International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

A Review on 'Imidazole': There Chemistry, Methods of Preparation and Pharmacological Potentials

Ajay Kumar[1,2*], Somesh Verma[1], Samiksha,[3]Ashok Kumar Yadav[4]

1. *Research scholar Hygia Institute of Pharmaceutical Education & Research, Ghaila Road, Gazipur Balram Rd, near IIM Road, Prabandh Nagar, Lucknow, Uttar Pradesh 226020*
2. *Assistant professor, B.N. College of Pharmacy, NH -24, Sitapur Rd, Bakshi Ka Talab, Lucknow, Navi Kot Nandana, Uttar Pradesh 226201*
3. *Associate professorHygia Institute of Pharmaceutical Education & Research, Ghaila Road, Gazipur Balram Rd, near IIM Road, Prabandh Nagar, Lucknow, Uttar Pradesh 226020*
4. . *Assistant professor, Nova College of Pharmacy, KH. no. 74 STP Road Behind Ganpati Vihar Colony, Khargapur, Gomti Nagar, Extention, Uttar Pradesh 226010*

Date of Submission: 05-02-2025 Date of Acceptance: 15-02-2025

ABSTRACT: In contemporary synthetic organic chemistry, a key role is played by the creation of a systematic, directed synthesis of complex organic compounds with the goal of obtaining the physiologically active material with selective action. Derivatives of imidazoles are an essential part of a wide variety of bioactive substances, both synthetic and natural. In recent years, they have drawn the attention of numerous scientists in the fields of pharmaceutical chemistry and pharmacology. This is a result of their remarkable chemical characteristics and biological activity. Modifying and creating novel imidazole derivatives is a significant task for scientists.

KEYWORDS:imidazole, synthesis, formamide,.

I. INTRODUCTION

Imidazole (ImH) is an organic compound with the formula $(CH)_3(NH)N$. It is a white or colourless solid that is soluble in water, producing a mildly alkaline solution. It can be classified as a heterocycle, specifically as a diazole. Many natural products, especially alkaloids, contain the imidazole ring. These imidazoles share the 1,3-C_3N_2 ring but feature varied substituents. This ring system is present in important biological building blocks, such as histidine and the related hormone histamine. Many drugs contain an imidazole ring, such as certain antifungal drugs, the nitroimidazole series of antibiotics, and the sedative midazolam.

When fused to a pyrimidine ring, it forms a purine, which is the most widely occurring nitrogen-containing heterocycle in nature.[10]

The name "imidazole" was coined in 1887 by the German chemist Arthur Rudolf Hantzsch (1857–1935).

Imidazole is a planar 5-membered ring, that exists in two equivalent tautomeric forms because hydrogen can be bound to one or another nitrogen atom. Imidazole is a highly polar compound, as evidenced by its electric dipole moment of 3.67 D,[12] and is highly soluble in water. The compound is classified as aromatic due to the presence of a planar ring containing 6 π-electrons (a pair of electrons from the protonated nitrogen atom and one from each of the remaining four atoms of the ring).

Imidazole is amphoteric, which is to say that it can function both as an acid and as a base. As an acid, the pK_a of imidazole is 14.5, making it less acidic than carboxylic acids, phenols, and imides, but slightly more acidic than alcohols. The acidic proton is the one bound to nitrogen. Deprotonation gives the imidazolide anion, which is symmetrical. As a base, the pK_a of the conjugate acid (cited as pK_{BH^+} to avoid confusion between the two) is approximately 7, making imidazole approximately sixty times more basic than pyridine. The basic site is the nitrogen with the lone pair (and not bound to hydrogen). Protonation gives the imidazolium cation, which is symmetrical.

Imidazole was first reported in 1858 by the German chemist Heinrich Debus, although various imidazole derivatives had been discovered as early as the 1840s. It was shown that glyoxal, formaldehyde, and ammonia condense to form imidazole (glyoxaline, as it was originally named).[13] This synthesis, while producing

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

relatively low yields, is still used for generating C-substituted imidazoles.

General method for synthesis of imidazole

Debus-Radziszewaski imidazole synthesis

A dicarbonyl, benzaldehyde, and ammonia are used in an organic process to create the debus-Radziszewski imidazole. It involves combining a benzaldehyde with a dicarbonyl molecule, such as glyoxal, -ketoaldehydes, or -diketones, while the reaction is occurring in the presence of ammonia. For instance, 2, 4, 5- triphenyl imidazole are produced when benzoyl reacts with benzaldehyde and two molecules of ammonia. Kumar et al. **[30]**

Wallach synthesis of imidazole

Wallach said that a Cl holding molecule is produced when N, N-diethyl oxamide reacts with PCl_5 and further reduction by HCl results in (N-methyl imidazole).

