Available online on www.ijtpr.com
International Journal of Toxicological and Pharmacological Research 2016; 8(6); 434-439

ISSN: 0975-5160

Research Article

Study of Bioactive Methanolic Extract of *Camponotus fellah* Using Gas Chromatography – Mass Spectrum

Jenan Mohammed Ubaid[1], Mohanad Jawad Kadhim[2], Imad Hadi Hameed[3*]

[1]*Department of Biology, College of Science for women, University of Babylon, Iraq*
[2]*College of Biotechnology, Department of Genetic Engineering, Al-Qasim Green University, Iraq*
[3]*College of Nursing, University of Babylon, Iraq*

Available Online: 25th December, 2016

ABSTRACT
GC-MS analysis of *Camponotus fellah* revealed the existence of the Cyclopentaneacetaldehyde ,2-formyl-3-methyl-α-methylene-, Cyclohexene, 1-methyl-5-(1-methylethenyl)-,(R)-, Bicyclo[5.1.0]octane, 8-methylene-,5-Methyl-6-phenyltetrahydro – 1,3-oxazine-2-thione, Decane, 1-Heptanol, 2-propyl, Octane, -4-methyl, Cyclopentanol, 2-(2-propynyloxy)-, trans-, Hydroxylamine, O-decyl, Trans-2-Ethyl-2-hexen-1-ol, Cyclopropene,1-methyl-3-(2-methylcyclopropyl)-, 10-methyl-endo-tricyclo[5.2.1.0(2.6)]decane, Undecen-1-yne, (Z, Exo-Norbornyl propionate, 5,8,10-Undecatrien-3-ol, 3-Methylene-bicyclo[3.2.1]oct-6-en-8-ol, Cyclohexane, 1,3-butadienylidene- , Cyclopropane. -1-methyl-1-ethenyl-2-(2-furyl)-, Pyrroline, 1,2-dimethyl, Cyclooctene-1-carboxaldehyde, Cyclopentanol,1-(1-methylene-2-propenyl)-, Eicosanoic acid, phenylmethyl ester, Octahydrochromen-2-one, Methyl 12-oxo-9-dodecenoate, 14-Methylpentadec-9-enoic acid methyl ester, 10-Octadecenoic acid, methyl ester, 9-Octadecenoic acid (Z)-, phenylmethyl ester, 14-Octadecenal, Butyl 9-tetradecenoate. *Camponotus fellah* produce many important secondary metabolites with high biological activities.

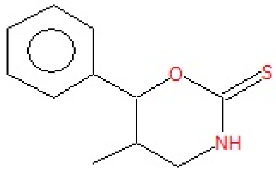
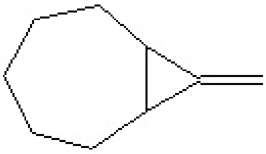
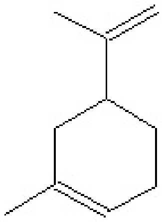
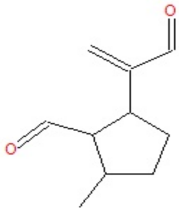
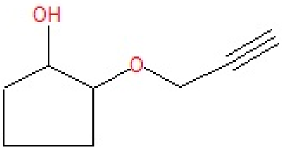
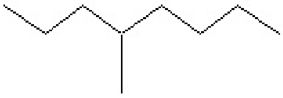
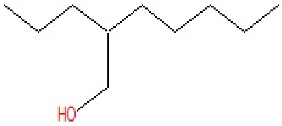
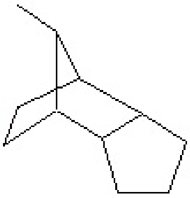
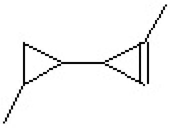
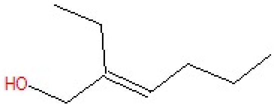
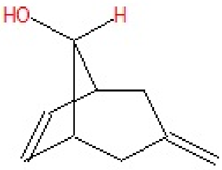
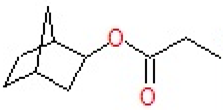
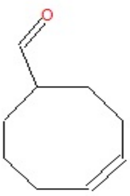
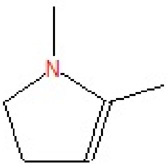
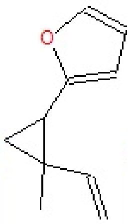
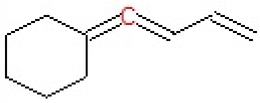
Keywords: Bioactive compounds, *Camponotus fellah*, GC-MS, Insect.

