



IMIDAZOLE-CYCLIC DERIVATIVES (PREPARATION, SPECTRAL STUDIES, MICROBIAL STUDIES)

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Abstract: The study aimed to prepare organic compounds that are more resistant to fungi, where antimicrobial resistance occurs when bacteria, viruses, fungi or parasites change their shape over time and do not respond to drugs, which poses a threat to health and development at the global level. New compounds have been prepared from heterocyclic imidazole rings, chalcone, and cyclic-chalcone compounds. Although some new antibiotics are being developed, none of them is expected to be effective in combating the most dangerous forms of antibiotic-resistant bacteria, but these compounds have been studied on several Different types of microbes, some prepared to know their effectiveness in eliminating microbes., Also organic identifications were carried out to supporting results in this study .

Keywords: imidazole, cycle, bacteria, microbe, medical, health

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INTRODUCTION

Organic compounds of wide fame in this field are imidazole derivatives and chalcone [1,2], which were used in the development of many anti-cancer, anti-bacterial, anti-viral, anti-fungal and antihypertensive drugs [3-5]. They were also used in the field of analytical chemistry to detect many transitional and non-transitional elements as organic ligands [6-9]. Among the organic compounds of great importance in many fields are chalcone-cycle compounds [10-13], which are famous for their wide use in inhibiting the growth of bacteria and germs [14-17], anti-corrosion and as organic reagents, which are used to detect many metal ions [18-22], whether transitional or non-transitional, and good extraction reagents for some transitional element ions from aqueous solution [23-25].

This type of biological compound has been widely used in recent times because of its distinct properties, as it is coordinated through a nitrogen atom [26-29], which has an empty orbital with an energy similar to the orbital of the donor atom of the same ring [30-33], and if these rings contain one or more substituted group in A suitable site for the azo group [34-37], chalcone, or imine qualifies for coordination through it, producing a chelated ligand in coordination chemistry or the field of biochemistry [38-40].

EXPERIMENTAL PART

It is known to us that any new chemical compound for which the evidence for its preparation is to prove its chemical composition by various means, including spectral and non-spectral, and the study of its vital behaviors, and this is what we have proven through several diagnostic methods that were carried out in this study which carried out in Asfahan university, as follows:

Production of Anile Compound {1}

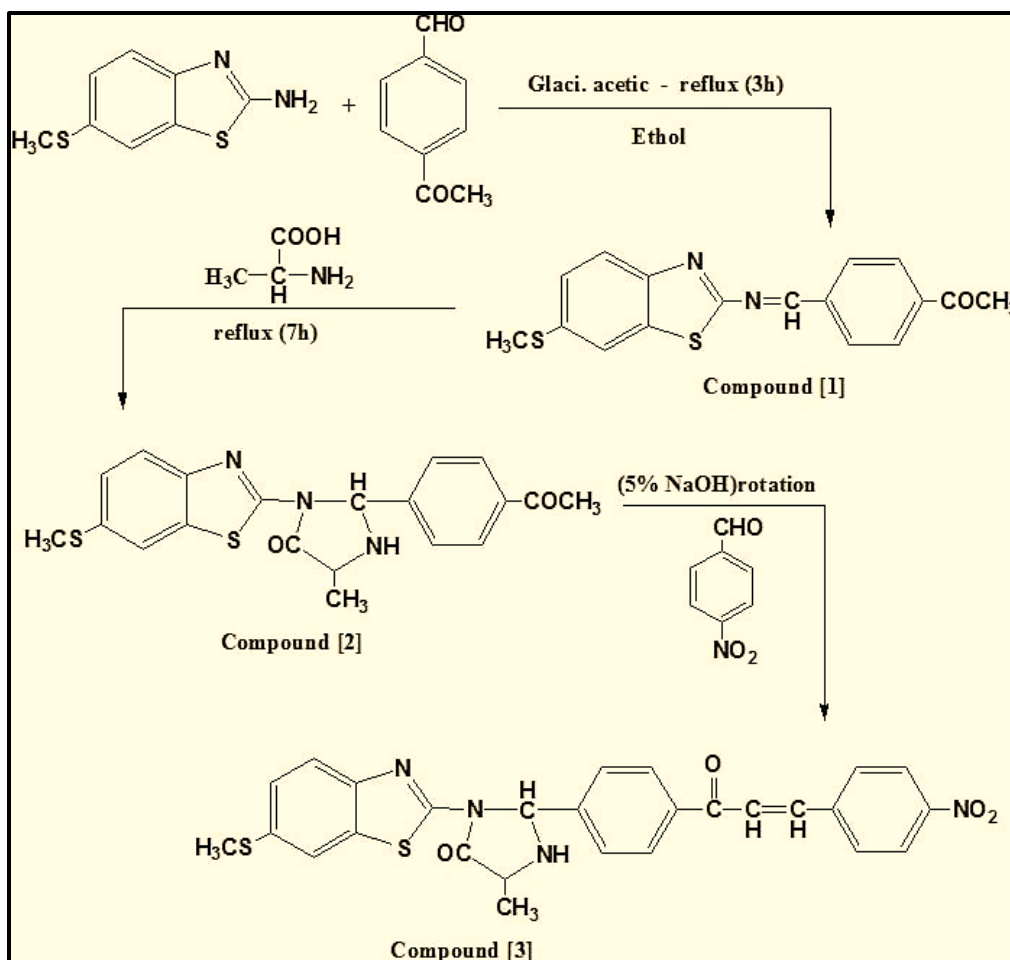
2-Amino-4-methyl sulfide benzothiazole (0.01) mole liquefied with (0.01) mole of p-acetobenzaldehyde in acidic medium, the resulted was separated, purified, desiccated to offer Anile compound {1} obliged to ways in references [6, 7].

