaia-1(10),11-diene | 204 | $C_{15}H_{24}$ | 1.552 |
| 5 | 13.075 | Methyl 4,7,10,13-hexadecatetraenoate | 262 | $C_{17}H_{26}O_2$ | 0.96 |
| 6 | 13.364 | cubedol | 222 | $C_{15}H_{26}O$ | 1.526 |
| 7 | 14.18 | Elemol | 222 | $C_{15}H_{26}O$ | 2.13 |
| 8 | 14.421 | trans-Nerolidol | 222 | $C_{15}H_{26}O$ | 2.873 |
| 9 | 15.12 | Caryophyllene oxide | 220 | $C_{15}H_{24}O$ | 3.572 |
| 10 | 16.221 | (-)-Spathulenol | 220 | $C_{15}H_{24}O$ | 3.72 |
| 11 | 16.677 | .(-)-Cedreanol | 222 | $C_{15}H_{26}O$ | 2.353 |
| 12 | 16.738 | Triethyl citrate | 276 | $C_{12}H_{20}O_7$ | 1.546 |
| 13 | 16.913 | β-Eudesmol | 222 | $C_{15}H_{26}O$ | 0.777 |
| 14 | 16.99 | α-acorenol | 222 | $C_{15}H_{26}O$ | 0.698 |
| 15 | 17.111 | (2E)-3-(1,3-Benzodioxol-5-yl)-2-propenal | 176 | $C_{10}H_8O_3$ | 0.691 |
| 16 | 18.72 | 4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol | 180 | $C_{10}H_{12}O_3$ | 1.44 |
| 17 | 21.416 | Dibutyl phthalate | 278 | $C_{16}H_{22}O_4$ | 0.83 |
| 18 | 22.074 | Benzoisofuran-1-one | 346 | $C_{17}H_{18}N_2O_4S$ | 0.438 |
| 19 | 22.539 | 2,2,4-Trimethyl-4-(2-methyl-2-propenyl)hexahydro-cyclopropa[cd]pentalene-1,3-dione | 232 | $C_{15}H_{20}O_2$ | 1.142 |
| 20 | 23.032 | 8-Hydrazino-1,3,7-trimethyl-3,7-dihydro-purine-2,6-dione | 224 | $C_8H_{12}N_6O_2$ | 13.526 |
| 21 | 23.493 | Palmitic acid | 256 | $C_{16}H_{32}O_2$ | 0.75 |
| 22 | 24.236 | Ethyl palmitate | 284 | $C_{18}H_{36}O_2$ | 0.177 |
| 23 | 26.922 | 1-Cinnamoylpiperidine | 215 | $C_{14}H_{17}NO$ | 2.334 |
| 24 | 27.006 | (3E)-4-(2,2,6,7-Tetramethyl-7-azabicyclo[4.1.0]hept-1-yl) | 221 | $C_{14}H_{23}NO$ | 1.867 |
| 25 | 27.181 | Linoleic acid | 280 | $C_{18}H_{32}O_2$ | 0.621 |
| | | -3-buten-2- | | | |
| 26 | 27.281 | cis-8,11,14-Eicosatrienoic Acid | 306 | $C_{20}H_{34}O_2$ | 1.22 |
| 27 | 27.447 | N-Cyclodecylidenecy- | 235 | $C_{16}H_{29}N$ | 7.148 |
| | | -clohexanamine | | | |
| 28 | 27.641 | n-Propyl linoleate | 322 | $C_{21}H_{38}O_2$ | 1.143 |
| 29 | 27.74 | α-Glyceryllinolenate | 352 | $C_{21}H_{36}O_4$ | 1.396 |
| 30 | 33.691 | Octyl phthalate | 390 | $C_{24}H_{38}O_4$ | 7.617 |
| 31 | 35.312 | 3-Phenoxybenzaldehyde | 198 | $C_{13}H_{10}O_2$ | 4.454 |
| 32 | 36.243 | 4-(1,3-Dimethyl-3-butenyl) phenyl methyl ether | 190 | $C_{13}H_{18}O$ | 18.868 |
| | | NI | | | 2.1 |

NI: Not identified

terminated due to the low effect and low zone of inhibition.