INTRODUCTION

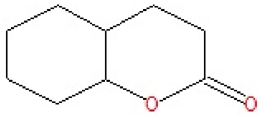
C. fellah is a large species of *Tanaemyrmex*, with accentuated ground sculpture (major worker is mostly matte) and prismatic hindtibia that is provided ventrally with a row of bristles[1,2]. *C. fellah* is similar to *Camponotus xerxes*, *Camponotus thoracicus sensu lato*, and *Camponotus oasium* from which it differs by the presence of erect setae on the ventral head surface, as opposed to a lack of such setae. *C. fellah* is distributed in Syria and Lebanon, Jordan, Iraq, Iran, Egypt, and the Arabian Peninsula. It also showed that the cuticular hydrocarbon profile is polymorphic, and that its homogeneity within a colony is maintained by frequent exchanges of hydrocarbons between workers. Behavioural observations of resident workers, in their nest, towards nestmates reintroduced after isolation indicated that a short isolation period (3-5 days), which induced a minor change in hydrocarbon profile, provoked frequent trophallactic solicitations[3-6]. These were likely to permit the isolated ants to readjust their hydrocarbon profile to that of the ants in the mother colony. Longer isolation periods (20-40 days) induced a greater change in hydrocarbon profile and made the residents intolerant towards their introduced nestmates. Therefore, our results clearly support the existence of a Gestalt colony odour in C. fellah. They also show that since individual hydrocarbon production is dynamic, workers are obliged to exchange hydrocarbons continually (mainly by trophallaxis) in order to be in the Gestalt, and properly integrate into the colony. Copyright 2000. The Association for the Study of Animal Behaviour. Ants are widespread and abundant in almost every terrestrial ecosystem, yet surprisingly little is known about their reproductive ecology[7,8]. In many ant species, mating occurs in nuptial flights, in which males and females emerge from their maternal nest in order to mate and establish new colonies. Most ant species are exogamous and invest much energy and biomass in their reproductive castes, making the precise timing of nuptial flights also of paramount importance for their predators[9,10]. Synchronization among colonies could serve as an antipredator strategy by swamping the predator population. Such a reproductive strategy is known for many ant and termite species, as well as for tropical trees with mass flowering. In temperate latitudes, nuptial flights are brief, usually synchronized with meteorological events such as first rain of the season or an extremely hot day or concentrated at the beginning of summer or early fall. There are two main types of ant mating syndromes: (1) male aggregation, in which large swarms of male alates gather in aggregations that function as leks, at which the females arrive to select males. These gatherings tend to be short in time and are assumed to be synchronous across a large area and (2) female "calling," in which females attract males[11,12]. This

**Author for Correspondence: imad_dna@yahoo.com*

Table 1: Bioactive chemical compounds identified in methanolic extract of *Camponotus fellah*.

