Review on- Importance of Heterocycles in medicinal field

[1]Dr. Jyoti Mahadev Madar

[1] Assistant Professor

[1] Department of Chemistry

[1]K.R.C.E. Society's G.G.D. Arts, B.M.P. Commerce and S.V.S. Science Degree College, Bailhongal.

[1] madar.jyoti651@gmail.com

Abstract:

According to research, 90% of medicines containing heterocyclic compounds. All heteroatoms containing heterocyclic compounds play vital role in medicinal field to cure cancer, inflammation, fungal infection, allergic, HIV, viral and bacterial infection. Most of the naturally occurring medicinal importance compounds containing heterocycles like alkaloids, penciline, morphine, and amino acids contain heteroatom such as nitrogen, oxygen, sulphur and phosphors. More than 90% of heterocyclic compounds show physiological activities. Hence, currently in research there is wide verity of interest to synthesize the various heteroatom containing heterocyclic compounds. This article provides brief information about such heterocyclic compounds which are medicinally important and biologically active.

Keywards: Heterocyclic compounds, Biological active compounds, medicinally important heteroatoms.

Introduction:

Heterocycles are the most important in organic chemistry, and has huge research interest on heterocycles because of their medicinal, anti-microbial, and industrial applications. The most frequent hetero-atoms are nitrogen, oxygen and sulfur but heterocyclic rings including additional hetero-atoms i.e. phosphorus, iron, magnesium, selenium etc. are also common [1]. Heterocyclic compounds have the majority in pharmaceutical medications. Histidine, Tryptophan, Proline such Amino acids as well as most of the vitamins and synthetase precursors like pyrodoxine, riboflavin, thiamine, biotin, folic acid, B12 are contain various heteroatom having heterocycles [2]. Heterocyclic compounds, especially nitrogen and sulfur containing small ring heterocycles have been under exploration for a long time due to their importance in medicinal chemistry and on other hand oxygen containing heterocycles exhibited as interesting pharmacological properties such as, antibacteria, anti-fungal anti-inflammatory, anti-oxidant , anti-viral, anti-cancer, anti-HIV ,and anti-tuberculosis activity[3]. Heterocycles are also the building blocks of proteins and they make up the structure of the body, as well as the photosynthesizing pigment chlorophyll and the oxygen transporting pigment hemoglobin[4]. Oxygen containing Coumarins shows tremendous pharmacological activities such as anticancer, anticoagulant, anti-inflammatory,

antimicrobial, antioxidant, antiviral and antiproliferative activities. They show unique interest in antimicrobial and anti-inflammatory activities [5]. Nitrogen-based heterocycles have valuable source of therapeutic agents in medicinal chemistry and these drugs are approved by the FDA and currently available in the market even in forthcoming decade, have greater share of new nitrogen-based pharmaceuticals is anticipated [6]. Nitrogen and sulphur containing heterocycles have specific properties due to which they can be used as a potential material in a different type of industries along with medicinal/pharmaceutical. In present days, Nitrogen-Sulfur heterocycles are repeatedly attracting the interest of chemists due to their exceptional bioactive behavior[7].

Medicinal chemistry is a traditional science of organic chemistry, biology and physics. However, a large number of natural and synthetic heterocyclic compounds show significant medicinal properties. According to the literature survey, heterocycles play significant role in medicinal chemistry and a range of heterocyclic molecules with a condensed ring system have a variety of physiological functions. This review shows a importance of medicinal and biological study of heterocyclic compounds.

Biological active Heterocyclic compounds:

Anti-cancer active molecule:

Indol and indol derivatives shows anti cancer agent. The indole structure plasticity observable in drug rational design is translated to the wide range of biological targets that these have been found to affect often ranging from topoisomerase inhibitors to G2/M abrogators [8]. benzoxazole derivatives linked to the piperazine hybrids were prepared by nitration and piperazinylation followed by in situ reductive cyclization. The prepared compounds were evaluated against human lung cancer epithelial cells A549 [9]. Sulfur heterocycles have been found to potentiate existing in cancer therapie. Sulfur heterocycles, when combined with chemotherapy or radiation therapy, can actually aid the latter by synergistically improving treatment they can sensitize cancer cells to chemotherapy drugs so that the cells become susceptible to treatment [10].

Anti-fungal active molecules:

The effect of antifungal medicine by killing the fungal cells by affecting the cell membrane which is lead to cells die and preventing the growth and reproduction of the fungal cells. Heterocyclic Dipicolinic acid derivatives, show antifungal activity against fungal strains called Aspergillus flavus, Aspergillus ochraceus, Fusarium graminearum and Fusarium verticilioides [11]. Indole 3-acetic acid based biopolymeric hydrogels, also show antifungal activity and tested of several type of fungi including, Aspergillus fumigates, Rhizopus oryzae and Candida albicans at different concentrations using ketoconazole and Dimethyl Sulfoxide [12]. Thiophene heterocycle chalcones showed antifungal activity against fungi utilizing the fluconazole as the positive control at various doses even benzo-[d]oxazole-4,7-iones heterocycles are active against pathogenic fungi comparing with 5-fluorocytosine as a common standard agent[13].

