ISSN: 2581-4311
DOI: doi.org/10.51219/IJCRSET/Mohammed-R-Eletmany/146

URF PUBLISHERS
connect with research world

International Journal of Current Research in Science, Engineering & Technology

https://urfpublishers.com/journal/ijcrset

Vol: 7 & Iss: 2

Research Article

Recent Developments in Pyranopyrazole Derivatives: Synthesis, Reactions, and Potential Pharmaceutical Applications

Mashael M Barqi[1], Assia Bashir[2], Muh ibnu sholeh[3] and Mohammed R Eletmany[4]*

[1]Faculty of Science, Chemistry Department, Albaha University, Saudi Arabia

[2]Department of Chemistry, University of Agriculture, Pakistan

[3]STAI Kh Muhammad Ali shodiq Tulungagung, Indonesia

[4]Faculty of Science, Chemistry Department, South Valley University, Egypt

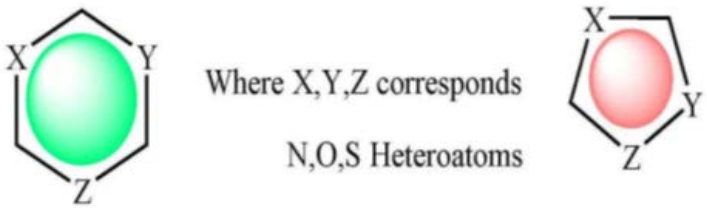
Citation: Barqi MM, Bashir A, ibnu Sholeh M, et al., Recent Developments in Pyranopyrazole Derivatives: Synthesis, Reactions, and Potential Pharmaceutical Applications. *Int J Cur Res Sci Eng Tech* 2024; 7(3), 85-84. DOI: doi.org/10.51219/IJCRSET/Mohammed-R-Eletmany/146

Received: 31 Jily, 2024; **Accepted:** 05 August, 2024; **Published:** 07 August, 2024

***Corresponding author:** Dr. Mohammed R Eletmany, Chemistry Department, Faculty of Science, South Valley University, Qena 83523, Egypt. Email: mrmoham2@ncsu.edu

A B S T R A C T

In the recent years the science of assembling heterocyclic ring has made enormous strides. Heterocyclic compounds consist of very important key compounds in organic chemistry. Due to their various pharmaceutical properties resulting many researchers are syntheses of these compounds. A number of drugs containing simple heterocyclic or a combination of different heterocyclic moieties have been used these days as anticancer, antibacterial and antifungal agents. Because of the heteroatoms in the heterocycle compounds they are playing very role in the organic chemistry.



The presence of nitrogen atoms in the cyclic compounds increased their pharmaceutical efficiency which we can find in many natural compounds like vitamins, hormones and enzymes. The compounds which consist of five and six membered heterocyclic nitrogen containing systems such aspyrazole, imidazole, trizoles, thiozolidine, pyrazolidine etc. as far by the most important in the ongoing research for more efficacious drugs in the fields such as antibacterials, antifungal, anti-inflammatory, diuretics, antirheumatics and antihistaminic. Here we will shed light on Synthesis, Reactions and Biological Applications of Pyrazolopyrimidine Derivatives.

1. Introduction

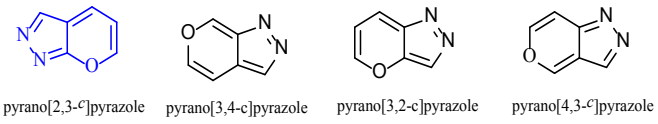
The heterocyclic compounds are widely spread in nature and play an important role in life. Due to the characteristic properties, the heterocyclic compounds hold a large area in medicinal

chemistry. The chemistry of heterocyclic chemistry has been explored widely in the past two -three decades. The synthesis and the application of heterocyclic compounds of medium size rings became popular[1].

Heterocyclic compounds, bearing atoms of at least two different elements as a member of its ring have attracted considerable attention in the growth of pharmacologically active molecules and advanced organic materials Because of the heteroatoms in the heterocycle compounds they are playing very rule in the organic chemistry. The presence of nitrogen atoms in the cyclic compounds increased their pharmaceutical efficiency which we can find in many natural compounds like vitamins, hormones and enzymes[2].