Markwald synthesis

An efficient way to create imidazoles is by converting amino ketones, aldehydes, and potassium thiocyanate or alkyl isothiocyanates into 2-mercaptoimidazoles. Oxidation is a simple method for removing sulphur.

From aminonitrile

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

Aldehyde and aminonitrile are both condensed given the proper reaction conditions to produce substituted imidazole.

Dehydrogenation of imidazoline

2-substituted imidazoles are produced by converting imidazolines to imidazoles using the milder reagent barium magnate and in the presence of sulphur. Alkyl nitriles and 1, 2 ethane diamine were used to create imidazolines, which were then converted to BaMnO4.

Maquenne synthesis

Shahzad Farooq et al. (2021) design and synthesized N-Mannich base derivativescontainging2-phenyl-2-imidazoline. The biological activities of the synthesized substances **(1a)** including their antioxidant, a-amylase inhibiting, anti-microbial, cytotoxic, and anti-inflammatory properties were evaluated. All bacterial and fungal strains were successfully inhibited by compounds with good to moderate activity. **[45]**

K. Nandni et al. (2020) in the current investigation, created few imidazole analogues by synthetic means. Spectral data was used to confirm the structures of freshly synthesized compounds, while fluconazole and streptomycin were used as reference drugs to determine their anti-microbial activity. The strongest analogues in the series were discovered to be compounds **(2a)** and (**2b). [22]**

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

Heba E Hashem et al. **(2020)** The development and production of the several novel thiourea derivatives with different moieties. In the experiments to as certain their antibacterial activity, Gram (+ve) and Gram (–ve) bacteria were utilized, and the fungus Aspergillus flavus have a MIC value that varied from 0.95 0.22 to 3.25 1.00 g/mL. Additionally, experiments on cell toxicity showed that compounds **(3a)** and **(3b)** were the most powerful. **[19]**

Dumitrela Diaconu et al. (2020). The antibacterial and anti-cancer properties of two new classes of hybrid quinoline-imidazole/benzimidazole compounds were developed, synthesized, and tested. The compound **(4a)** exhibits outstanding quasi-nonselective action. **[13]**

Mohammed kareemsamad et al. (2019) developed and improved a powerful new azo-oxazolone that served as a model for the manufacture of two series of azo-benzimides and azo-imidazolones. The biological efficiency was determined by evaluating antimicrobial action against gram (+ve) and gram (–ve) bacteria. Compounds (**5a)** were the more potent. Determined by using the burning rats which contaminated by Staphylococcus aureus**. [31]**

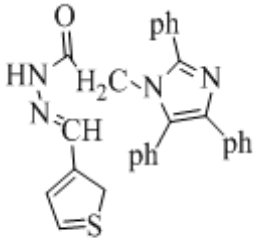
International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

Pratik G. Shobhashana et al. (2018) synthesized 2,4,5-trisubstituted imidazole from benzyl, 2-phenoxyquinoline-3-carbaldehyde and ammonium acetate with ceric ammonium nitrate used as catalyst with excellent yield. Among them compound **(6a)** was discovered to have great antibacterial action against Gram (+ve) and Gram (–ve) bacteria, including E. coli.**[35]**

Anna Bielenica et al. (2015) synthesized 3-(trifluoromethyl) aniline with aliphatic and aromatic isothiocyanates produced a total of 31 thiourea derivatives. Compounds **(7a)** most potent for in vitro anti-microbial activity. The strongest suppression against Gram-positive (+ve) cocci was shown with derivatives. The MIC values that were actually measured fell between 0.25 to 16 g/ml. Thioureas' inhibitory effects on topoisomerase IV, which was isolated from S. aureus, were investigated. **[7]**

Delia HernándezRomero et al. (2014) synthesized imidazole derivatives, which have demonstrated biological activity in the form of antibacterial, anti-inflammatory, analgesic, antifungal, anticancer, and antidepressant properties, within the biological processes of various therapeutic diseases. The compounds (**8a)** show important anti-microbial activity. **[11]**

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494



8a

Shailesh P.Zala et al. (2012) synthesized 2,4,5-triphenyl-1Himidazole-1-yl derivatives and tested for anti-microbial action using standard drug of ciprofloxacin and clotrimazole. Compound (**9a)** more potent drug. **[44]**