Production of Imidazole Compound {2}

Anile-benzothiazole compound {1} (0.01) mole liquefied with (0.01) mole of alanine acid in condensation step for cyclization reaction through (7 hrs), the resulted was separated, purified, desiccated to offer Imidazole compound {2} obliged to ways in references [6, 7].

Production of Imidazole-Chalcone Compound {3}

Imidazole compound {2} (0.01) mole liquefied with (0.01) mole of p-nitro benzaldehyde in rotation process through (9 hrs) in basic medium, the resulted was separated, purified, desiccated to offer Imidazole-Chalcone compound {3} obliged to ways in references [6, 7].



Form.1: Production of Imidazole-Chalcone Compounds{1, 2, 3}

Production of Imidazole-Cyclic Compound {4}

Imidazole-Chalcone compound {3} (0.01) mole liquefied with (0.01) mole of thiourea in rotation process with refluxing through (6 hrs) in acidic medium, the resulted was separated, purified, desiccated to offer Imidazole-Cycle compound {4} obliged to ways in references [6, 7].

Production of Imidazole-Cyclic Compound {5}

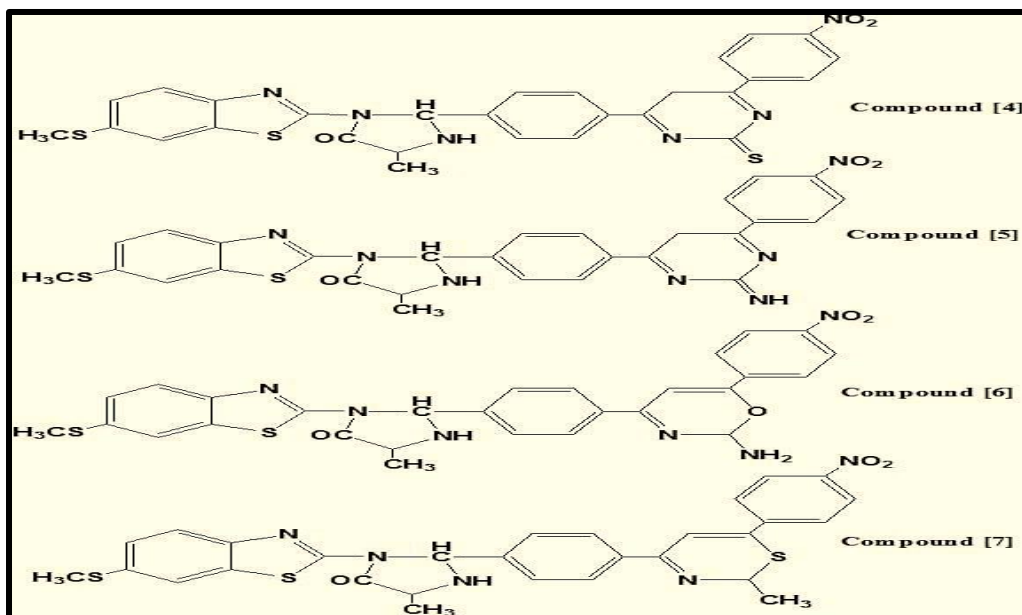
Imidazole-Chalcone compound {3} (0.01) mole liquefied with (0.01) mole of guanidine in rotation process with refluxing through (5 hrs) in acidic medium, the resulted was separated, purified, desiccated to offer Imidazole-Cycle compound {5} obliged to ways in references [6, 7].

Production of Imidazole-Cyclic Compound {6}

Imidazole-Chalcone compound {3} (0.01) mole liquefied with (0.01) mole of urea in rotation process with refluxing through (5 hrs) in acidic medium, the resulted was separated, purified, desiccated to offer Imidazole-Cycle compound {6} obliged to ways in references [6, 7].

Production of Imidazole-Cyclic Compound {7}

Imidazole-Chalcone compound {3} (0.01) mole liquefied with (0.01) mole of thioacetamide in rotation process with refluxing through (5 hrs) in acidic medium, the resulted was separated, purified, desiccated to offer Imidazole-Cycle compound {7} obliged to ways in references [6, 7].



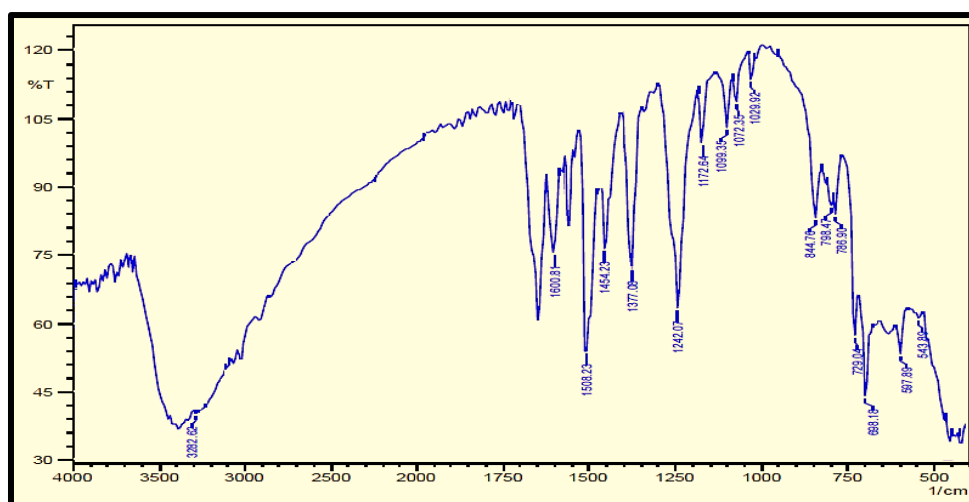
Form.2: Production of Imidazole-Cycles Compounds{4, 5, 6, 7}

