ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 9, Issue 6, June 2022

Comprehensive Study of Biological Aspects of Heteroring Annelated Benzothiazoles

[1] Vatsala Soni*, [2] Meenakshi Sharma, [3] Vandana Singh, [4] Vaishali Soni, [5] D. Kishore

[1][2][3][5] Department of Chemistry, Banasthali University, Rajasthan, India
[4] School of Public Health, PGIMER, Chandigarh, India

Abstract*— Heterocyclic chemicals are chemical structures which include at least a single carbon molecule plus at least one other element, such as sulphur, oxygen, or nitrogen, within the ring structure. Benzothiazoles are discussed in terms of synthesis methodologies, structural changes, chemical reactivity, and possible pharmaceutical effectiveness. This research relied upon secondary data obtained from the sources. The qualitative method was used to provide a section of such an evaluation which looked flawless and accurate. A handy methodology strategy is used in inquiry research. Heterocyclic compounds have been widely exploited in bioorganic and medical research for medication development. Scientists are interested in such compounds because of their various physicochemical and pharmacological properties. Recognizing heterocycles is advantageous in both industrial and biological processes. Benzothiazole, a molecular heterocyclic structure, is being studied as a candidate for such creation of larger, often medicinal chemicals. It is highly durable due to its aromatic components; however, it has reactive services that offer the synthesis method. The benzothiazole ring becomes an important framework for the production of colours used throughout the identification of lanthanide metal cations in aqueous environments. This identical basic N, S heterocycle, benzothiazoles, seems to be abundant; for example, it is required essential thiamine action (vitamin B1). Thiazole compounds could also be discovered in medications such as Nosiheptide. This chemistry group is used for about simply for antibacterial purposes; its distinctive heteroring linked derivatives have attracted the curiosity of scientists due to their various biological or indeed medicinal properties.

Index Terms*— Synthesis, Benzothiazole derivatives, biological interest, heteroaromatic structures, heterocyclic molecules

I. INTRODUCTION

A significant emphasis of study within chemical biology has been the quest for component libraries composed of tiny compounds containing possible biological functions. As a result, the advances in technological strategies for accessing tiny compounds with therapeutic use are of particular significance (Prabha et al., 2021). Heterocyclic compounds include chemical molecules that include at most 1 carbon molecule including at minimum 1 additional component, including sulphur, oxygen, and even nitrogen, inside the main chain. Heterocyclic compounds remain abundant and are also necessary for classification in a variety of manners. Several benzothiazole derivatives having diverse biological processes have been utilised through chemical synthesis, several industrial as well as commercial items, and pharmaceuticals. Benzothiazoles, cover synthesis techniques, structural modifications, reactivities, as well as potential pharmacological efficacy (Irfan et al., 2020). [1] Traditional multiphase operations along with one-pot atomic economics procedures employing green chemical concepts including readily accessible chemicals are used to synthesise such heterocycles. The main objectives of this work is to explore the chemistry of synthesis of heteroring annelated Benzothiazole derivatives, investigate the biological activity of synthesis of heteroring annelated Benzothiazole derivatives and suggest appropriate strategies to better study the synthesis of heteroring annelated Benzothiazole derivatives. Because of their strong pharmacological as well as biological activity, benzothiazoles had already performed an essential function within biochemistry as well as pharmaceutical applications. The creation of chemical synthesis constitutes without a question among the foremost pressing issues confronting scientists (Pathak et al., 2020).[2] In this research article, researchers discussed significant advancements inside the heteroring annelated benzothiazole derivatives compounds derived from its evaporation of 2-amino benzenethiol of rather aldehydes/ketones/acids/acyl chloride ions but also such carbonylation of thioamide but rather carbon dioxide (CO2) as natural resources, including the potential advancement tendency and prospects of benzothiazole synthesising derivatives.