H.R. Parabh et al.(2011) Preparation of 6-bromo-2-chloro-3-formylquinoline was used to create oxazole and its imidazole derivatives. The structures of each chemical were clarified using elemental analysis along with IR, ^{1}H NMR, and ^{13}C NMR spectra. Their anti-bacterial activity was evaluated in vitro. It was discovered that some synthetic compounds **(10a)** have biological action against bacterial species that are both gram (-ve) and gram (+ve) as well as fungi. **[17]**

N. C. Desai et al. (2011) synthesized N-(4-((2-chloroquinoline-3-yl) mrthylene)-5-oxo-2-phenyl-4,5-dihydro-1H-imidazole-1-yl)(aryl)amides. All the compounds are tested in vitro anti-microbial activity with bioassay that is serial broth dilution method. Among them compounds (**11a)** show more potent against different microbial strains. **[34]**

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

S. P. Nanda et al. (2010) synthesized imidazole and benzothiazolyl derivatives starting at easy precursors. The particular compounds (**12a)** were evaluated as potential for anti-microbial activities. **[41]**

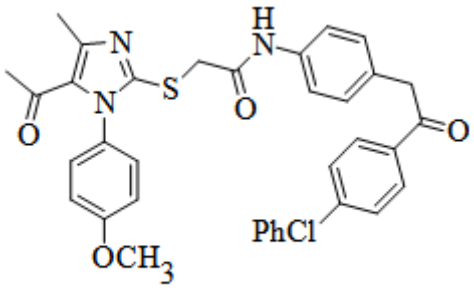
Deepika Sharma et al. (2008) synthesized substituted phenyl)-[2-(substituted phenyl)-imidazole-1-yl] and 2-substituted phenyl)-1H-imidazole methanone analogues and they were examined for their ability to fight of fungus, bacteria, and gram (+ve), gram (–ve), and the fungal species.The compounds (**13a)** and **(13b)** was found to be most potent antimicrobial activity. **[10]**

Andrzej Olczak et al. (2023) design structures of three novels 1H-benzo[d]imidazole derivatives. A similar system of hydrogen bonds, Solid-state NMR was used to assess the sample quality that was obtained. By examining their selectivity, Gram-positive with Gram-negative bacteria are both resistant to in vitro antibacterial and antifungal activity. Compounds **(14a)** were more potent**. [5]**

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

Salunke PrashantRamrao et al. (2021) novel 4,5-diphenyl-1H-imidazole connected to piperazine hybrids were developed. By using spectroscopic methods, the targeted compounds were located, and their abilities to inhibit BACE-1, displace Propidium iodide, inhibit in vitro cholinesterase, and break down A were evaluated. The compound **(15a)** and **(15b)** was found to be most active. **[42]**

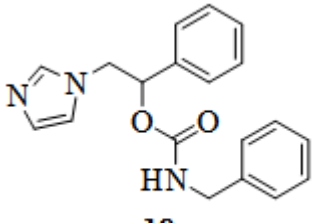
Drashti G.Daraji et al. (2021) derivatives of N-(4-((benzyl)oxy)phenyl)acetamide, which were produced as 2-((5-acetyl-1-(phenyl)-4-methyl-1H-imidazol-2-yl) thio).Imidazole derivative shown more anti-bacterial efficacy against the all bacterial strains tested, including VRE, ESBL, and MRSA strains. The molecule **(16a)** was determined to be the most effective. **[12]**



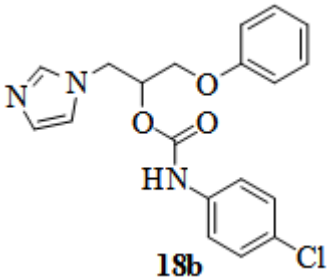
16a

Adel A. Marzouka et al. (2020) designed, synthesized, and tested for the anticonvulsant activity of tetra-substituted imidazole derivatives and imidazolidindiones via maximum electroshock testing using valproate sodium and convulsions produced by pentylene tetrazole and phenytoin sodium as reference drugs, respectively. Compounds (**17a)** and **(17b)** showed higher activity. **[1]**

AlessandraAmmazzalorso et al. (2020) created and manufactured imidazole and triazole derivative using carbamate. It was tested for in vitro kinetic study against human aromatase against letrozole. Additionally, molecular-level explanations of the binding mechanisms that will be employed to bind to the human aromatase will be provided through docking simulations. The result of human breast cancer cell line showed that compound **(18a)** and **(18b)** are more active. **[2]**