The MIC as low as µg $mL^{-1}$ of a semi-purified fraction against gram negative and positive bacteria is suggestive of good antibacterial potential of the compounds of ginger roots. Hence *Zingiber officinale* may yield potential molecules in the treatment of infections caused by pathogenic bacteria which have developed resistance against the known antibiotics, Singleton, 1999[32].

**Table 4.** Identified compounds of 50% aqueous-ethanol extract of *Zingiber officinale*

| # | Retention Time (min.) | Compound name | MW | Formula | % of Total |
|---|---|---|---|---|---|
| 1 | 12.401 | α-Curcumene | 202 | $C_{15}H_{22}$ | 11.611 |
| 2 | 12.746 | Zingiberene | 204 | $C_{15}H_{24}$ | 3.297 |
| 3 | 13.087 | α-Himachalene | 204 | $C_{15}H_{24}$ | 2.148 |
| 4 | 13.518 | β-Sesquiphellandrene | 204 | $C_{15}H_{24}$ | 6.59 |
| 5 | 14.424 | trans-Nerolidol | 222 | $C_{15}H_{26}O$ | 0.972 |
| 6 | 14.732 | 4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol | 180 | $C_{10}H_{12}O_3$ | 1.826 |
| 7 | 15.826 | cis-sesquisabinene hydrate | 222 | $C_{15}H_{26}O$ | 1.61 |
| 8 | 16.328 | Alloaromadendrene oxide-(1) | 220 | $C_{15}H_{24}O$ | 1.76 |
| 9 | 16.535 | Zingiberone | 194 | $C_{11}H_{14}O_3$ | 42.183 |
| 10 | 16.915 | β-Eudesmol | 222 | $C_{15}H_{26}O$ | 2.05 |
| 11 | 17.3 | 1-(4-Methoxyphenyl)-1,5-pentanediol | 210 | $C_{12}H_{18}O_3$ | 0.573 |
| 12 | 17.592 | 6-Hydroxy-3,5a-dimethy--loctahydrocyclopenta [c]pentalen-2(1H)-one | 208 | $C_{13}H_{20}O_2$ | 2.029 |
| 13 | 17.8 | Methyl 2,5-octadecadiynoate | 290 | $C_{19}H_{30}O_2$ | 3.521 |
| 14 | 18.745 | Longipinocarveol, trans- | 220 | $C_{15}H_{24}O$ | 0.666 |
| 15 | 18.973 | 2-Methyl-5-(1,2,2-trimethylcyclopentyl)phenol | 218 | $C_{15}H_{22}O$ | 0.97 |
| 16 | 20.362 | Diepicedrene-1-oxide | 220 | $C_{15}H_{24}O$ | 1.66 |
| 17 | 21.577 | trans-Z-α-Bisabolene epoxide | 220 | $C_{15}H_{24}O$ | 1.225 |
| 18 | 22.125 | Corymbolone | 236 | $C_{15}H_{24}O_2$ | 0.304 |
| 19 | 26.489 | Methyl linoleate | 294 | $C_{19}H_{34}O_2$ | 1.095 |
| 20 | 28.539 | Gingerol | 294 | $C_{17}H_{26}O_4$ | 10.43 |
| | | NI | | | 3.48 |