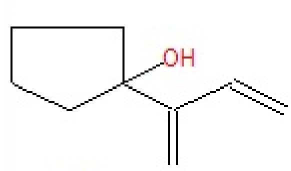
 5-Methyl-6-phenyltetrahydro – 1,3-oxazine-2-thione RT=4.231 MW=207.071785	 Bicyclo[5.1.0]octane , 8-methylene- RT=3.974 MW=122.1095505	 Cyclohexene, 1-methyl-5-(1-methylethenyl)-,(R)- RT=3.756 MW=136.1252	 Cyclopentaneacetaldehyde ,2-formyl-3-methyl-α-methylene- RT=3.156 MW=166.09938
 Cyclopentanol,2-(2-propynyloxy)- , trans- RT=4.701 MW=140.08373	 Octane, -4-methyl- Rt=4.672 Mw=128.156501	 1-Heptanol, 2-propyl- RT4.638 MW==158.167066	 Decane RT=4.586 MW=142.172151
 Anti-10-methyl-endo-tricyclo[5.2.1.0(2.6)]decan e RT=5.055 MW=150.140851	 Cyclopropene ,1-methyl-3-(2-methylcyclopropyl)- RT=4.941 MW=108.0939	 Trans-2-Ethyl-2-hexen-1-ol RT=4.781 MW=128.120115	 Hydroxylamine, O-decyl- RT=4.729 MW=173.177964
 3-Methylene-bicyclo[3.2.1]oct-6-en-8-ol RT=5.593 MW=136.088815	 5,8,10-Undecatrien-3-ol RT=5.496 MW=166.135765	 Exo-Norbornyl propionate RT=5.158 MW=168.115029	 3-Undecen-1-yne, (Z)- RT=5.084 MW=5.084
 4-Cyclooctene-1-carboxaldehyde RT=8.494 MW=138.1044655	 2-Pyrroline, 1,2-dimethyl- RT=8.111 MW=97.0891495	 Cyclopropane. -1-methyl-1-ethenyl-2-(2-furyl)-, RT=5.856 MW=148.088815	 Cyclohexane, 1,3-butadienylidene- RT=5.742 MW=134.1955

Methyl 12-oxo-9-dodecenoate
RT=14.388
MW=226.156895



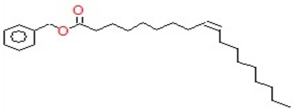
Octahydrochromen-2-one
RT=14.005
MW=154.09938

Eicosanoic acid, phenylmethyl ester
RT=13.512

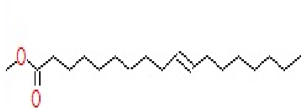


Cyclopentanol ,1-(1-methylene-2-propenyl)-
RT=9.507
MW=138.1044655

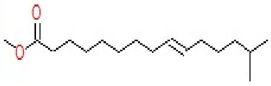
14-Octadecenal
RT=16.717
MW=266.260965



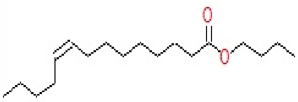
9-Octadecenoic acid (Z)-, phenylmethyl ester
RT=16.557
MW=372.30283



10-Octadecenoic acid ,methyl ester
RT=16.253
MW=296.27153



14-Methylpentadec-9-enoic acid methyl ester
RT=15.538
MW=268.24023



Butyl 9-tetradecenoate
RT=17.569
MW=282.25588

latter syndrome can last for very long periods or even year-round, with occasional males flying out in search of calling females. These species usually perform mass nuptial flights on spring afternoons, synchronized with a low-pressure system from North Africa that brings dry air and high temperatures ("sharav"), and is usually followed by a burst of rain[12]. Bioactive methanolic extract of *Camponotus fellah* using gas chromatography – mass spectrum was the aim of this study.

MATERIALS AND METHODS

The colonies of *C. fellah* were obtained by rearing newly mated queens collected in hillah in Abril 2015. They were maintained in a temperature-controlled room conditions. Colonies were installed in artificial plaster nests allowing direct observations of intranidal activities. Each nest was connected with a foraging area. The ants were fed with diet consisting of dead insects (mealworms, flies and moths) and sugar solution supplied twice a week. We used 15 colonies containing each one queen, at least 250 workers and abundant brood. We used as subjects media workers present in the foraging area. Laboratory culture of *C. fellah* was obtained from infested seeds from college of science for woman university of Babylon. The insects emerged after four weeks were used in entire investigation[13-18]. The extraction was performed by adding 100 ml methanol to the whole body insect powder. Methanol was used as solvent control.