18a



18b

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

LinglingFan et al. (2020) synthesized and characterized 3,6-disubstituted imidazo [1,2-b]pyrazine. Using the mycelium growth rate method, the potency of these compounds against the nine phytopathogenic fungi was tested. These compounds, notably **(19a)** and **(19b),** have more antifungal in vitro action against Corn Curvalaria Leaf Spot than the widely used fungicide hymexazol. **[25]**

Lingling Fana et al. (2019) Spectroscopic experiments have been utilized to describe a class of newly created imidazo[1,2-b]pyridine that are 3,6-disubstituted. Using the mycelium growth rate method, the antifungal efficacy of these compounds against the nine phytopathogenic fungi was assessed. Compounds **(20a)** and **(20b)** were more potent. **[25]**

Vasilichia Antoci et al. (2019) designed, and synthesized bis-(benzimidazole/imidazole)-pyridine derivative tested for the antibacterial activity. Compound **(21a)** performed extremely well anti-tubercular activity against the both replicating and non-replicating Mtb. strains. Some of the synthesized compounds also have bacterial mechanism. **[49]**

Rajesh KumarSingh et al. (2019) created by the reaction Aryl-4-fluoro-5-(2-Chloropyridinyl) aryl-2 substituted derivatives of 2-(2-chloropyridin-4-yl) -1H-imidazoleethyl-4-fluorobenzoate reacts with 2-chloro-4-methylpyridine to produce 1-(4-fluorophenyl)ethanone, which is then cyclized with an aryl (or hetero aryl)aldehyde while being present in the ammonium acetate and acetic acid. Compounds **(22a)** and **(22b)** most potent for antimicrobial activity**. [38]**

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

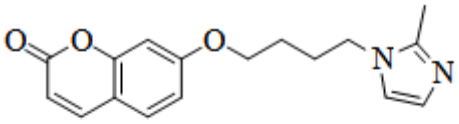
Sundaram M. et al. (2019) created and produced bisimidazoles and bisimidazo [1,2a] pyridines from Schiff base dimmers. Both compounds were tested for anti-cancer activity. The compounds **(23a)** show the most potent inhibitory effects against the breast tumor cell line (19, GI50 = 0.43 M; 24) and were much more potent than the control medication Adriamycin (GI50 = 0.51 M. **[20]**

Anupam et al. (2018) equimolar quantities of benzil and substituted benzaldehydes are used to create imidazole; the resultant mixture is then refluxed with acetyl chloride. For gram +ve (Staphylococcus aureus and Bacillus subtilis), gram -ve (E. coli and P. aureginosa), and fungal strain (Candida albicans) bacteria, all the produced compounds were evaluated using the agar diffusion techniques. The compound (**24a**) was more potent for antibacterial activity. **[8]**

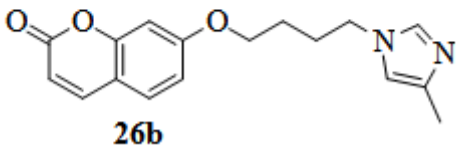
C. B. Pradeep Kumar et al. (2017) Based on 1,2,3-triazoles, a brand-new family of imidazole compounds has been developed. Utilizing spectral analysis including ^{1}H NMR, ^{13}C NMR, mass spectrometry, and the elemental analysis, the produced product is evaluated. In vitro, the compounds **(25a)** have strong anti-tubercular action. **[9]**

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

Yang Hu et al. (2017) A few coumarin compounds were created, produced, and physiologically assessed in an effort to utilize the synthesis of fatty acids as a lens through which to comprehend why bacteria are resistant to them. The structural study of coumarin indicated that its derivatives could be helpful for controlling and inhibiting the growth of microorganisms. Their antibacterial against Staphylococcusaureus and E.coliand demonstrated the strong antibacterial activity of compounds **(26a)** and **(26b). [53]**



26a



26b

NarasashettyJagadishbabu et al. (2017) The 2,4,5-triphenyl imidazole derivative is created by a three-component process involving ammonium acetate and aldehyde benzil.Compounds **(27a)** were identified using IR and ^{1}H NMR. **[35]**