2. Pyranopyrazole

Pyranopyrazoles are known since the 19th century and first synthesized in 1974 by Otto who synthesized it via cyclization of 4-aryliden-5-pyrazolone in the presence of base. Pyranopyrazole compounds, oxygen- and nitrogen-ring fused heterocycles, are important group of heterocyclic compounds with natural and synthetic molecules[3]. The synthesis of the heterocyclic compounds containing the pyranopyrazole moiety, is of great importance, besides its biological and medicinal properties. pyranopyrazoles have attracted the attentions of agrochemical research due to their fungicidal, bactericidal, and herbicidal properties.There are four isomeric structures for pyranopyrazole including: pyrano [2,3-c] pyrazole, pyran o[3,2-c] pyrazole , pyrano [3,4-c] pyrazole , and pyrano [4,3-c] pyrazole, but pyrano [2,3-c] pyrazole isomer is the most investigated one, on the other hand, reports on the preparation of other three pyranopyrazoles are rare[4].



1

Figure 1: Different chemical structures of pyrano pyrazoles.

3. Synthesis of Pyrano [2,3-c] pyrazoles

3.1. Two component synthesis of Pyrano [2,3-c] pyrazoles

Junek and Aigner treated tetracyanoethylene with pyrazol-5-one and 5-aminopyrazole to obtain pyrano[2,3- c]pyrazoles **(5)**, pyrazolo[3,4-b]pyridines **(6)** and dipyrazolylmalonodinitriles **(7)** respectively depending on reaction condition (**Figure 2**). 6-Amino-1,3-disubstituted-4,4-5-tricyanopyrano[2,3-c] pyrazole **(5)** was obtained by refluxing the appropriate pyrazolone and tetracyanoethylene in ethanol[5].

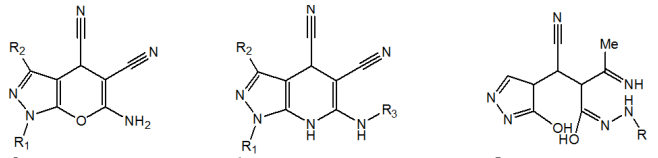
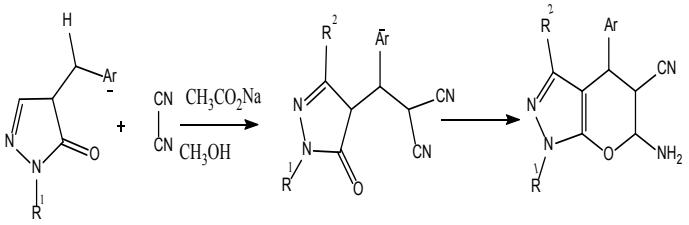


Figure 2: Two component synthesis of Pyrano [2,3-c] pyrazoles.

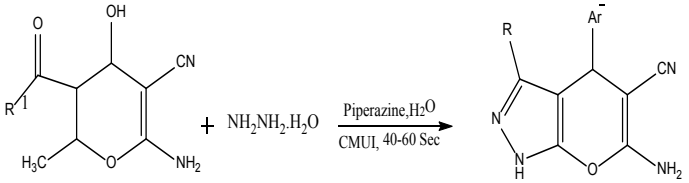
Otto refluxed 4-benzylide-pyrazol-5-one (**8**) with malononitrile (**9**) in methanol in the presence of sodium acetate catalyst to obtain pyrano [2,3-*c*] pyrazole (**11**)[6] (**Scheme 1**).



8 **9** **10** **11**

(**Scheme 1**)

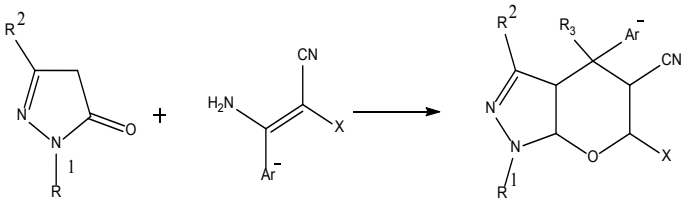
Water as a green solvent is the most environmentally friendly, safe and inexpensive choice to decrease pollution, toxicity and cost of a reaction. Peng and co-workers used pure aqueous media for reaction of 5- alkoxycarbonyl-2- amino-4-aryl-3-cyano-6-methyl-4*H*-pyrans (**12**) and hydrazine hydrate in the presence of a catalytic quantity of piperazine by three methods (i) heating (ii) exposing to microwave irradiation (iii) exposing to a combination of microwave and ultrasound irradiation where, the latter was found to be excellent in terms of yield within short time[7]. It was assumed that powerful ultrasound irradiation causes cavitations and high-velocity interparticle collisions, which cleaned the surface, thus mass transfer between two phases increased and the reaction completed fast without need of any organic co-solvent (**Scheme 28**).