Gas chromatography – mass spectrum analysis

GC-MS is a powerful technique used for many applications which has very high sensitivity and specificity. The GC-MS analysis of the insect (*C. fellah*) extract was made in a (Agilent 789 A) instrument under computer control at 70 eV. About 1μL of the methanol extract was injected into the GC-MS using a micro syringe and the scanning was done for 45 minutes[19-33]. The time from when the injection was made (Initial time) to when elution occurred referred to as the Retention time (RT). Helium gas was used as a carrier as well as an eluent. The flow rate of helium was set to 1ml per minute. Compounds were identified by comparing their spectra to those of the Wiley and NIST/EPA/NIH mass spectral libraries[34-44].

RESULTS AND DISCUSSION

Identification of biochemical compounds

Gas chromatography and mass spectroscopy analysis of compounds was carried out in methanolic extract of *C. fellah*, shown in Table 1. The GC-MS chromatogram of the peaks of the compounds detected was shown in Figure 1. Chromatogram GC-MS analysis of the methanol extract of *C. fellah* showed the presence of twenty nine major peaks and the components corresponding to the peaks were determined as follows. The set up peak were determined to be Cyclopentaneacetaldehyde,2-formyl-3-methyl-α-methylene-, Cyclohexene, 1-methyl-5-(1-methylethenyl)-, (R)-, Bicyclo[5.1.0]octane, 8-methylene-, 5-Methyl-6-phenyltetrahydro – 1,3-oxazine-2-thione, Decane, 1-

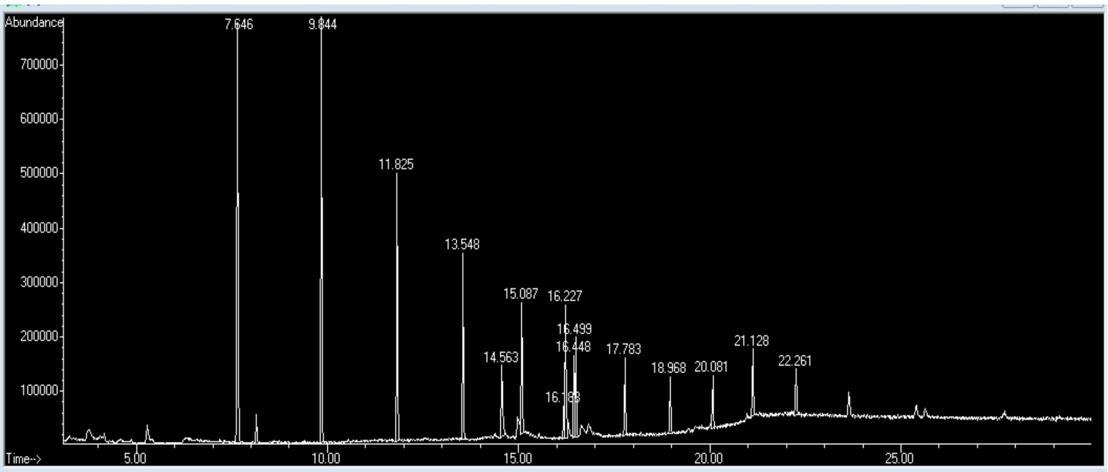


Figure 1: GC-MS chromatogram of methanolic leaves extract of *Camponotus fellah.*