Khaled R.A Abdellatif et al. (2017) created, manufactured, and evaluated for COX-2 inhibition of 5,4-H-imidazolone, 1,2-diaryl-4-substituted benzylidene derivatives. All of the substances were more COX-2 isozyme specific and had strong in vivo anti-inflammatory action. The compounds (**28a)** were more potent. **[23]**

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

Rutuja Sonawane et al. (2015) synthesis 1,5-disubstituted-4-chloro-IH-imidazoles and was tested for anticonvulsant activity. Imines and p-tolunesulfonyl methyl cyanide were used to create 5-disubstituted-4-chloro-IH-imidazole. Imines were produced utilizing commercially available amines and aldehydes. Compound (**29a)** and **(29b)** were more powerful in anticonvulsant action. **[40]**

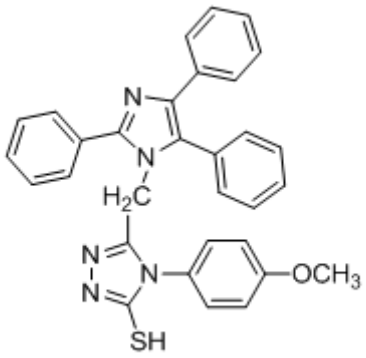
Harun M. Patel et al. (2013) synthesize and characterize [1,3,4]thiadiazole derivatives of 6-(4-nitrophenyl)-2-(1-methyl-1H-imidazol-2-yl) imidazo[2,1-b].The effectiveness of the compounds against Mycobacterium tuberculosis was evaluated with a MIC of 3.14 lg/ml, [1,3,4]thiadiazole**(30a)** showed the highest studied. **[18]**

Arzu Karakurt et al. (2012) a total of 23 brand-new nafimidone oxime ester compounds were created with the hope of developing anticonvulsant activity the rotorod test was used to detect neurological impairments. It was discovered that 18 substances prevented MES seizures. Aryl oxime ester compounds were discovered to be less active than alkyl and arylalkyl oxime ester derivatives. At all dosage levels, compound **(31a)** was the most active. **[8]**

M. Amir et al. (2011) synthesis of acetic acid hydrazide (2,4,5-triphenylimidazole-1-yl)has been used to create a digit of azole derivatives. Compounds **(32a)** evaluated for their anti-

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

inflammatory, antibacterial, and antifungal activities, each and every synthetic azole derivatives have moderate to excellent efficacy. **[26]**



32a

Balasubramanian Lakshmanan et al. (2011) synthesized 1-substituted imidazoles and their spectrum data was used to characterize them. At different doses (5, 10 and 20 mg/ml), was tested against Eudriluseugeniae, an African earthworm. It was found that every prototype was both vermicidal and vermifuge killing. The phenacyl imidazolescompounds **(33a)** were show important anthelmintic activity. **[10]**

V.S.V. Satyanarayna et al. (2010) As a crucial step in the creation of the Schiff bases, the production of 2-(2,4,5-Triphenyl-1H-imidazol-1-yl)acetohydrazide was performed **(34a).** Each molecule was then as shown by IR, ^{1}H NMR, and ^{13}C NMR, and HRMS spectrum analyses. Antioxidant and anti-cancer tests have been conducted on Schiff base molecules. **[48]**

II. CONCLUSION

Based on the above-presented literature survey we have underlined the importance of imidazole and its synthetic derivatives. In an attempt to help the medicinal chemists or pharmacists by researches, we have presented new, easy-to-use and environmentally safe synthetic strategies. This review presents further synthetic

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

approaches in applying the most usable strategy for obtaining a huge scope of modified imidazoles bearing different pharmacophores, allowing structures with better effects and low toxicity

REFERENCES

[1]. Adel A. Marzouka, Amr K. A. Bassb, Montaser Sh. Ahmeda, Antar A. Abdelhamidc,d, Yaseen A.M. M. Elshaiere, Asmaa MM Salmanf, and Omar M. Aly. "Design, synthesis and anticonvulsant activity of new imidazolidindione and imidazole derivatives." Bioorganic Chemistry (2020).

[2]. Alessandra Ammazzalorso, Marialucia GalloriniMarialuigiaFantacuzzi Nicola Gambacorta, Barbara De Filippis Letizia Giampietro Cristina Maccallini, Orazio Nicolott, Amelia Cataldi Rosa Amoroso. "Design, synthesis and biological evaluation of imidazole and triazole-based carbamates as novel aromatase inhibitors." European Journal of Medicinal Chemistry 211, (2021): 113115.