12 13 14

Scheme 2

Abdou and co-workers, in a simple procedure, refluxed various alkene derivatives (16) and pyrazolones in piperidine containing ethanolic solution to produce a variety of pyranopyrazoles bearing carbonitrile, hydroxyl or a phenyl group at the 6-position (Scheme 3)[8].

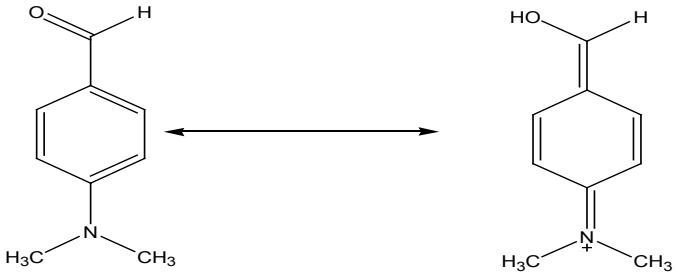


15 16 17

(**Scheme 3**)

3.2. Three components synthesis of Pyrano [2,3-c] pyrazoles

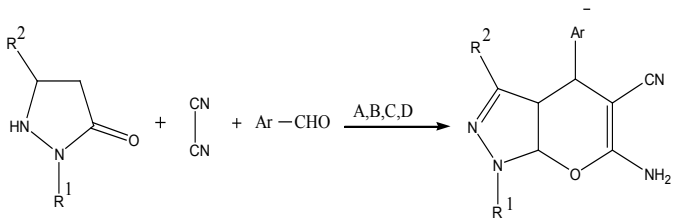
Most of these examples are used pyrazolone, aldehydes and malononitrile and allowed to react together under different reaction conditions to form a variety of pyranopyrazoles. Jin and co-workers added p-dodecylbenzenesulfonic acid (DBSA), as phase transfer catalyst, for uniform dispersion of reactants to get a better yield (84-94%). Initially, the reaction was tested in the absence of catalyst and yielded traces of product or no product as in case of 4-dimethylaminobenzaldehyde, which has strong electron donating dimethylamino group that has significant contributions of the quinoid resonance form, hence reactivity decreased **18-19** (**Figure 3**)[9].



18 19

Figure 3: Three components synthesis of Pyrano [2,3-c] pyrazoles.

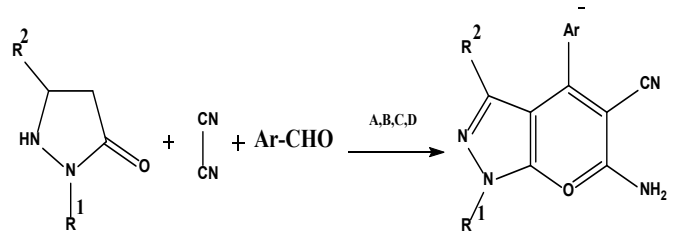
In another attempt, various PTC namely, TBAB, DBSA, sodium dodecyl sulphate (SDS) and HTMAB were tested for similar reactants where HTMAB was found best in term of yield[10]. The reaction conditions worked equally for aromatic aldehydes with electron-withdrawing and donating substituents, but did not proceed for aliphatic aldehydes probably, due to their low reactivity. Prajapati and co-workers refluxed substituted aldehydes, malononitrile and 1-(2,4-dinitrophenyl)-3-methylpyrazol-5-one in ethanol containing piperidine catalyst to give the respective pyranopyrazoles which were found to be good antibacterial agents[11].



20 21 22 23

(**Scheme 4**)

Pyranopyrazoles bearing a triflouromethyl group at the 3-position were obtained by reaction of aldehydes, malononitrile and trifluoromethylpyrazol-5-one, in water as solvent without catalyst at 90°c, in good yields in 3-5 h (Scheme 5)[12]. The yield of the product is not affected by the electronic nature of the aryl substituents.

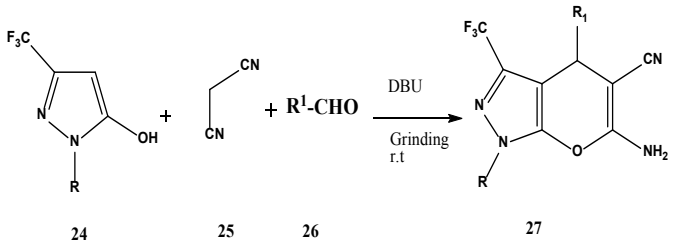


20 21 24 25

(**Scheme 5**)

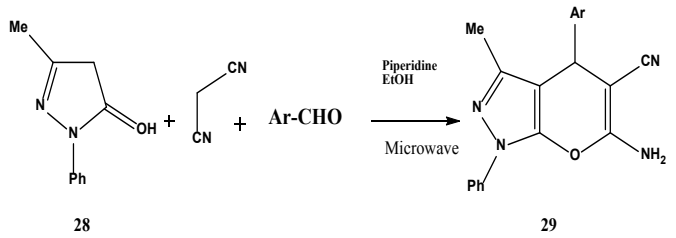
Bhavanarushiandco-workerspreparedflouropyranopyrazoles by grinding similar reactants in a pestle mortar using DBU as catalyst and established the molecular mechanism for DNA binding of resultant products (Scheme 6) [13].