RESULTS AND DISCUSSION

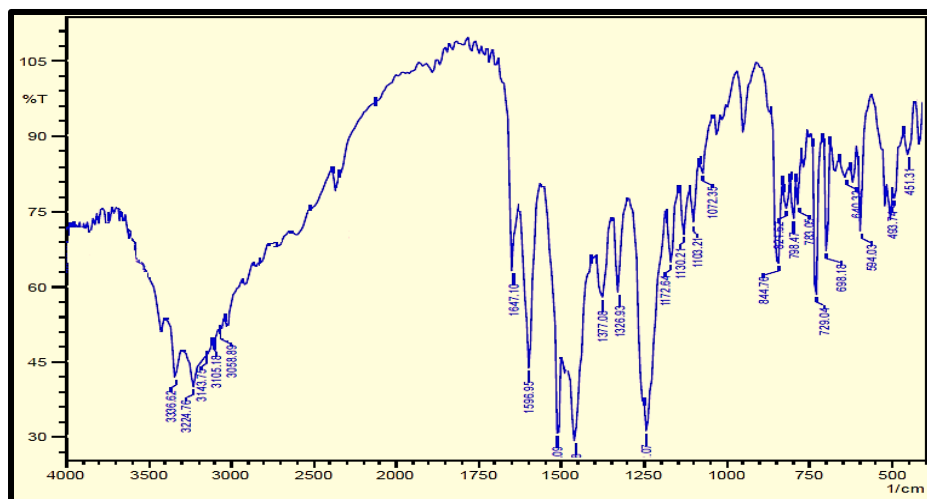
Imidazole derivatives occupied a unique place in the field of medicinal chemistry, as many of them are known for their wide use in the medical and pharmacological fields. Some of them are used as analgesics, anti-fungal, anti-inflammatory, anticoagulants and stimulants. For the heart (Cardiovascular Activity) Some of the azo-imidazole compounds were also used as anticancer, due to their formation of complexes with ions of transitional elements and the ability of their complexes to link with coordination bonds with the nitrogen atoms present in the DNA bases to form a ring.

FT.IR- Analysis of Data

This chemical-spectral conclusion presented robust values of gatherings of resulting Imidazole-Chalcone derivatives [1-7] as a result of existence exciting groups of frequency at (1617) cm^{-1} of Anile group for compound [1], other frequency at (1683) cm^{-1} of carbonyl of amide in imidazole (CO-N), frequency at (3280) cm^{-1} of Amine group (NH) for compound [2], while frequency at (1694) cm^{-1} for carbonyl group for chalcone and (3092) cm^{-1} for (CH=CH) in chalcone in compound [3], frequencies at (3312 ,3334) cm^{-1} of Amine group (NH₂) for Imidazole-Cycle compound [6], frequency at (748) cm^{-1} of (C-S) endocycle for compound [7], depending on identification literature [15].