Heptanol, 2-propyl, Octane, -4-methyl, Cyclopentanol, 2-(2-propynyloxy)-, trans-, Hydroxylamine, O-decyl, Trans-2-Ethyl-2-hexen-1-ol, Cyclopropene, 1-methyl-3-(2-methylcyclopropyl)-, 10-methyl-endo-tricyclo[5.2.1.0(2.6)]decane, Undecen-1-yne, (Z, Exo-Norbornyl propionate, 5,8,10-Undecatrien-3-ol, 3-Methylene-bicyclo[3.2.1]oct-6-en-8-ol, Cyclohexane, 1,3-butadienylidene-, Cyclopropane. -1-methyl-1-ethenyl-2-(2-furyl)-, Pyrroline, 1,2-dimethyl, Cyclooctene-1-carboxaldehyde, Cyclopentanol,1-(1-methylene-2-propenyl)- , Eicosanoic acid, phenylmethyl ester, Octahydrochromen-2-one, Methyl 12-oxo-9-dodecenoate, 14-Methylpentadec-9-enoic acid methyl ester, 10-Octadecenoic acid ,methyl ester, 9-Octadecenoic acid (Z)-, phenylmethyl ester, 14-Octadecenal, Butyl 9-tetradecenoate. AMPs are short bioactive molecules either cationic or non-cationic in nature with broad-spectrum antimicrobial effects against many pathogens. AMPs are short bioactive molecules either cationic or non-cationic in nature with broad-spectrum antimicrobial effects against many pathogens. They generally act in destabilizing the cell membrane permeability or interacting with the specific targets in cells which cause signaling pathway disruption. Interestingly, insect whole body is also an alternative source for the discovery of a new class of small AMPs which may have a role in processes other than immunity[45-50]. The AMP extraction from the whole body is governed by the following facts: (i) AMP production is not restricted to fat bodies and hemocytes, (ii) unknown physiological location of the molecules and (iii) small-sized body of insects. Initial peptide recovery from insect whole body requires the sample to be first subjected to homogenization. The beetle is known for attacking the cowpea (*Vigna unguiculata*), but it readily attacks other beans and peas such as the mung bean (*Vigna radiata*) and adzuki bean (*Vigna angularis*). The adult is more likely to seek the legume in which it developed as a larva, but if it is not available or less common, the beetle will utilize another type. Research devoted to the impact of immune responses on insect social behaviour is still at its beginning, especially in the case of ants. If we assume that both social relations and immune responses are costly, we will have to assume as well that each individual has to choose where to invest its energy. To throw more light on that question, we studied the relations between immune responses and social behaviour in the ant *Camponotus fellah*, a species known to engage in intense social interactions[51]. PGNs are the major component of the cell wall of Gram-positive organisms that confer to the cell wall great mechanical strength, eliciting immune reactions in the infected organisms[52,53].

CONCLUSION

Twenty nine bioactive chemical constituents have been identified from methanolic extract of the *Camponotus fellah* by GC-MS technique.

ACKNOWLEDGMENT

The authors thank the department of Medical Science in college of nursing for providing all necessary facilities to conduct this study.

REFERENCES

1. Advani R. Food and feeding ecology of the rat tailed bat in the Rajasthan Desert. *Act Theriol*. 1981; 26: 269–272.
2. Boomsma JJ, Baer BC, Heinze J. The evolution of male traits in social insects. *Annu Rev Entomol*. 2005; 50:395–420.
3. Brigham M. Prey selection by big brown bats (Eptesicus fuscus) and common nighthawks (Chordeiles minor). *Am Mid Nat*. 1990; 124:73–80.
4. Dunn RR, Parker C, Geraghty M, Sanders NJ. Reproductive phenologies in a diverse temperature ant fauna. *Ecol Entomol*. 2007; 32:135–142.
5. Folgarait PJ. Ant biodiversity and its relationship to ecosystem functioning: a review. *Bio Conserv*. 1998; 7:1221–1244.
6. Kelly D. The evolutionary ecology of mast seeding. *Trends Ecol Evol*. 1994; 9:465–470.
7. Tel TH, Whitaker JO, Wadanoli MD. Dietary energetics of the Mexican free-tailed bat (Tadarida brasiliensis) during pregnancy and lactation. *Oecologia* 1995; 101:107–115.