Microwave irradiation to eliminate the need of heat, enhances the rate of reaction, is a widely applicable technique and has been used for the synthesis of pyranopyrazoles within 2-8 min in dry ethanol containing piperidine catalyst (**Scheme 7**)[14].



24 25 26 27

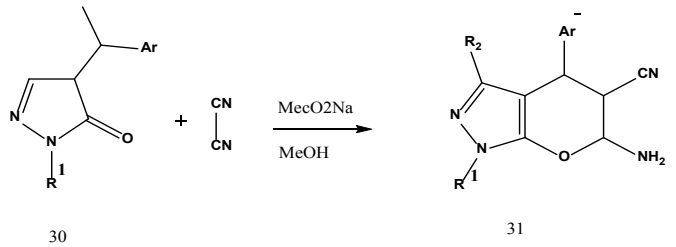
Scheme 6



28 29

Scheme 7

Diaminopyrano [2,3-c] pyrazoles were prepared at room temperature in ethanolic solvent containing secondary amine/ organic bases such as pyridine, piperidine and pyrrolidine[15]. The resultant compounds were found to be potential antibacterial agent while, some of them also exhibited antifungal activity (**Scheme 8**).



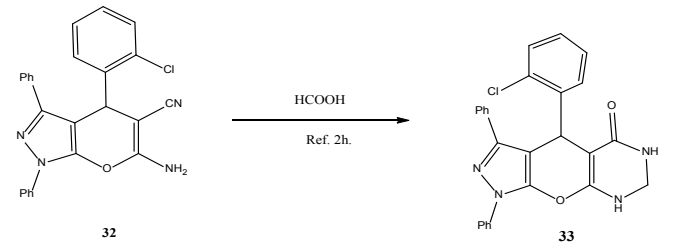
30 31

Scheme 8

4. Reactions of Pyranopyrazoles

4.1 Reaction with formic acid

Nassar etal[16] reported reaction of pyranopyazole derivative 32 with formic acid by reflux at high temperature to produce pyranopyrazolopyrimidinone derivative 33 [Scheme 9]

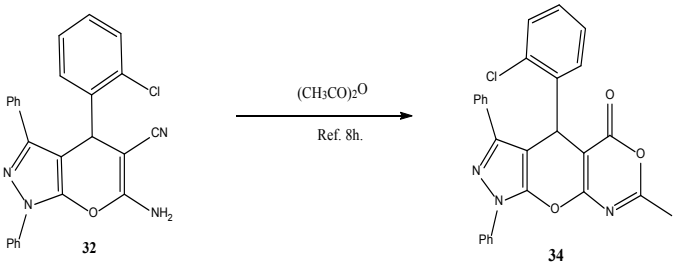


32 33

Scheme 9

4.2. Reaction with acetic anhydride

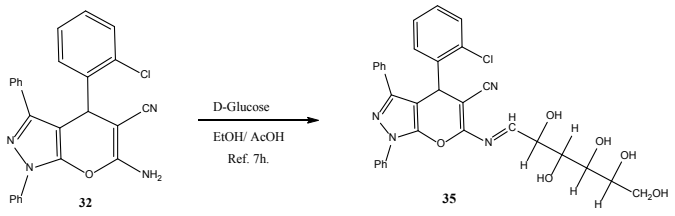
Nassar etal [16] reported reaction of pyranopyazole derivative 32 with acetic anhydride by reflux to produce pyranopyrazolooxazinone derivative 34 [Scheme 9].