Form.(3):I.R of Imidazole-Cycle Compound{4}

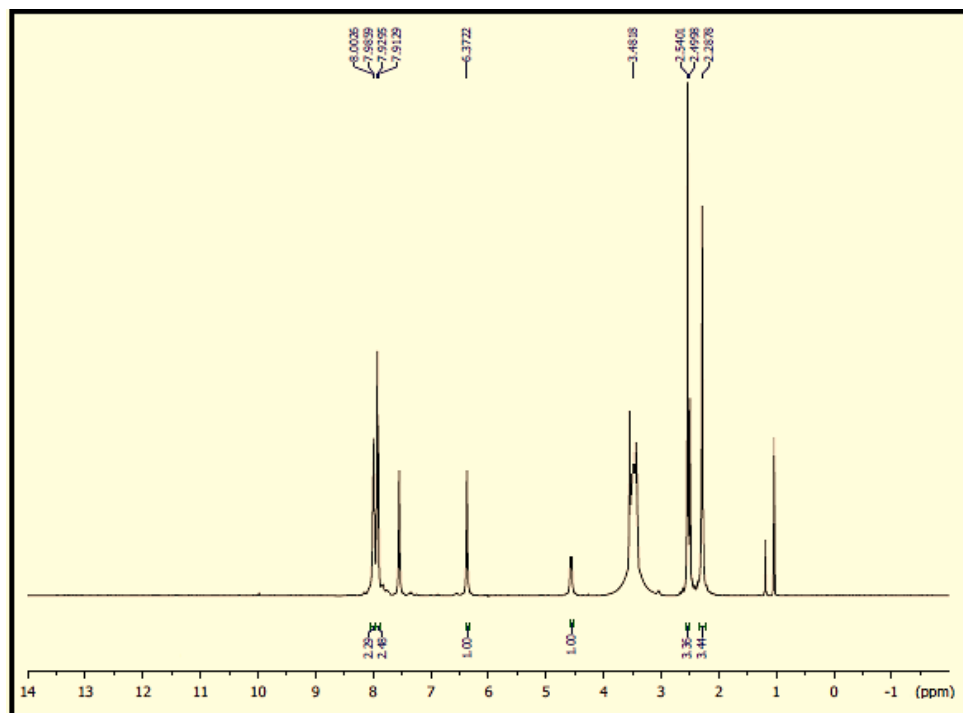


Form.(4):I.R of Imidazole-Cycle Compound{6}

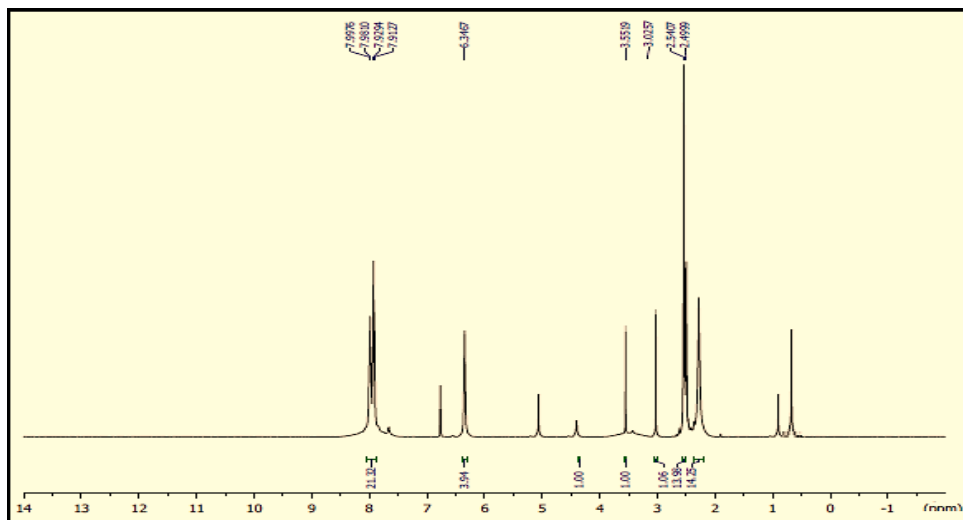
¹H.NMR- Analysis of Data

This chemical-spectral conclusion presented robust values of gatherings of resulting Imidazole-Chalcone derivatives [1-7] as a result of existence exciting groups of peak at δ (8.55) to proton of (CH=N) in Imidazole compound {1}, also of peak at δ (4.73) to proton of (NH) in Imidazole –Cycle compound

{2}, other of peaks at δ (6.01 , 6.11) to protons of (CH=CH) in Imidazole-Chalcone compound {3, also of peak at δ (4.91) to proton of (NH) in Imidazole –Cycle compound {5}, peak at δ (5.03) to protons of (NH₂) in Imidazole –Cycle compound {6}, depending on identification literature [15] .



Form.(5):H.NMR Imidazole-Cycle Compound{4}



Form.(6):¹H.NMR Imidazole-Cycle Compound{5}

Impost of the resistance of Imidazole-Chalcone compounds against Bacteria

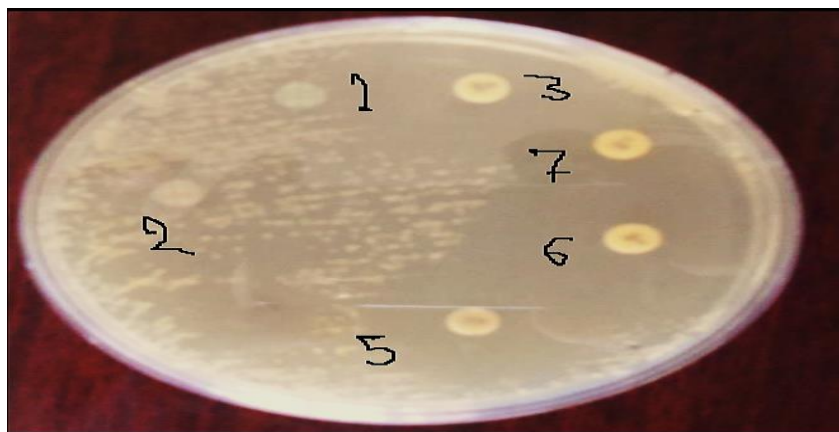
Studying the biological activity of the prepared compounds and the extent to which they can be used in the medical field through their effect on inhibiting the growth of types of