[3]. Ameen A. Abu-Hashem, Hoda A. R. Hussein and Khadeja M. Abu-zied. Synthesis of novel 1, 2, 4-triazolopyrimidines and their evaluation as antimicrobial agents." Medicinal chemistry research (2016).

[4]. Amita Verma, Sunil Joshi, and Deepika Singh. "Imidazole: Having Versatile Biological Activities." Journal of Chemistry (2013): 29412.

[5]. Andrzej Olczak, Tomasz Pawlak, Sylwia Kału˙zy ´nska Katarzyna Gobis, Izabela Korona-Głowniak, Katarzyna Su´sniak, Marcin Zaborowski and Małgorzata Szczesio. Structure and "Microbiological Activity of 1H-benzo[d]imidazole Derivatives." International Journal of Molecular Science 24, (2023): 3319.

[6]. Anna Bielenica, Ph.D., Joanna Stefańska, Karolina Stępień, Agnieszka Napiórkowska, Ewa Augustynowicz-Kopeć, Giuseppina Sanna, Silvia Madeddu, Stefano Boi, Gabriele Giliberti, Małgorzata Wrzosek and Marta Struga. "Synthesis, cytotoxicity andantimicrobial of thiourea derivatives incorporating 3-(trifluoromethyl)phenyl moiety, European Journal of Medicinal Chemistry 15, (2015): 30102.

[7]. Anupam, Al-Bratty M., Alhazmi A. H., Ahmad S.,Maity S., Alam S.M., and Ahsan W. "Synthesis and biological evaluation of triphenyl-imidazoles as a new class ofantimicrobial agents." European Journal of Chemistry 9, no (4) (2018): 369-374.

[8]. Arzu Karakurt, Mehmet A. Alagöz, Burcu Sayoglu, Ünsal Çalıs and Sevim Dalkara. "Synthesis of some novel 1-(2-naphthyl)-2-(imidazol-1-yl) ethanone oxime ester derivatives and evaluation of their anticonvulsant activity, Original article Synthesis of some novel 1-(2-naphthyl)-2-(imidazol-1-yl) ethanone oxime ester derivatives and evaluation of their anticonvulsant activity." European Journal of Medicinal Chemistry 57, (2012): 275-282.

[9]. Balasubramanian Lakshmanan, Wayne Huang, David Olmeijer and John W. Weidner. "Polyetheretherketone Membranes for Elevated Temperature PEMFCs."Electrochemical and Solid-State Letters 6, no. 12 (2011): 118-189.

[10]. C.B. Pradeep Kumar, B.S. Prathibha, K.N.N. Prasad, M.S. Raghu d, M.K. Prashanth B.K. Jayanna, Fahad A. Alharthi, S. Chandrasekhar, H.D. Revanasiddappa, K. Yogesh Kumar." Click synthesis of 1,2,3-triazole based imidazoles: Antitubercular evaluation, molecular docking and HSA binding studies." Bioorganic & Medicinal Chemistry Letters 36, (2021): 127810.

[11]. Deepika Sharma, Balasubramanian Narasimhan, Pradeep Kumar, Vikramjeet Judge Rakesh Narang Erik De Clercq and Jan Balzarini. "Synthesis, antimicrobial and antiviral evaluation of substituted imidazole derivatives." European Journal of Medicinal Chemistry 44, (2009): 2347–2353.

[12]. Delia Hernández Romero, Víctor E. Torres Heredia, Oscar García-Barradas, Ma. Elizabeth Márquez López & Esmeralda Sánchez Pavón. "Synthesis of Imidazole Derivatives and Their Biological Activities." Journal of Chemistry and Biochemistry 2, no. 2 (2014) 45-83.

[13]. Drashti G. Daraji, Dhanji P. Rajani, Smita D. Rajani, Edwin A. Pithawala, Sivaraman Jayanthi and Hitesh D. Patel. "Structure based design, synthesis, and biological evaluation of imidazole derivatives targeting dihydropteroate synthase enzyme." Bioorganic & Medicinal Chemistry Letters 36, (2021): 127819.

[14]. Dumitrela Diaconu, Vasilichia Antoci, Violeta Mangalagiu and Dorina

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 1 Jan - Feb 2025, pp: 1219-1234 www.ijprajournal.com ISSN: 2456-4494

Amariucai-Mantu. "Quinoline–imidazole/benzimidazole derivatives as dual-/multi-targeting hybrids inhibitors with anticancer and antimicrobial activity." Rev. Roum. Chim. 67, no. (1-2) (2022): 89–92.