Anti-inflammatory active molecules:

2-thiopyrimidine derivatives-7, 7, 8a-trimethyl-Hexa-hydro-thiazolo [3, 2-*c*] pyrimidine-5-thione were showed good analgesic, anti-inflammatory and kinase inhibitory activities [14]. Pyrido [2, 3, - d] pyrimidinone and 3-Subtstituted - Pyrido-[3, 4-e]- as-triazines derivatives have been found to possess antiinflammatory activities. 2-(hydroxymethy1)- 5-pheny1- 1, 3, 4-oxadiazoles also show antiinflammatory activities in mice , rats, and guineapigs [15]. 4, 6-Diamino-3-cyano-2-methylthiopyridine derivatives has ability to reduce inflammation. [10]

Anti-bacterial active molecules:

Many chemists have synthesized and tested numerous molecules with this kind of action against various bacteria. Antibacterial or antibiotics is a term that used to describe the drugs which are used for prevention or treatment of bacterial infections, either by killing or inhibit the growth of bacteria. The antiprotozoal activity also related to some of the antibiotics. Antibiotics do not effective against viral infections such as the common cold or influenza[14]. Aromatic heterocyclic derivatives, like β-lactam derivatives, are a key component of the chemical structure of antibiotics [16]. Triazine, Thiourido, oxazole and thiazole derivatives were found antibacterial agents[11]. Coumacin synthesized from coumarins detecting show antibacterial activity against different standard aerobic and anaerobic bacterial strains using ciprofloxacin and metronidazole as positive controls [16].

Conclusion:

Heterocyclic compounds have numerous applications in pharmaceutical chemistry and play a vital role in biochemical functions. Lot of heterocycles that contain heterocyclic core skeletons like as antifungal, anti-inflammatory, antibacterial, antiviral, anti-oxidants, anticonvulsants, anthelmintic, antipyretics, anti-allergic, anti-histamine, herbicidal, anticancer, antihypertensive and anti-leprosy agents. Heterocyclic compounds are versatile synthetic targets and key structural units in organic synthesis and medicinal chemistry because of their exciting biological activities. Interestingly, an increasing number of heterocycles have been identified as potential drug candidates in ongoing drug development.

References:

1. E. Kabir, M. Uzzaman, “A review on biological and medicinal impact of heterocyclic compounds”. Results in Chemistry, vol. 4, 2022, pp.100606.
2. M. S. Saini, A. Kumar , J. Dwivedi, R. Singh, “ A Review: Biological Significances Of Heterocyclic Compounds”. IJPSR, Vol. 4, Mar 2013, pp. 66.
3. J. M. Madar, L. A. Shastri1, S. L. Shastri, M. Holiyachi, N. S. Naik, F. Shaikh, V. A. Sungar, S. D. Joshi, “Synthesis and characterization of coumarin-4-thiazolidinone scaffolds as new class of anti-tuberculosis and antibacterial agents”. IOSR Journal of Applied Chemistry (IOSR-JAC), Vol. 11(7), July. 2018, pp. 77-101.

4. P. Fürst, P. Stehle, J. Nutr, "What Are the Essential Elements Needed for the Determination of Amino Acid Requirements in Humans?". Journal of nutrition, vol.134, 2004, pp. 1558–1565.
5. F. Shaikh, Samundeeswari S., R. Kulkarni, N. S. Naik, J. M. Madar, S. D. Joshi, V. Sunagar, L. Shastri, "Synthesis and Characterization of Chlorophenyl- thiazolocoumarinyl Hydrazides as Promising Antimicrobial and Anti-Inflammatory Agents". IOSR Journal of Applied Chemistry (IOSR-JAC), Vol. 11(7), July. 201), pp. 09-39
6. N. Kerru, L. Gummidi, S. Maddila, K. K. Gangu, S. B. Jonnalagadda, "A Review on Recent Advances in Nitrogen-Containing Molecules and Their Biological Applications". Molecules, Vol. 25, 2020, pp.1909.
7. P. K. Sharma, A. Amin, and M. Kumar, "A Review: Medicinally Important Nitrogen Sulphur Containing Heterocycles". The Open Medicinal Chemistry Journal, vol. 14, 2020, pp. 49-64.
8. Kaur, A. K. Shakya, R. Singh, R. Badhwar, S. K. Sawhney, "Heterocyclic Compounds and their Derivatives with Potential Anticancer Activity". Ind. J. Pharm. Edu. Res., 58, 2024, pp.26-39.
9. H. T. Hamad , "The anti-cancer effectiveness of some heterocyclic compounds containing sulfur atom". R e s u l t s i n C h e m i s t ry, vol. 15, 2025, pp. 102182.
10. A. Al-Mulla, "A Review: Biological Importance of Heterocyclic Compounds". Der Pharma Chemica, 2017, vol. 9(13), pp. 141-147.
11. G. panelChitra, D. S. Franklin, S. Sudarsan, M. Sakthivel M, S. Guhanathan," Indole-3-acetic acid/diol based pH-sensitive biological macromolecule for antibacterial, antifungal and antioxidant applications". International Journal of Biological Macromolecules Vol. 95, February 2017, pp. 363-375.
12. E. Kabir, M. Uzzaman, "A review on biological and medicinal impact of heterocyclic compounds". Results in Chemistry, Vol. 4, 2022, pp. 100606.
13. T. Qadir, A. Amin, P. K. Sharma, I. Jeelani and H. Abe, "A Review on Medicinally Important Heterocyclic Compounds". The Open Medicinal Chemistry Journal, vol. 16, 2022.
14. Sourav De, Niranjan Babu M., Suneel Babu T., Bhavya Sree R., Sai Kiran A., K. S. K. Reddy, "A Review Article On Importance Of Heterocyclic Compounds". Mintage journal of Pharmaceutical & Medical Sciences, Vol.5 (2), 2016, 18-27.
15. Shilpi S., "The Significance Of Heterocyclic Compounds In Biological Activity And Medicinal Chemistry: A Review Study". IJNRD, Vol. 9 (12), December 2024.
16. Yasser F. M., "Synthesis, characterization and antibacterial activity of novel heterocycle, coumacine, and two of its derivatives". Saudi Pharmaceutical Journal,vol. 26, 2018, pp. 870 87.