8. Kurta A, Bell GP, Nagy KA, Kunz TH. Energetics of pregnancy and lactation in free-ranging little brown bats—Myotis lucifugus. *Physiol Zool*. 1989; 62:804–818 140:41–52.
9. Schlitter DA, Qumsiyeh MB. Rhinopoma microphyllum. Mamm Spec. 1996; 542:1–5.
10. Sharifi M, Hemmati Z. Variation in the diet of the Greater mouse-tailed bat, Rhinopoma microphyllum (Chiroptera: Rhinopomatidae) in south-western Iran. *Zool Middle East*. 2002; 26:65–70.
11. Sparks WD, Valdez EW. Food habits of Nyctinomops macrotis at maternity roost in Mexico, as indicated by analysis of guano. *South Nat*. 2003; 48:132–135.
12. Van Schaik CP, Terborgh JW, Wright SJ. The phenology of tropical forests: adaptive significance and consequences for primary consumers. *Annu Rev Ecol Syst*. 1993; 24:353–377.
13. Kadhim MJ, Sosa AA, Hameed IH. Evaluation of anti-bacterial activity and bioactive chemical analysis of *Ocimum basilicum* using Fourier transform infrared (FT-IR) and gas chromatography-mass spectrometry (GC-MS) techniques. *International Journal of Pharmacognosy and Phytochemical Research*. 8(6), 127-146 (2016).
14. Mohammed GJ, Kadhim MJ, Hussein HM. Characterization of bioactive chemical compounds from *Aspergillus terreus* and evaluation of antibacterial and antifungal activity. *International Journal of Pharmacognosy and Phytochemical Research.* 2016; 8(6): 889-905.
15. Hameed IH, Altameme HJ, Idan SA. Artemisia annua: Biochemical products analysis of methanolic aerial parts extract and anti-microbial capacity. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2016; 7(2): 1843- 1868.
16. Hussein AO, Mohammed GJ, Hadi MY, Hameed IH. Phytochemical screening of methanolic dried galls extract of *Quercus infectoria* using gas chromatography-mass spectrometry (GC-MS) and Fourier transform-infrared (FT-IR). *Journal of Pharmacognosy and Phytotherapy*. 2016; 8(3): 49-59.
17. Sosa AA, Bagi SH, Hameed IH. Analysis of bioactive chemical compounds of *Euphorbia lathyrus* using gas chromatography-mass spectrometry and fourier-transform infrared spectroscopy. *International Journal of Pharmacognosy and Phytochemical Research*. 2016; 8(5): 109-126.
18. Altameme H J, Hadi MY, Hameed IH. Phytochemical analysis of *Urtica dioica* leaves by fourier-transform infrared spectroscopy and gas chromatography-mass spectrometry. *Journal of Pharmacognosy and Phytotherapy*. 2015; 7(10): 238-252.
19. Mohammed GJ, Omran AM, Hussein HM. Antibacterial and Phytochemical Analysis of *Piper nigrum* using Gas Chromatography-Mass Spectrum and Fourier-Transform Infrared Spectroscopy. *International Journal of Pharmacognosy and Phytochemical Research*. 2016; 8(6): 977-996.