pathogenic bacteria, some of bacteria is Gram positive, symbolized concluded (Staphylococcus aureus , Streptococcus pneumonia), and the another classification is Gram negative, symbolized by dint of (E.Coli) on (three concentrations :30 , 50 , 80 micro gram) depending on literatures [6, 15] .

Table 1: Impost of the resistance of Imidazole-Chalcone compounds against Bacteria in Conc. (50 micro gram)

Imidazoles	Staphylococcus aureus	Streptococcus pneumonia	Escherichia. Coli
Imidazole {1}	+	+	+
Imidazole {2}	+	+	+
Imidazole {3}	++	++	++
Imidazole {4}	+++	+++	+++
Imidazole {5}	+++	+++	+++
Imidazole {6}	++	+++	++
Imidazole {7}	++	++	++

(+) : inhibition (2-6) mm
 (++) : inhibition (7-10) mm
 (+++) : inhibition (11-16) mm

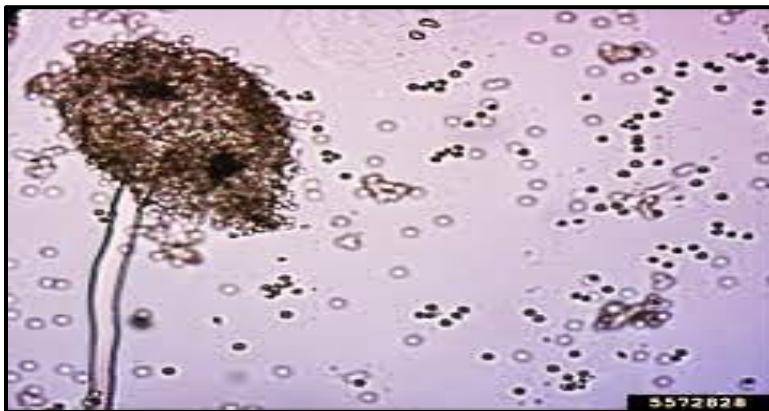


Form. 7: Inhibition of Imidazole-Chalcone Derivatives on Staphylococcus aureus

Impost of the resistance of Imidazole-Chalcone compounds against Fungi (6)

The effect of the ligands and their combination complexes referred to above on three types of pathogenic fungi isolated

and diagnosed in the laboratory using biochemical and microscopic tests were also studied, namely (*Aspergillus flavus* , *Aspergillus terreus*) depending on literature(6, 15) .