II. LITERATURE REVIEW

According to Djuidje et al., (2020) [3] they have been commonly used in bioorganic as well as medicinal science for developing drugs. Benzothiazole moiety has been found in a variety of molecules with diverse biological functions. Because of their own broad range of pharmacodynamic uses, heterocyclic chemicals constitute extremely important. Because of highly diverse physicochemical as well as pharmacological effects, such molecules have piqued the interest of scientists as well as scientists. As per Sankar et al., (2020) [4] a highly abundant of physiologically relevant heterocyclic chemicals remain defined within the research, although this quantity is continually rising; as a result, **research studies** about the topic are immense. Heterocyclic compounds are abundant also in a range of synthetic substances. A significant percentage of heterocyclic molecules have been required for humans to live. Alkaloids,

antibiotics, vital amino groups, minerals, haemoglobin, enzymes, and thereby a wide range of synthesized medications including colours all comprise **heteroaromatic structures.** [24] Understanding heterocyclic compounds provides beneficial in both manufacturing and even biochemical changes. Nucleic molecules have a role in biochemical functions such as inheritance and development. **Several synthetic heterocyclic molecules** have vital uses, including several are useful intermediaries during synthesis. Because of their strong phytochemical or even pharmaceutical action, heterocyclic substituents having bonded benzene plus thiazole chains including electron-rich heterocyclic rings, plus sulphur have caught the imagination of scientists regarding drug creation.

As opined by Mohapatra et al., (2021) [5] heterocycles with nitrogens form the central architecture of one variety of essential biologically chemical ingredients as well as perform a significant part in the metabolic of **biological systems.** Their own functional uses span from widespread therapeutic implications to farming, cinematography, and biocide synthesis, including polymer chemistry, among others. As opined by Mohapatra et al., (2021)[6] the spectra of active constituents appear nearly infinite, spanning a wide variety of mechanical, biochemical, or rather **biological characteristics.** Among the most, extensively researched use of heterocycles has been towards the synthesis of physiologically functional as well as medicinally significant compounds. As opined by Subramanyam et al., (2018)[7] the creation of particular biomolecular objectives, that typically have a heterocyclic element, has been the emphasis of contemporary drug development. The discovery of novel routes as well as the enhancement of current routes remains a major issue in the synthesizing of these molecules. According to a review of related evidence regarding nitrogen, and sulphur heterocycles, this thiazole core has significant **pharmacological characteristics.** Several pharmacologically important drugs with noteworthy therapeutic effects have heterocyclic frameworks with thiazole nuclei linked with benzene rings.

Upon the premise, those are the highest probable compounds being explored as pioneer compounds in the search for innovative medicinal purpose powerful medicines. And including conventional methods, practical or even ecologically responsible alternate processes relying on widely accessible chemicals plus green chemical concepts have been established. As opined by Payaz et al., [8] (2019) they eliminate the usage of hazardous chemicals as well as reduce the development of byproducts. Several processes were carried out with freshwater also as solvents, which makes the procedure more inexpensive. **Benzothiazole, becoming a chemical heterocyclic molecule**, is used for an investigation as a beginning precursor for the production of bigger, typically bioactive compounds. Because of one's aromatic compounds, it is very durable; nonetheless, being a heterocycle, this possesses reactivity sites that enable the synthesis process. As per Sever et al., (2019) [9] **benzothiazole** is not used in the home. It's also utilised in manufacturing as well as investigation. This **benzothiazole** nucleus is used to manufacture a wide range of medicinal medicines. There have been several noteworthy advancements in the bioactivities with benzothiazole compounds within current history. Because of their own exceptional pharmacological possibilities, such molecules have significant relevance inside the domain of biomedical sciences.