32 34

5. Reaction with sugars

Nassar etal [16] reported reaction of pyranopyazole derivative 32 with d-glucose by reflux to produce sugar derivative 35 [Scheme 10]



5. Biological Activities

Pyranopyrazoles in general are biologically active and have remarkable antimicrobial, anticancer[17], anti-inflammatory, analgesic, anticonvulsant, anti-platelet[18], vasodilator, antifungal, potential Chk1 inhibitor[19] herbicidal16 and molluscicidal properties. Moreover, pyranopyrazoles were found to be effective inhibitors to steel corrosion 6 and as antioxidants for lubricant oil. Since these can lead to a variety of pyrano[2,3-c] pyrazoles by virtue of aryl and hetaryl aldehydes, hydrazines and malononitriles and other reactants, the researchers from time to time have subjected the novel synthesized compounds to diverse type of biological activities which may be summed up in the following: Tetrahydroquinolines derivatives being biological active anti-HIV, antibacterial, antifungal, antimalarial, antitrypanosomal, antitumor, psychotropic, anti-allergic, anti-inflammatory, and estrogenic agents, were incorporated with pyranopyrazoles to obtain potential biologically active compounds[20-63].

6. Conclusion

In conclusion, the research presented in this paper demonstrates the versatility and potential of pyranopyrazole derivatives in organic and pharmaceutical chemistry. The innovative synthesis methods, including environmentally friendly approaches and the use of phase transfer catalysts, have led to the efficient production of these compounds. The biological activities of pyranopyrazoles, especially their antibacterial properties, suggest their promise as candidates for drug development. Future research should focus on exploring the full therapeutic potential of these compounds, investigating their mechanisms of action, and developing more targeted applications in medicine. The continued exploration of pyranopyrazole derivatives is likely to yield significant contributions to the field of heterocyclic chemistry and pharmacology.

7. References

1. Katritzky AR, Jug K, Oniciu DC. Quantitative measures of aromaticity for mono-, bi-, and tricyclic penta- and hexaatomic heteroaromatic ring systems and their interrelationships. Chem. Rev 2001;101(5):1421-1450.
2. Kucukguzel SG, Senkardes S. Recent advances in bioactive pyrazoles. Eur J Med Chem 2015;5(97):786-815.
3. Abdelrazek FM, Metz P, Jäger A and Metwally NH. An Eco-friendly Synthesis of Some Novel 4-methyl-4-hetaryl Chromene and Pyrano[2,3-c]pyrazole Derivatives. J Heterocyclic Chemistry 2017;2313-2318.
4. Babaie M, Sheibani H. Nanosized magnesium oxide as a highly effective heterogeneous base catalyst for the rapid synthesis of pyranopyrazoles via a tandem four-component reaction. Arab. J. Chem 2011;4:159-162.
5. Khan MA, Ellis GP, Pagotto MC. Pyranopyrazoles III Synthesis of 1H-Pyrano [2, 3-c] pyrazol-4-ones. Heterocyclic Chemistry.2001;38(1):193-197.
6. Smith R. Superheated water: the ultimate green solvent for separation science. Analytical and Bioanalytical Chemistry 2006;385(3):419-421.
7. Peng Y, Song G and Dou R. Surface cleaning under combined microwave and ultrasound irradiation: flash synthesis of 4H-pyrano [2, 3-c] pyrazoles in aqueous media. J Green Chemistry 2006;8(6):573-575.
8. Wang J, Huang GB, Yang LJ, Li F, Nie J and Maa JA. Tandem Stereoselective Synthesis of New Trifluoromethylated Pyranopyrazoles. J Fluorine Chemistry 2015;171:27-35.
9. Jin TS, Zhao RQ, Li TS. A one-pot three-component process for the synthesis of 6-amino-4-aryl-5-cyano-3-methyl-1-phenyl-1, 4-dihydropyrano [2,3-c] pyrazoles in aqueous media. Archive for Organic Chemistry 2006;11:176-182.
10. Jin TS, Wang AQ, Cheng ZL, Zhang JS, Li TS. A Clean and simple synthesis of 6-Amino-4-Aryl-5-cyno-3-methyl-1-phenyl-1, 4-dihydropyrano[2,3-c]pyrazole in water. An International Journal for Rapid Communication of Synthetic Organic Chemistry 2005;35(1):137-143.
11. Prajapati SP, Patel DP and Patel PS. Phenylboronic acid-catalyzed a four-component synthesis of pyrano[2,3-c] pyrazole derivatives in aqueous media: an eco-friendly method. J Chemi Pharma Res 2012;4:2652-2655.
12. Yu C, Yao C, Li T, Wang, X. An aqueous, catalyst-free and three-component synthesis of 6-amino-3-(trifluoromethyl)-1,4-dihydro1-phenyl-4-arylpyrano [2,3-c] pyrazole-5-carbonitriles. Research on Chemical Intermediates 2014;40(4):1537-1544.
13. Bhavanarushi S, Kanakaiah V, Yakaiah E, Saddanapu V, Addlagatta A and Rani. Synthesis, cytotoxic, and DNA binding studies of novel fluorinated condensed pyrano pyrazoles. J Medicinal Chemistry Research 2013;5:2446-2454.
14. Zhou JF, Tu SJ, Zhu HQ Zhi. A facile one pot synthesis of pyrano[2,3-c] pyrazole derivatives under microwave irradiation. An International Journal for Rapid Communication of Synthetic Organic Chemistry 2002;32:3363-3366.
15. Katariya LK and Kharadi GJ. A Facile One Post Synthesis of Pyrano[2,3-c] Pyrazoles with Implement of Various Basic Catalysts and its Biological Evaluation. International Journal for Pharmaceutical Research Scholars 2014;3:627-637.
16. Nassar IF, Abo-Salem HM, Abdel Rahman AAH. Design, Synthesis, Antimicrobial, Antifungal, AntiOxident and Anticancer Evaluations of Some Novel Pyranopyrazole Derivatives and Their Sugar Analogs, Egypt. J. Chem 2022;65.SI13B,1489-1505.
17. Mohamed NR, Khaireldin NY, Fahmyb AF, AAF El-Sayeda, Der. Pharma. Rapid four-component synthesis of dihydropyrano[2,3-c] pyrazoles using nano-eggshell/Ti(IV) as a highly compatible natural based catalyst Chem. 2010;2:400-417.
18. Capodanno JL, Ferreiro DJ, Angiolillo J. Thrombosis Haemostasis. 2013;11:316-329.
19. Maugeri-Saccà M, Bartucci R. De Maria Cancer Treatment Reviews. 2013;39:525-533.
20. Ismail ZH, Aly GM, El-Degwi MS, Heiba HI, Ghorab MM. J. Biotech 2003;13:73-82.
21. Abdellah IM, Eletmany MR, Abdelhamid AA, (2023). One-pot synthesis of novel poly-substituted 3-cyanopyridines: Molecular docking, antimicrobial, cytotoxicity, and DFT/TD-DFT studies. J Molecular Structure 2032;1289:135864.
22. Ashar A, Bhutta ZA, Shoaib M, et al. Cotton fabric loaded with ZnO nanoflowers as a photocatalytic reactor with promising antibacterial activity against pathogenic E. coli. Arabian Journal of Chemistry 2023;16(9):105084.