[15]. Elizabeth and Temidayo Oluwayemi. "Imidazole derivative improves antioxidant status and causes differential alteration of redox-status in Drosophila melanogaster alteration of redox-status in Drosophila melanogaster." Karbala International Journal of Modern Science 8, no 1 (2022).

[16]. Fernanda Souza Macchi, Kenia Pissinate, Anne Drumond Villela, Bruno Lopes Abbadi, Valnês Rodrigues-Junior, Débora Dreher Nabinger, Stefani Altenhofen, Nathalia Sperotto, Adílio da Silva Dadda, Fernanda Teixeira Subtil, Talita Freitas deFreitas, Ana Paula Erhart Rauber, Ana Flávia Borsoi, Carla Denise Bonan, Cristiano Valim Bizarro, Luiz Augusto Basso, Diógenes Santiago Santos, Pablo Machado. "1H-Benzo[d]imidazoles and 3,4-dihydroquinazolin-4-ones: Design, synthesis and antitubercular activity." European Journal of Medicinal Chemistry (2018).

[17]. Gyanendra Kumar sharma and Devender pathak. "Microwave-Assisted, Solvent-Free and Parallel Synthesis of Some Novel Substituted Imidazoles of Biological Interest." Chem. Pharm. Bull. 58, no 3 (2010): 375-380.

[18]. H.R. Parabh and C.B. Dixit. "Synthesis, Characterization and AntimicrobialActivity of Imidazole Derivatives Based on 2-chloro-7-methyl-3-formylquinoline." E-Journal of Chemistry9, no 3 (2012):1188-1195.

[19]. Harun M. Patel Malleshappa N. Noolvi, Navdeep Singh Sethi, Andanappa K. Gadad, Swaranjit Singh Cameotra. "Synthesis and antitubercular evaluation of imidazo[2,1-b][1,3,4]thiadiazolederivatives."Arabian Journal of Chemistry10, no. 9 (2017).

[20]. Heba E Hashem, Eman S Nossier, Abd El-Galil E Amr, Elsayed A Elsayed and Eman M Azmy. "Synthesis, Antimicrobial Activity and Molecular Docking of Novel Thiourea Derivatives Tagged with Thiadiazole, Imidazole and Triazine Moieties as Potential DNA Gyrase and Topoisomerase IV Inhibitors." Molecules 25, no. 12 (2020): 2766.

[21]. K. Shelkea, G. Kakadea, B. Shingateb and M. Shingare. "Microwave-induced one-pot synthesis of 2,4,5-triarylimidazoles using glyoxylic acid as acatalyst under solvent-free conditions." National Chemical Laboratory 1, no.3 (2008): 489-494.

[22]. K.D. Tripathi. "Essential of Medical pharmacology". Published by Jaypee Brothers Pvt. Ltd Seventh Edition (2013): 635.

[23]. K. Nandini and S.Suriya. "A Review of Potential Impact of Climate Change on Global Water." Journal of University of Shanghai for Science and Technology 22, no. 10 (2020): 1007-6735.

[24]. Khaled R.A. Abdellatif and Wael A.A. Fadaly. "New 1,2-diaryl-4-substituted-benzylidene-5-4H-imidazolone derivatives: design, synthesis and biological evaluation as potential anti-inflammatory and analgesic agents." Bioorganic Chemistry 720, (2017): 123-129.

[25]. Khodairy Ahmed, Ahmed EA, Ismaed M., Mohamed K. and Thabet SA. "Design and synthesis of some new Analgesic azole derivatives containing tramadol moity." Journal of Heterocyclic Chemistry 56, no. 3 (2019): 1055-62.

[26]. Lingling Fana ,ZhongfuLuoa , Yi Lia , XinyunLiua, Judi Fana, Wei Xueb, Lei Tanga and Yong Li. "Synthesis and antifungal activity of imidazo[1,2-b]pyridazine derivatives against phytopathogenic fungi." Eur J Med Chem (2020): 1-16

[27]. M. Amir, I. Ahsan, W. Akhter, A S Khan & I. Ali. "Design and synthesis of some azole derivatives containing 2,4,5-triphenyl imidazole moiety as anti-inflammatory and antimicrobial agents." Indian Journal of Chemistry 50, (2011): 207-213.