Inside the elimination of fluids, employing catalysis may typically improve the efficacy or even specificity of multiphase processes. Furthermore, technologies determined by the combination **utilisation of ultrasonic irradiation** with multicomponent reactions using environmentally acceptable solvent rather than in the solvent-free protocol have been increasingly widely employed. As per Sever et al., (2019) [10] the benzothiazole circle has become a critical scaffolding for such synthesis of dyes utilised inside the detection of lanthanide metallic ions through aqueous media. Among the greatest prominent industrial uses using benzothiazole compounds include corroding regulators including **[23] surface-active related compounds** used in mineral extraction. They have antioxidant effects as well. Certain benzothiazole compounds are effective pesticides or rather herbicides. Thiazole, one basic N, S heterocycle, appears quite available in large quantities; for instance, it's indeed essential for thiamine activity (vitamin B1). Thiazole rings can likewise be found in medicines like Nosiheptide. As opined by Kumar et al., (2020) [11] **benzothiazoles,** on either hand, remain very uncommon among natural ingredients, presumably since the biosynthetic pathway towards the ring structure wasn't as clear as what appears with thiazoles. The prevalence of benzothiazoles in chemistry research is certainly due to the diverse biological responses they evoke in fighting a number of bodily illnesses. This family of chemicals is employed for more than only antimicrobial activities; their unique heteroring fused derivatives have piqued the interest of researchers owing to their own diverse biological or otherwise therapeutic features.

III. METHODOLOGY

This work examines the concept, organisation, or methods used to develop the article. This study was conducted using secondary information from the internet. Only as result, the qualitative approach was employed to produce a portion of such an assessment that appears faultless plus correct (Emerson, 2021). [12] Investigators, on either hand, employ such techniques to contact their audience in a lovely manner using their scientific report about literary proof. Nevertheless, as per moral guidelines, the information supplied inside the article must be true, or the individual who offers their identity must not be presented in either situation. In such a study, philosophical interpretivism is already applied to present everyone with a specific article.

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 9, Issue 6, June 2022

Interpretivism has become a person's viewpoint upon the topic rather than a particular person's viewpoint as information is retrieved after that standpoint. The potential study expects to provide an in-depth understanding of such participants' experiences through interpretivism (Andrade, 2021). [12] Therefore, the observer understands why one person addressed the query in this way. Throughout this scientific report, this researcher had performed the similar with several literary works he had studied for such contents with this document, then following comprehending, he has supplied the argument such that audience may connect towards the document too though.

- **Research approach and design**

In the scientific report, the deductive fashion method is utilised for enhancing the investigation manner plus it additionally aids in investigating or demonstrating the link among the covariate with themes[22] (Archibald et al., 2019). The scholars utilise this method to be more effective while producing the article upon the premise of certain objective facts. Several authors employ this approach as it's ideal for conducting research about it plus users will be drawn to it. This descriptive study with this article, on either extreme, provides it simple for such purchasers to digest this argument by studying it simply. Nevertheless, initially, the researcher aspires for such a descriptive approach to give meaningful work without becoming perfect in either element.

- **Data collection method and its source**

This study is focused entirely on the elements of the library discovered during investigations, together with appropriate proof to substantiate these inside the inquiry (Lobe et al., 2020).[13] It's also a qualitative stylish payment ecosystem scientific article, so this would be an actuality gathering publication without errors, with non-primary data frame or supplementary attribute values, as well as there were indeed numerous influencing fragments of hypotheses that such researcher has utilised to construct the correlation among the subject matters to continue providing the definitive results.

- **Sampling**

In order to achieve the greatest results within the argument, the investigation study employs a convenient methodological approach (Moser & Korstjens, 2018). [14] This approach selects a number of persons out of a large collection, but also a selection of papers or even publications is selected consistently from its subgroups. Utilizing a sample strategy inside the scientific report would boost the worth of such an argument supplied plus make it easier for the customer to grasp.

- **Data analysis**

The findings inside this investigation study include descriptive analysis that has been examined based upon the findings of such topic or material analyses. Based on such characteristics, the examination of the material reveals that such information inside this work is well-written and accurate owing to its presence of specific proof (Woiceshyn & Daellenbach, 2018). [15] The qualitative approach is employed inside this scientific report, and such reasoning language is utilized to fully describe the ideas inside the study. Furthermore, the researcher's comprehensive handwriting has assisted him with providing every shred of information properly from its literary background.

- **Ethical consideration**

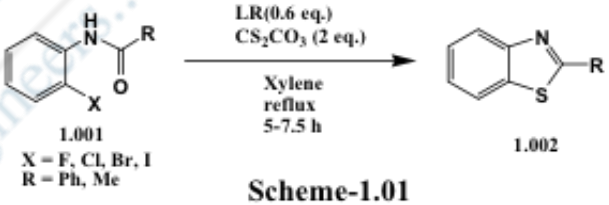
The researcher must focus on particular ethical requirements inside the research article, that are critical to comprehend while producing each journal article. Because the information should be de-identified prior have been sent to the publication, such information utilised should not cause harm or injury to everybody.