23. Barqi MM, Abdellah IM, Eletmany MR, Ali NM, Elhenawy AA, Abd El Latif FM. Synthesis, Characterization, Bioactivity Screening and Computational Studies of Diphenyl−malonohydrazides and Pyridines Derivatives. ChemistrySelect 2023;8(2):e202203913.

24. Ashar A, Qayyum A, Bhatti IA, Aziz H, Bhutta ZA, Abdel-Maksoud MA, Eletmany MR. Photo-Induced Super-Hydrophilicity of Nano-Calcite@ Polyester Fabric: Enhanced Solar Photocatalytic Activity against Imidacloprid. ACS omega, 2023;8(39):35722-35737.

25. Mahmood N, Eletmany MR, Jahan UM, El-Shafei A, Gluck JM. Surface Modified Fibrous Scaffold for Ocular Surface Regeneration. In Society for Biomaterials: 2023 Annual Meeting and Exposition, San Diego, California 2023.

26. Eletmany MR, El-Shafei A. Cotton Dyeing for Sustainability and Long-Lasting Color Fastness using Reactive dyes, 2022-2023 Research Open House Conference - Duke Energy Hall, Hunt Library, NC State University, North Carolina, USA.

27. Barqi MM, Ashar A, Bhutta ZA, Javed M, Abdellah IM, Eletmany MR. Comprehensive Investigation of the Potential of Hydrazine and its Derivatives for the Synthesis of Various Molecules with Biological Activity. Intensification. Inter J Chemi Biochemi Sci. 2023;24(4):369-385.

28. Eletmany MR, Albalawi MA, Alharbi RA, et al. (2023). Novel arylazo nicotinate derivatives as effective antibacterial agents: green synthesis, molecular modeling, and structure-activity relationship studies. Journal of Saudi Chemical Society 2023;27(3):101647.

29. Abbas Ali M, Abdellah IM, Eletmany MR. Towards Sustainable Management of Insect Pests: Protecting Food Security through Ecological Intensification. IJCBS 2022;4(4):386-394.

30. Abdellah IM, Eletmany MR. A mini review on the molecular structure, spectral characteristics, solvent-free synthesis, and multidisciplinary applications of cyanine dyes. Chelonian Research Foundation 2023;18(2):775-794.