Form. 8: Aspergillus flavus



Form. 9: Aspergillus terreus

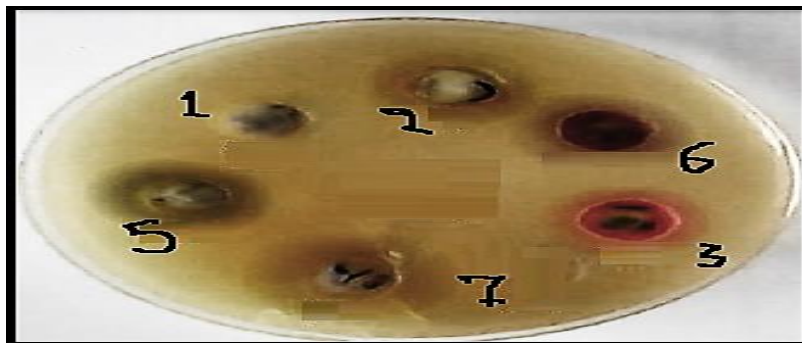
Table 2: Impost of the resistance of Imidazole-Chalcone compounds against Fungi in Conc. 5 micro gram)

Imidazoles	<i>Aspergillus. flavus</i>	<i>Aspergillus. terreus</i>
Imidazole {1}	+	+
Imidazole {2}	+	+
Imidazole {3}	+	++
Imidazole {4}	+++	+++
Imidazole {5}	+++	+++
Imidazole {6}	++	++
Imidazole {7}	++	++

(+) : inhibition (2-6) mm

(++) : inhibition (7-10) mm

(+++): inhibition (11-16) mm



Form. 10: Inhibition of Imidazole-Chalcone Derivatives on *Aspergillus. flavus*

CONCLUSIONS

When comparing the preparation course of the compounds, it was found that the difference in the compensated groups on the base compound has a clear effect on the time to complete the reaction, which was followed up by TLC technique), as well as the difference in effectiveness as a result of the difference in these groups. Also the preparation compounds have high efficacy against bacteria and fungi

REFERENCES

- i. Bush K.; Jacoby G A. A functional classification scheme for beta-lactamases and its correlation with molecular structure . *Antimicrob. Agents Chemother.* 1995, 39 (6): 1211–33. PMC 162717. PMID 7574506.
- ii. Nagham Mahmood Aljamali.; Jawad S . Preparation, Spectral Characterization, Thermal Study, and Antifungal Assay of (Formazane -Mefenamic acid)-Derivatives., *Egyptian Journal of Chemistry* . 2022, 411, 65, 2 ., DOI: 10.21608/EJCHEM.2021.88727.4266 .
- iii. Aljamali N M .Effect of Conditions and Catalysis on Products .,1th -Edition, 2021 , Eliva Press SRL., ISBN: 9781636482286
- iv. Stockert JC, Blázquez-Castro A, Cañete M, Horobin RW, and Villanueva A. MTT assay for cell viability: Intracellular localization of the formazan product is in lipid droplets. *Acta Histochemica* , 2012, 114: 785-796 . doi:10.1016/j.acthis.2012.01.006
- v. Mosmann T .Rapid colorimetric assay for cellular growth and survival: application to proliferation and cytotoxicity assays". *Journal of Immunological Methods.* 1993, 65, (1–2): 55–63 . doi:10 .1016/0022-1759(83)90303-4. ISSN 0022-1759. PMID 6606682
- vi. Nagham M A. Synthesis of Antifungal Chemical Compounds from Fluconazole with (Pharma-Chemical) Studying., *Research journal of Pharmaceutical, biological and chemical sciences*, 2017, 8 (3), 564 -573 .
- vii. Aljamali N M . Alternative Methods in Organic Synthesis .,1th-Edition, Eliva Press SRL, 2020 ., ISBN: 9798680201176.
- viii. Bernas T .; Dobrucki, J. Reduction of a tetrazolium salt, CTC, by intact HepG2 human hepatoma cells: subcellular localisation of reducing systems. *Biochim Biophys Acta*, 1999, 1451(1): p. 73-81.
- ix. Fadel O.; Gomes RD.; Girard, L. B. Separation and identification of polar polyphenols in oily formulation using high-performance thin-layer chromatography and mass spectroscopy techniques. 2015, 4, 5.; OCL, <https://doi.org/10.1051/ocl/2018039>.
- x. Nagham Mahmood Aljamali. Synthesis and Biological Study of Hetero (Atoms and Cycles) Compounds. *Der Pharma Chemica.* 2016, 8,6, 40-48.
- xi. Sun S.Y., Jiang W.G., Zhao Y.P. Comparison of aromatic and phenolic compounds in cherry wines with different cherry cultivars by HS-SPME-GC-MS and HPLC. *Int. J. Food Sci. Technol.* 2012;47:100–106. doi: 10.1111/j.1365-2621.2011.02812.x. [CrossRef] [Google Scholar]
- xii. Imd K, Hasaneen K A ,Nagham M A. Invention of (Gluta.Sulfazane-Cefixime) Compounds as Inhibitors of Cancerous Tumors., *Journal of Cardiovascular Disease Research*, 2020,11, 2., 44-55 ., DOI: 10.31838/jcdr.2020.11.02.09 .
- xiii. Aseel M J, Nagham M A, Saher M J. Development and Preparation of ciprofloxacin Drug Derivatives for Treatment of Microbial Contamination in Hospitals and Environment., *Indian Journal of Forensic Medicine & Toxicology*,2020,14, 2, p:1115-1122.
- xiv. Agnieszka W, Irena M ., Wiesława F, Beata C., Chromatographic Study of Novel Heteronuclear Complexes with Schiff Base as Main Reagent., *Chromatographia* (2014) 77:1103–1112 ., DOI 10.1007/s10337-014-2664-2.
- xv. Nagham Mahmood Aljamali. Spectral and Laboratory Diagnostics of Compounds., 1th -Edition, 2022, Eliva Press SRL., ISBN: 9781636482118.
- xvi. Ren J ; Yao P; Chen J; Jia, Lingyun . "Salt-independent hydrophobic displacement chromatography for antibody purification using cyclodextrin as supermolecular displacer". *Journal of Chromatography A* . 2014, . 1369: 98–104. doi:10.1016/j.chroma.2014.10.009 . PMID 25441076.
- xvii. Nagham Mahmood Aljamali . Synthesis and Chemical Identification of Macro Compounds of (Thiazol and Imidazol) ., *Research J. Pharm. and Tech*, 2015, 8,1, 78-84., DOI : 10.5958/0974-360X.2015.00016.5.
- xviii. Shireen R. R, Nagham Mahmood Aljamali ,Ali J A. Guanine substituted heterocyclic derivatives as