[28]. Marija B. Petrovic, Mihajlovic, Milan B. Radovanovic, Zaklina Z. Tasic and Milan M. Antonijevic. "Imidazole based compounds as copper corrosion inhibitors in seawater." Journal of Molecular Liquids (2016).

[29]. Marwa A.M.Sh. El-Sharief, Abbas Y. Samir, Ahmed M.Sh. El-Sharief, Nermien M. Sabry, Shahenda M. EI-Messery, Ahmed R. Elsheakh, Ghada S. Hassan, Mardia T. El Sayed. "5-thioxoimidazolidine-2-one derivatives: synthesis, anti-inflammatory activity, analgesic activity, COX inhibition assay and molecular modelling study." Bioorganic Chemistry 1, no. 8 (2019): 679-89.

[30]. Maxime Beuvin, Maxime Manneveau, Sonia Diab Baptiste Picard, Morgane Sanselme ,Serge R. Piettre, Julien Legros and Isabelle Chataigner. "New synthesis of imidazole derivatives from cyanobenzenes." Tetrahedron Letters 59, (2018): 4487–4491.
[31]. Mazin N. Mosa, Roaa S. Baiwn, Ali K. Mohammed. "Synthesis and Characterization of the Novel Compounds ContainingImidazole, Thiadiazole, Schiff Base, and Azetidinone Chromospheres as New Antibacterial Agents." Journal of Drug Delivery Technology 10, no. 4 (2020): 602-607.
[32]. Mohammed kareemsamad, Farouq Emam Hawaiz. Synthesis, characterization, antioxidant power and acute toxicity of some new azo-benzimide and azo-imidazolone derivatives with in vivo and in vitro antimicrobial evaluation, Bioorganic Chemistry 18, (2019): 31359.
[33]. Mr.Rohit Keshav Dimote and Asst. Prof. KhandreRajeshre. "Synthesis of 2,4,5 triphenyl imidazole." International Journal of Creative Research Thoughts (IJCRT) 10, no. 6 (2022): 2320-2882.
[34]. Munish Kumar, Deepak Kumar and Vinit Raj. "Studies on Imidazole and its Derivatives with Particular Emphasis on Their Chemical/biological Applications as Bioactive Molecules/Intermediated to Bioactive Molecule." Current Synthetic and Systems Biology 5, no 1 (2017): 1000135.
[35]. N.C. Desai, A.S. Maheta, K.M. Rajpara, V.V. Joshi, H.V. Vaghani and H.M. Satodiya. "Green synthesis of novel quinoline based imidazole derivatives and evaluation of their antimicrobial activity." Journal of Saudi Chemical Society (2011).
[36]. NarasashettyJagadishbabu and Kalegowda Shivashankar. "One-Pot Synthesis of 2,4,5-Triphenyl Imidazoles from 1,2-Diols as Key Reagents." J. Chin. Chem. Soc. (2017).
[37]. Periyasamy Ramanathan. "Synthesis, Spectral Characterization and Biological Studies of 2-(4-Methoxynaphthalen-1-Yl)-1-(4-Methoxyphenyl)-1H-Phenanthro[9,10 D]Imidazole." Modern Chemistry & Applications 5, no 4 (2017): 1000242.
[38]. Pratik G. Shobhashana, Pratibha Prasad, Anirudhdha G. Kalola, Manish. P. Patel. "Synthesis of imidazole derivatives bearing quinoline nucleus catalysed by can and their antimicrobial, antitubercula and molecular docking studies." Life Science Informatics Publications 4, no (3) (2018): 175.
[39]. Rajesh Kumar Singh, Ashish Bhatt and Ravi Kant. "Design and synthesis of some novel imidazole derivatives as potent antimicrobial & antimalarial agents." Der Pharmacia Lettre 8, no (7) (2016): 2016188-194.
[40]. Rajesh Kumar Singh, Kaushal Chandrul, Biswa Mohan Sahooa and Ravi Kant "Facile. Synthesis, characterization and in vitro anti-Tubercular screening of novel imidazole Incorporated heterocyclic 2-substituted aryl-4-Fluoro phenyl-5-(2-chloropyridinyl)-1h-imidazole derivatives." World Journal of Pharmaceutical Research 8, no 12 (2019): 1005-1013.
[41]. Rutuja Sonawane and Dr. Chandrakant Magdum. "Synthesis, Anticonvulsant Acitivity and Screening of Some Novel 1,5-Disubstituted-4-Chloro-IH-Imidazole Derivatives." Asian Journal of Biomedical and Pharmaceutical Sciences (2015).