20. Hamza LF, Kamal SA, Hameed IH. Determination of metabolites products by *Penicillium expansum* and evaluating antimicobial activity. *Journal of Pharmacognosy and Phytotherapy*. 2015; 7(9): 194-220.
21. Jasim H, Hussein AO, Hameed IH, Kareem MA. Characterization of alkaloid constitution and evaluation of antimicrobial activity of *Solanum nigrum* using gas chromatography mass spectrometry (GC-MS). *Journal of Pharmacognosy and Phytotherapy*. 2015; 7(4): 56-72.
22. Hadi MY, Mohammed GJ, Hameed IH. Analysis of bioactive chemical compounds of *Nigella sativa* using gas chromatography-mass spectrometry. *Journal of Pharmacognosy and Phytotherapy*. 2016; 8(2): 8-24.
23. Hameed IH, Ibraheam IA, Kadhim HJ. Gas chromatography mass spectrum and fourier-transform infrared spectroscopy analysis of methanolic extract of *Rosmarinus oficinalis* leaves. *Journal of Pharmacognosy and Phytotherapy*. 2015; 7 (6): 90-106.
24. Shareef HK, Muhammed HJ, Hussein HM, Hameed IH. Antibacterial effect of ginger (*Zingiber officinale*) roscoe and bioactive chemical analysis using gas chromatography mass spectrum. *Oriental Journal of Chemistry*. 2016; 32(2): 20-40.
25. Al-Jassaci MJ, Mohammed GJ, Hameed IH. Secondary Metabolites Analysis of *Saccharomyces cerievisiae* and Evaluation of Antibacterial Activity. *International Journal of Pharmaceutical and Clinical Research.* 2016; 8(5): 304-315.
26. Mohammed GJ, Al-Jassani MJ, Hameed IH. Anti-bacterial, Antifungal Activity and Chemical analysis of *Punica grantanum* (Pomegranate peel) using GC-MS and FTIR spectroscopy. *International Journal of Pharmacognosy and Phytochemical Research*. 2016; 8(3): 480-494.
27. Al-Marzoqi AH, Hadi MY, Hameed IH. Determination of metabolites products by *Cassia angustifolia* and evaluate antimicobial activity. *Journal of Pharmacognosy and Phytotherapy.* 2016; 8(2): 25-48.
28. Altameme HJ, Hameed IH, Abu-Serag NA. Analysis of bioactive phytochemical compounds of two medicinal plants, *Equisetum arvense* and *Alchemila valgaris* seed using gas chromatography-mass spectrometry and fourier-transform infrared spectroscopy. *Malays. Appl. Biol*. 2015b; 44(4): 47–58.
29. Hameed IH, Hamza LF, Kamal SA. Analysis of bioactive chemical compounds of *Aspergillus niger* by using gas chromatography-mass spectrometry and fourier-transform infrared spectroscopy. *Journal of Pharmacognosy and Phytotherapy*. 2015; 7(8): 132-163.
30. Hameed IH, Hussein HJ, Kareem MA, Hamad NS. Identification of five newly described bioactive chemical compounds in methanolic extract of *Mentha viridis* by using gas chromatography-mass spectrometry (GC-MS). *Journal of Pharmacognosy and Phytotherapy*. 2015; 7 (7): 107-125.