31. Abdelshafy F, Barqi MM, Ashar A, Javed M, Kanwal A, Eletmany MR. Comprehensive Investigation of Pyrimidine Synthesis, Reactions, and Biological Activity. Comprehensive Investigation of Pyrimidine Synthesis, Reactions, and Biological Activity 2023;8(10):21.

32. Ali MA, Abdellah IM, Eletmany MR. advances and applications of insect genetics and genomics. Chelonian Research Foundation 2022;17(1):80-87.

33. Eletmany MR. Development of New Organic Hole Transport Compounds for high Performances Organic Solar cells. In 3rd International Conference on Natural Resources and Renewable Energy (ICNRRE). South Valley University, Hurghada, Egypt 2019.

34. Abdellah IM, Zaky OS, Eletmany MR. Visible light photoredox catalysis for the synthesis of new chromophores as co-sensitizers with benchmark N719 for highly efficient DSSCs. Optical Materials 2023;145:114454.

35. Eletmany MR, Hassan EA, Fandy RF, Aly KI. Synthesis and characterization of Novel 2-substituted 1, 3-benzoxazines monomers and studies their Polymerization. In 14th International Conference on Chemistry and its Role in Development (ICCRD-2019). Mansoura University, Hurghada, Egypt 2019.

36. Aly KI, Fandy RF, Hassan E A, Eletmany MR. Synthesis and characterization of novel 1, 3-benzoxazines monomers and studies their polymerization and industrial applications. In Assiut University 11th International Pharmaceutical Sciences Conference, Faculty of Pharmacy, Assiut, Egypt 2018.

37. Ali MA, Abdellah IM, Eletmany MR. climate change impacts on honeybee spread and activity: a scientific review. Chelonian Conservation and Biology 2023:18(2);531-554.

38. Abdellah IM, Eletmany MR. A mini review on the molecular structure, spectral characteristics, solvent-free synthesis, and multidisciplinary applications of cyanine dyes. Chelonian Conservation and Biology 2023;18(2):775-794.

39. Eletmany MR, Abdellah IM. Advances in the Synthesis and Chemistry of Arylhydrazonals Derivatives as Key Players in Medicinal Chemistry and Biological Science. Chelonian Conservation and Biology 2023;18(2):555-594.

40. Eletmany MR, Abdellah IM, El-Shafei A. Sustainable Cotton Dyeing with Reactive Dyes for Enhanced Color Fastness and Durable Antimicrobial Properties. In NC Global Health Alliance Annual Conference, McKimmon Center on NC State's campus 2023.

41. Eletmany MR, Hassan EA, Fandy RF, Aly KI. Synthesis and Characterization of Some New Benzoxazine Polymers with Their Industrial Applications. In 3rd Annual Conference of the Faculty of Science. Presented at the 3rd Annual Conference of the Faculty of Science, Faculty of Science, South Valley University, Qena, Egypt 2019.

42. Eletmany MRAA. Reaction of 3-oxo-arylhydrazonal with Active Methylene Nitriles: Synthesis of Heterocyclic Compounds Via the Reaction of 3-oxo-arylhydrazonal Derivatives with Active Methylene Nitriles. Academic Publishing 2017.

43. Chisoro P, Jaja IF, Assan N. Incorporation of local novel feed resources in livestock feed for sustainable food security and circular economy in Africa. Frontiers in Sustainability 2023.

44. Aly KI, Fandy RF, Hassan EA, Eletmany MR. Synthesis and characterization of novel 2-substituted 1, 3-benzoxazines monomers and studies their polymerization. In 13th IBN SINA International Conference on Pure and Applied Heterocyclic Chemistry. Presented at the 13th IBN SINA International Conference on Pure and Applied Heterocyclic Chemistry, Hurghada, Egypt 2018.

45. Selim MA, Hassan EA, Harb AEA, Eletmany MR. Some spectral studies of New Derivatives of Nicotine, Pyridazine, Cinnoline Compounds. In 7th International Conference on Optical Spectroscopy, Laser and Their Applications. Presented at the 7th International Conference on Optical Spectroscopy, Laser and Their Applications, NRC, Cairo, Egypt 2016.

46. Hassan NM, Eletmany MR. Baubiology Science between Theory and Application. In 2nd Young Researchers of Egyptian Universities Conference (YREUC-2). Presented at the 2nd Young Researchers of Egyptian Universities Conference (YREUC-2), South Valley University, Qena-Luxor, Egypt 2015.