- bioactive compounds., *Biochem. Cell. Arch.* 2020, 20, Supplement 2, pp. 3651-3655 ., DocID: <https://connectjournals.com/03896.2020.20.3651>.
- xix. Nagham M. A.; Jawad S . Preparation, Diagnosis and Evaluation of Cyclic-Tryptophan Derivatives as Anti Breast Cancer Agents. *Biomed Pharmacol J .*, 2021; 14(4)., Available from: <https://bit.ly/3HuvlVG>
- xx. Xu, Hua¹; Hazra, Saugata²; Blanchard, John S. (2012) , "NXL104 Irreversibly Inhibits the β -Lactamase from Mycobacterium tuberculosis". *Biochemistry* 51 (22): 4551–7 . doi:10.1021/bi300508r . PMID 22587688.
- xxi. Nagham Mahmood Aljamali . Designation of Macrocyclic Sulfazan and Triazan as Originated Compounds with Their Estimation in Nano-Activities by the Scanning Microscope ., *International Journal of Convergence in Healthcare*, January-June 2022, Vol. 02, No. 01., P: 25-34 , Available at : <https://www.ijcih.com/index.php/ijcih/article/view/21>
- xxii. Rajaa A A, Nour A A, Nagham Mahmood Aljamali. Synthesis of Triazole Derivatives via Multi Components Reaction and Studying of (Organic Characterization, Chromatographic Behavior, Chem-Physical Properties)., *Egyptian Journal of Chemistry*.2020, 63, 11, pp. 4163 - 4174 . DOI: 10.21608/EJCHEM.2020.23541.2399 .
- xxiii. Nagham Mahmood Aljamali.; Zainab M. F. Anticancer Study of Innovative Macrocyclic Formazan Compounds from Trimethoprim Drug . *Egyptian Journal of Chemistry* . 2023, 66 ., DOI: 10.21608/EJCHEM.2022.132514.5852
- xxiv. D. Bravo-Díaz, Carlos ., "Diazo hydroxides, Diazoethers and Related Species", in Rappoport, Zvi (ed.), *PATAI's Chemistry of Functional Groups*, John Wiley & Sons, Ltd, 2020 doi:10.1002/9780470682531.pat0511, ISBN 9780470682531
- xxv. Carey, Francis A. *Advanced organic chemistry*. Sundberg, Richard J. (5th ed.). New York: Springer. 2007 . ISBN 9780387448978. OCLC 154040953.
- xxvi. Nagham Mahmood Aljamali , Nemah S M . Chemo - Spectral and Biological Studying of New Ligands ., *Research Journal of Pharmaceutical, Biological and Chemical Sciences .*, May – June, 2017 , RJPBCS ,8,(3) ,Page No. 674
- xxvii. BADAWEY,S.S.;ISSA,Y.M.;ABDELFAHATTAH,H.M. Thermogravimetric studies on lanthanide complexes of new derivatives of 1,5-di aryl-3-acetylformazan. *Thermo chim. Acta*, 144,1999,249-255.
- xxviii. Katritzky,A.R.;Belyakov,S.A.;Cheng,D.;Durst,H. D. Syntheses of formazan sunderphase -transfer conditions. *Synthesis*. 5,1995, 577-581.
- xxix. Stockert, J.C .; Horobin, R.W .; Colombo, L.L .; Blázquez, C.A. Tetrazolium salts and formazan products in Cell Biology: Viability assessment, fluorescence imaging, and labeling perspectives. *Acta Histochemica* . 2018, 120, 4, 159-167 . doi:10.1016/j.acthis.2018.02.005
- xxx. Mhand K, Saden Ab, Nour A, Nagham Mahmood Aljamali . Synthesis, Characterization and Biological activity study for new hybridpolymers by grafting 1,3,4-triazole and 1,2,4-oxadiazle moieties ontopolyvinyl chloride ., *Egyptian Journal of Chemistry .*, 2021,64, 3 , 1273 – 1283 ., DOI: 10.21608/EJCHEM.2021.27879.2584
- xxxii. Nagham Mahmood Aljamali.; Intisar Obaid Alfatlawi . Synthesis of Sulfur Heterocyclic Compounds and Study of Expected Biological Activity. ,*Research J. Pharm. and Tech.*, 2015, 8,9 ,1225-1242 , DOI: Nagham 10.5958/0974-360X.2015.00224.3.
- xxxiii. Nagham Mahmood Aljamali.; Saher Mahmood Jawd.; Zainab M J.; Intisar, Obaid. Alfatlawi. Inhibition activity of (Azo-acetyl acetone) on bacteria of mouth., *Research Journal of Pharmacy and Technology* , 2017, 10(6):1683-1686, DOI: 10.5958/0974-360X.2017.00297.9
- xxxiv. Ghyath Salih Mahmoud, & Dr. Wael Adil Obaid. (2022). Experimental studies on the effect of Chlorpyrifos on rats. VI. Population of intestinal mast cells and hypersensitivity reactions. *Al-Salam Journal for Biochemical and Medical Science*, 1(1), 6–11. <https://doi.org/10.55145/ajbms.2022.1.1.002>
- xxxv. Ghyath Salih Mahmoud, Ameen H. Ahmed, & Bassam M. Kassim. (2022). Assessment of histopathological and hematological changes in mice treated with the aqueous extract of origanum (*Driganum majorana.L*)in algabal Alakhder libya. *Al-Salam Journal for Biochemical and Medical Science*, 1(1), 12–17. <https://doi.org/10.55145/ajbms.2022.1.1.003>
- xxxvi. S Al-Daffay, R. K. H. ., Al-Hamdani, A. A. S. (2022). Synthesis and Characterization of Some Metals Complexes with New Acidicazo Ligand 4-[(2-Amino-4-Phenylazo)-Methyl]-Cyclohexane Carboxylic Acid. *Iraqi Journal of Science*, 63(8), 3264–3275. <https://doi.org/10.24996/ijcs.2022.63.8.2>
- xxxvii. Kadhim, S. M., Mahdi,. M. (2022). Preparation and Characterization of New (Halogenated Azo-Schiff) Ligands with Some of their Transition Metal Ions Complexes. *Iraqi Journal of Science*, 63(8), 3283–3299. <https://doi.org/10.24996/ijcs.2022.63.8.4>
- xxxviii. Salih, A. R. ., Al-Messri, Z. A. K. (2022). Synthesis, Characterization and Evaluation of Some Pyranopyrazole Derivatives as Multifunction Additives for Medium Lubricating Oils. *Iraqi Journal of Science*, 63(7), 2827–2838. <https://doi.org/10.24996/ijcs.2022.63.7.7>
- xxxix. Mohamad, B. J ., Zghair, F. A ., Fadhil, Z. T. (2022). Clinical and Histopathological Features of Ovarian Cancer in Iraq, Baghdad Between 2014-2020. *Iraqi Journal of Science*, 63(6), 2354–2361. <https://doi.org/10.24996/ijcs.2022.63.6.4>
- xl. Hayder A. H. Jalil. (2022). The Protective Effect of Small Molecule Sirt1 Activators on Human Corneal Epithelial Cells Against Oxidative Stress. *Journal of Pharmaceutical Negative Results*, 13(1), 80–88. Retrieved from <https://www.pnrjournal.com/index.php/home/article/view/190>
- xli. Muthana Anad Majid. (2022). Studying The Impact of Plasminogen Activator Inhibitor -1 and Some Biochemical Parameters In Iraqi Children with Type -1 Diabetes Mellitus. *Journal of Pharmaceutical Negative Results*, 13(1), 35–38. Retrieved from <https://www.pnrjournal.com/index.php/home/article/view/181>