31. Hussein HM, Hameed IH, Ibraheem OA. Antimicrobial Activity and spectral chemical analysis of methanolic leaves extract of *Adiantum Capillus-Veneris* using GC-MS and FT-IR spectroscopy. *International Journal of Pharmacognosy and Phytochemical Research*. 2016; 8(3): 369-385.
32. Hussein HJ, Hadi MY, Hameed IH. Study of chemical composition of *Foeniculum vulgare* using Fourier transform infrared spectrophotometer and gas chromatography - mass spectrometry. *Journal of Pharmacognosy and Phytotherapy*. 2016; 8(3): 60-89.
33. Kadhim MJ, Mohammed GJ, Hameed IH. In *vitro* antibacterial, antifungal and phytochemical analysis of methanolic fruit extract of *Cassia fistula*. *Oriental Journal of Chemistry*. 2016; 32(2): 10-30.
34. Altameme HJ, Hameed IH, Idan SA, Hadi MY. Biochemical analysis of *Origanum vulgare* seeds by fourier-transform infrared (FT-IR) spectroscopy and gas chromatography-mass spectrometry (GC-MS). *Journal of Pharmacognosy and Phytotherapy*. 2015; 7(9): 221-237.
35. Hussein HM. Determination of phytochemical composition and ten elements content (CD, CA, CR, CO, FE, PB, MG, MN, NI AND ZN) of *CARDARIA DRABA* by GC-MS, FT-IR and AAS technique. *Int. J Pharm Bio Sci*. 2016;7(3): (B) 1009 – 1017.
36. Hussein HM. Analysis of trace heavy metals and volatile chemical compounds of *Lepidium sativum* using atomic absorption spectroscopy, gas chromatography-mass spectrometric and fourier-transform infrared spectroscopy. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2016; 7(4): 2529 – 2555.
37. Jaddoa HH, Hameed IH, Mohammed GJ. Analysis of volatile metabolites released by *Staphylococcus aureus* using gas chromatography-Mass spectrometry and determination of its antifungal activity. *Orient J Chem*. 2016;32(4).
38. Hameed IH, Salman HD, Mohammed GJ. Evaluation of antifungal and antibacterial activity and analysis of bioactive phytochemical compounds of *Cinnamomum zeylanicum* (Cinnamon bark) using gas chromatography-mass spectrometry. *Orient J Chem*. 2016; 32(4).
39. Kadhim MJ, Mohammed GJ, Hussein HM. Analysis of bioactive metabolites from *Candida albicans* using (GC-MS) and evaluation of antibacterial activity. *International Journal of Pharmaceutical and Clinical Research*. 2016; 8(7): 655-670.
40. Ubaid JM, Hussein HM, Hameed IH. Analysis of bioactive compounds of *Tribolium castaneum* and evaluation of anti-bacterial activity. *International Journal of Pharmaceutical and Clinical Research.* 2016; 8(7): 655-670.
41. Hameed IH, Jebor MA, Ommer AJ, Abdulzahra AI. Haplotype data of mitochondrial DNA coding region encompassing nucleotide positions 11,719–12,184 and evaluate the importance of these positions for forensic genetic purposes in Iraq. *Mitochondrial DNA*. 2016; 27(2): 1324-1327.
42. Hameed IH. A new polymorphic positions discovered in mitochondrial DNA hypervariable region HVIII from central and north-central of Iraq. *Mitochondrial DNA*. 2016; 27(5): 3250-4.
43. Mohammad A, Imad H. Autosomal STR: From locus information to next generation sequencing technology. Research Journal of Biotechnology. 2013.
44. Hameed, I.H., Abdulzahra, A.I., Jebor, M.A., Kqueen, C.Y., Ommer, A.J. Haplotypes and variable position detection in the mitochondrial DNA coding region encompassing nucleotide positions 10,716-11,184. *Mitochondrial DNA*. 2015.
45. Boulay, R., Hefetz, A., Soroker, V., Lenoir, A. Camponotus fellah colony integration: worker individuality necessitates frequent hydrocarbon exchanges. *Animal Behaviour*. 2000; 59: 1127–1133.
46. Altaee N, Kadhim MJ, Hameed IH. Detection of volatile compounds produced by *Pseudomonas aeruginosa* isolated from UTI patients by gas chromatography-mass spectrometry. *International Journal of Current Pharmaceutical Review and Research*. 2017; 7(6).
47. Altaee N, Kadhim MJ, Hameed IH. Characterization of metabolites produced by *E. coli* and analysis of its chemical compounds using GC-MS. *International Journal of Current Pharmaceutical Review and Research*. 2017; 7(6).
48. Hussein J H, Ubaid JM, Hameed IH. Gas chromatography – mass spectrum analysis of volatile components of methanolic leaves extract of *Cordia myxa. International Journal of Current Pharmaceutical Review and Research*. 2017; 7(6).
49. Kadhim MJ. *In Vitro* antifungal potential of *Acinetobacter baumannii* and determination of its chemical composition by gas chromatography-mass spectrometry. *Der Pharma Chemica*, 2016; 8(19): 657-665.
50. Al-Yaseri A, Kadhim WA, Hameed IH. Detection of volatile compounds emitted by *Proteus mirabilis* isolated from UTI patients and its anti-fungal potential. *Der Pharma Chemica*, 2016; 8(19): 671-678.
51. Stewarttull DE. The immunological activities of bacterial peptidoglycans. *Annual Review of Microbiology*. 1980; 34: 311–340.
52. Gundappa, S, Jayappa J, Chandrashekara K. Bioprospecting for antimicrobial peptides from insects: In vitro antimicrobial activity of acidified methanol extract of dung beetles. *Journal of Entomology Research*. 2012; 36: 41- 44.
53. Chernysh, HF, Kim SL, Bekker G, Pleskach VA, Filatova NA, Bulet P. Antiviral and antitumor peptides from insects. *Proceeding National Academy Science USA.* 2002; 99: 12628-12623.