47. Selim MA, Hassan EA, Harb AEA, Eletmany MR. Synthesis of Some New Derivatives of Nicotine via the Reaction of Arylhydrazonals with Active Methylene Derivatives. In 13th IBN SINA International Conference on Pure and Applied Heterocyclic Chemistry. Presented at the 13th IBN SINA International Conference on Pure and Applied Heterocyclic Chemistry, Hurghada, Egypt 2015.

48. Eletmany MR, Hassan EA, Fandy RF, Aly KI. Synthesis and characterization of new benzoxazines polymers and their applications. In 4th Young Researchers of Egyptian Universities Conference (YREUC-4). Presented at the 4th Young Researchers of Egyptian Universities Conference (YREUC-4), South Valley University, Qena, Egypt 2018.

49. Selim MA, Hassan EA, Eletmany MR, Harb AEA. Synthesis of New Derivatives of Nicotine, Pyridazine, Cinnoline Compounds via the Reaction of Pyridylhydrazonals with Active Methylene Derivatives. Assiut University 9th International Pharmaceutical Sciences Conference. In Assiut University 9th International Pharmaceutical Sciences Conference, Faculty of Pharmacy, Assiut, Egypt 2024.

50. Eletmany MR, Abdellah IM. Climate Change Mitigation through Sustainable Chemistry: Innovations and Strategies. Climate Challenges and Solutions At: North Carolina State University USA 2023.

51. Rashwan AK, Osman AI, Eletmany MR, Chen W. Potential of Chinese Bayberry (Myrica rubra Sieb. et Zucc.) Fruit, Kernel, and Pomace as Promising Functional Ingredients for the Development of Food Products: A Comprehensive Review. Food and Bioprocess Technology 2024;1-19.

52. Abdellah IM, Eletmany MR. Short Review on Metallocene Complexes: Synthesis, and Biomedical Applications. Short Review on Metallocene Complexes: Synthesis, and Biomedical Applications 2023;8(11):16.

53. Ismael EM, Abdellah IM, Eletmany MR. Concise Review of Nanomaterial Synthesis and Applications in Metal Sulphides. Int J Cur Res Sci Eng Tech 2023;6(4):21-29.

54. Eletmany MR, Abdellah IM, Barqi MM, Al-Ghorbani M. Advancements in Green Chemistry: Microwave-Assisted Synthesis of Poly-Heterocyclic Compounds in Aqueous Media. Int J Cur Res Sci Eng Tech 2023;7(1):16-26.

55. Khawaga AS, Ali, M., Mostafa MM, Eletmany MR. The Potential of Licorice Extract as a Sustainable Alternative for Improving Budbreak and Productivity of Grapes Grown Under Insufficient Winter Chilling.11:(1)9.

56. Abdellah IM, Barqi MM, Zaky OS, Eletmany MR. Short Review on the Synthesis and Applications of Heterocyclic Quinones. 16:(1)9.

57. Ismael EM, Abdellah IM, Bakheet ME, Eletmany MR. Mini Review on Nano Materials Synthesis and Applications in Metal Sulphides. Mini Review on Nano Materials Synthesis and Applications in Metal Sulphides 2023;8(12):13.

58. Ali MA, Mahmoud MAB, Shoaib M, et al. Isolation and Molecular Identification of Serratia Nematodiphila associated with Red Palm Weevil, Rhynchophorus ferrugineus Olivier (Coleoptera: Curculionidae) as bio-insecticide in Egypt. Asian Journal of Agriculture and Biology 2024;(2):2023352.

59. Eletmany, MR. Development of New Organic Hole Transport Compounds for high Performances Dye-sensitized Solar cells. In 1st International Conference on Natural Resources and Renewable Energy (ICNRRE). Presented at the 1st International Conference on Natural Resources and Renewable Energy (ICNRRE), South Valley University, Hurghada, Egypt 2017.

60. Eletmany MR, Hassan EA, Fandy RF, Aly KI. Synthesis and characterization of some new polymers with biological and industrial applications. In 2nd Annual Conference of the Faculty of Science. Presented at the 2nd Annual Conference of the Faculty of Science, South Valley University, Qena, Egypt. 2018.

61. Elsagheer MA, Wadea MK, Ali NM, Eletmany MR. Enhancing antioxidant status, productive and reproductive performance for post-molt broiler breeders by using maca powder (lepidium meyenii). Chelonian Conservation and Biology 2024;19(01):485-499.

62. Azmy HA, Aboseidah AA, El-Morsi E,et al. Combating Multidrug Resistance: The Potential of Antimicrobial Peptides and Biofilm Challenges.

63. Rashwan AK, Younis HA, Abdelshafy AM, et al. Plant starch extraction, modification, and green applications: a review. Environmental Chemistry Letters 2024;1-48.