- xli. J W LEWIS and C SANDORFY. "Infrared absorption and resonance Raman scattering of photochromic triphenylformazans" *Can. J. Chem.* (1983). 61, pp. 809 - 816.
- xlii. Yu. Zaitceva. (2022). Sensor Intelligent Systems for Monitoring the Oxygen Status of Human Tissues Under Functional Loads. *Journal of Pharmaceutical Negative Results*, 13(1), 6–13. Retrieved from <https://www.pnrjournal.com/index.php/home/article/view/183>
- xliii. S A Khan, S Shahid, S Kanwal and G Hussain "Synthesis characterization and antibacterial activity of Cr (III), Co (III), Fe (II), Cu (II), Ni (III) complexes of 4-(2-(((2-hydroxy-5-nitrophenyl) diazenyl) (phenyl) methylene) hydrazinyl) benzene sulfonic acid based formazandyes and their applications on leather"Dyes and Pigments. January 2018, Vol. 148, Pages 31-43.
- xliiii. Mohammad-Esmaeil Hejazi. (2022). Twenty-five Years of Laser Therapy: Causes and Treatment Results in the Pulmonology Ward of Imam Reza Hospital, Tabriz - Iran., *Journal of Pharmaceutical Negative Results*, 13(1), 44–49. Retrieved from <https://www.pnrjournal.com/index.php/home/article/view/186>
- xlv. Yasamin Hamza Sharif. (2022). The Induction of Ovulation in Women with Polycystic Ovarian Syndrome Via: Letrozole vs Clomiphene Citrate. *Journal of Pharmaceutical Negative Results*, 13(1), 30–34. Retrieved from <https://www.pnrjournal.com/index.php/home/article/view/184>
- xlvi. Hussein, A. (2022). Detection of role the enzyme adenosine deaminase in leishmaniasis as biomarkers during of infection . *Al-Salam Journal for Biochemical and Medical Science*, 1(2), 9–18. <https://doi.org/10.55145/ajbms.2022.1.2.002>
- xlvii. Raad, M. ., Ahmed, A. H., Ahmed, F. (2022). Identification of MRSA(methicillin resistant Staphylococcus aureus) by mecA gene. *Al-Salam Journal for Biochemical and Medical Science*, 1(2), 25–30. <https://doi.org/10.55145/ajbms.2022.1.2.004>
- xlviii. S. Ahmed, F., Ahmed, A. H., Raad, M. ., M. Ali, A. prof. M. (2022). Isolation of ferric Yersinia bactin A (fyuA) as virulence gene and biofilm forming in Escherichia coli was Collected from patient with UTI. *Al-Salam Journal for Biochemical and Medical Science*, 1(2), 31–36. <https://doi.org/10.55145/ajbms.2022.1.2.005>
- xlix. Djamil Hissein Didane, Muhammad Nur Arham Bajuri, Bukhari Manshoor, & Mahamat Issa Boukhari. (2022). Performance Investigation of Vertical Axis Wind Turbine with Savonius Rotor using Computational Fluid Dynamics (CFD). *CFD Letters*, 14(8), 116–124. <https://doi.org/10.37934/cfdl.14.8.116124>
- i. Ghassan Nasif, Yasser El-Okda, Mouza Alzaabi, & Habiba Almohsen. (2022). Effects of the Conjugate Heat Transfer and Heat Flux Strength on the Thermal Characteristics of Impinging Jets. *CFD Letters*, 14(7), 18–30. <https://doi.org/10.37934/cfdl.14.7.1830>
- ii. Suaib Al Mahmud, & Ahmad Faris Ismail. (2021). Multiphase CFD Investigation on Convective Heat Transfer Enhancement for Turbulent Flow of Water-Al2O3 Nanofluid. *CFD Letters*, 13(10), 11–24. <https://doi.org/10.37934/cfdl.13.10.1124>
- iii. Wadhah Hussein Abdulrazzaq Al Doori. (2022). Experiments and Numerical Investigations for Heat Transfer from a Horizontal Plate via Forced Convection Using Pin Fins with Different Hole Numbers. *CFD Letters*, 14(9), 1–14. <https://doi.org/10.37934/cfdl.14.9.114>
- lii. Merilin A. S., Petko A., Vessela V., Antonia D., Denitsa A., Virginia T., Ilza P .(2021). Development of a Protocol for Virtual Screening of PPARγ Weak Partial Agonists and Their Metabolites: Case Study on Naturally-derived Oleanane Triterpenoids, *Int J Bioautomation*, 25, 117-132, doi: 10.7546/ijba.2021.25.2.000792
- liiii. Wei Wang, Bo Gao. (2022). A Clustering Algorithm for Tumor Gene Data Based on Improved DPC Algorithm, *Int J Bioautomation*, 26, 175-192, doi: 10.7546/ijba.2022.26.2.000872 .
- liiii. Nora K., Albena S., Ljubomira P. H., Dimka G., Ilonka I., Rositsa H. (2021) . Radioprotective Effect of Curcumin on DNA Double Strand Breaks in Human Blood Lymphocytes after *in vitro* γ-Irradiation, *Int J Bioautomation*, 25, 159-168, doi: 10.7546/ijba.2021.25.2.000794
- liiii. Ghyath S. Mahmoud, Raged H. Rashed, Afrah Jabbar Lazim, & Heyam Aziz Mohammed. (2022). The Effects of Capparis Spinosa Leaves on The Histological Findings Associated With The Exposure of Mice to Trichloroacetic Acid. *Al-Salam Journal for Biochemical and Medical Science*, 1(1), 18–25. <https://doi.org/10.55145/ajbms.2022.1.1.004>
- liiii. Kavitha Ramsundar, Aravind Kumar Subramanian, Swapna Sreenivasagan. Evaluation Of Shear Bond Strength Of Bracket Bonded Using Light Cure Composite And With And Without Primer: A Comparative In-Vitro Study.. *ECB*. 2022; 11(7): 1-5. doi:10.31838/ecb/2022.11.07.001
- liiii. Ghyath Salih Mahmoud, Wael Adil Obaid. (2022). Cellular Elements of the Human's Bone Marrow. *Al-Salam Journal for Biochemical and Medical Science*, 1(1), 26–34. <https://doi.org/10.55145/ajbms.2022.1.1.005>
- liiii. Abdalkader Saeed Latif, Zena Abbas Fadel. Evaluation Study Of The Effectiveness For Some Antibacterial Agent Against Dna Gyrase Enzyme Of Staphylococcus Aureus. *ECB*. 2022; 11(7): 29-32. doi:10.31838/ecb/2022.11.07.005
- liiii. Estabraq Mohammed Ati, Rana Fadhil Abbas, Huda Farooq Zeki, Reyam Naji Ajmi. Temporal Patterns Of Mercury Concentrations In Freshwater And Fish Across A Al-Musayyib River / Euphrates System. *ECB*. 2022; 11(7): 23-28. doi:10.31838/ecb/2022.11.07.004
- liiii. Hadi Sunaryo, Elly Wardani, Pramulani Mulya Lestari, Haryanti, Susilo. Nanosuspension Of Carica Papaya L. Seed Extract For Anti-Hyperlipidemic Propyl Lipids In Hyperlipidemic Hamsters. *ECB*. 2022; 11(7): 6-14. doi:10.31838/ecb/2022.11.07.002