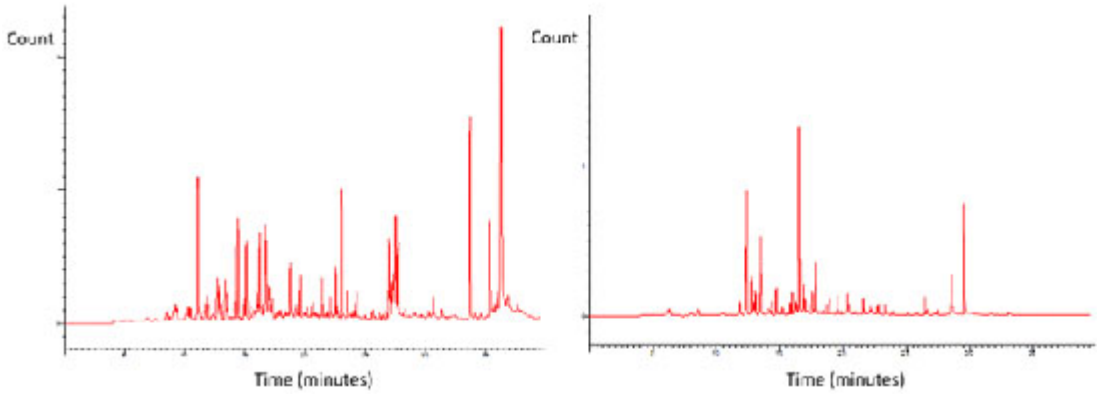


**Fig. 1.** Typical GC/MS chromatogram of two different extraction methods (a) shaking extraction method using 50% ethanol/water and (B) Soxhlet extraction method using ethanol of Ginger (*Zingiber officinale* Roscoe)

**Chemical composition of *Zingiber officinale* extract**

Fig. 1 presented the typical GC/MS chromatograms of compounds were recorded in 50% ethanolic and methanol extracts as indicated in Table 4. Most of these identified compounds are playing a role in the biological activity of natural extracts. Some of these compounds are reported for the first time in *Zingiber officinale*.

The major compounds characterized in 50% ethanol/water extract were ?-Caryophyllen (9.248), (-)-Spathulenol (3.72), 8-Hydrazino-1,3,7-trimethyl-3,7-dihydro-purine-2,6-dione (13.526), N-Cyclodecylidenecyclohexanamine (7.148), Octyl phthalate (7.617), 3-Phenoxybenzaldehyde (4.454) and 4-(1,3-Dimethyl-3-butenyl)phenyl methyl ether (18.868). The identified compounds in *Zingiber officinale* extract were given in (Table 3&4). Phenolic compound and one of the major flavour compounds. Phenolic compounds were found to inhibit the cell growth and fermentation and used as antioxidant[23, 32]. Furthermore, its derivatives have also been used for therapeutic purposes. For instance, Hydroxymethylfurfural is a potential candidate for treating sickle cell anemia[22]. Gingerol, has been found to possess many interesting pharmacological and physiological activities, such as anti-inflammatory, analgesic, and cardiotonic effects. Gingerone results from the thermal degradation of gingerols during extraction[33]. 7-Ethyl-4-decen-6-one (9.73%), Lineoleoyl chloride (8.54%), Linoleic acid (6.37%), 2,5-Octadecadiynoic acid, methyl ester (5.57%) also play a role in the activity of *Zingiber officinale* extracts. While for the first time we identified Palatinol A (4.81%) in *Zingiber officinale*extracts. *Zingiber officinale* extract were found to contain small amounts of other compounds, this in line with other investigators[34].

## CONCLUSION

In conclusion, our study was one of very few studies have confirmed that the antimicrobial activity of *Zingiber officinale* extract against certain microorganisms. Results of this study showed that the have found for the first time that ginger roots extracts are effective in inhibiting thegrowth of *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumonia* and *Listeria monocytogenes*. Remarkably, they elicited no effects on immortalized normal human foreskin fibroblasts cells and nonmalignant epithelial breast cells. Triterpenic acids resulted the bioactive compounds present in the most effective extracts (ZE2 and ZE4). Our data provide a strong rationalbase for the use in Traditional Chinese Medicine of ginger extracts in the treatment of cancers. Moreover, our results highlight that *Zingiber officinale* are valuable roots rich in bioactive compounds with potential human health benefits. More experiments are in progress to understand the molecular targets and pathways affected by *Zingiber officinale*.

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