- **Summary**

Researchers learned a lot regarding the architecture with this investigation report as well as the techniques or techniques needed for making it exact and thorough from the whole approach section. A research article seems critical, and producing it requires an understanding of such procedures. Alternatively, the document would be perfect and pointless inside the conclusion. The strategies employed in this study endeavour make it highly approachable.

IV. RESULTS AND DISCUSSION

- **Benzothiazole Synthetic properties**



1.001

X = F, Cl, Br, I
R = Ph, Me

1.002

Scheme-1.01

Shorter response durations, large-scale synthesis, effective or even rapid separation of such compounds, outstanding chemoselectivity, plus outstanding efficiencies are the key benefits of such a straightforward approach for such synthesis of such 2-substituted benzimidazoles including benzothiazoles (Strus et al., 2021). [16]Several benzothiazoles have been produced in excellent quantities through a cyclization condensation reaction of thioformanilides throughout dichloromethane employing 2,6-dichloro-3,5-dicyano-1,4-benzoquinone (DDQ). The mixture of Bromo dimethyl sulfonium bromine (BDMS) plus ammonia thiocyanate was used to effectively thiocyanate a wide variety of aliphatic as well as heteroaromatic chemicals (Chakraborty et al., 2018).[17] Within solvent-free microwave-assisted production synthesized 2-substituted benzothiazoles using carboxylic or rather 2-amino thiophenol, Lawesson's solution became an effective activator. Several cyclic, hetero aromatics, including aliphatic organic molecules, interact significantly better returns underneath the circumstances established.

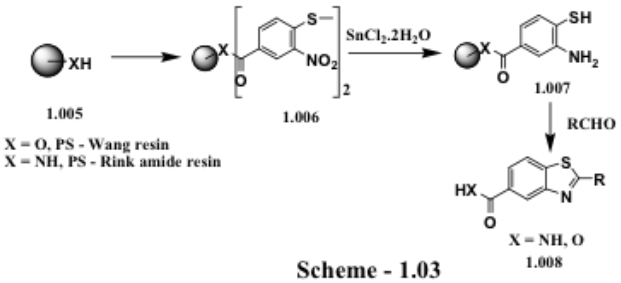
ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 9, Issue 6, June 2022

Scheme-1.02

- **Chemistry of synthesis of heteroring annelated Benzothiazole derivatives**



Scheme - 1.03

A technique enabling the manufacturing of **benzothiazole derivatives** provides disclosed within innovation. Thiourea has been employed like a sulphur supply, whereas three-step transformation has been used to constantly transform thiourea with o-fluoronitrobenzene derivatives producing benzothiazole compounds (Ikpa et al., 2020).[18] Carbazoles including substituted carbazoles joined containing heterocyclic rings have been of particular significance due because the wide range of carbazole alkaloids having antibacterial, antifungal, as well as cytotoxic activities. Carbazoles become a significant characteristic of an anticancer drug that has expanded significantly within the last 3 generations. **Carbazole derivatives can be located** within a range of biological active items including pharmacological molecules (Kundu et al., 2019).[19] They include significant heteroaromatic chemicals widely employed as basic components inside the creation of prospective electroluminescent substances, polymers exhibiting beneficial thermoelectric characteristics, including host equipment enabling triplet transmitters through organic light-emitting devices.

Scheme - 1.04

- **Aspects of biology**

Thiazole, this same basic N, S heterocycle, appears quite available in large quantities; for instance, it's indeed essential for thiamine activity (vitamin B1). Thiazole groups can likewise be found within medicines like Nosiheptide. Benzothiazoles, on either hand, are very uncommon as organic ingredients, presumably since the biosynthetic pathway towards the compound wasn't as clear as those with thiazoles (Ballari et al., 2019).[20] The prevalence of benzothiazoles in chemistry research is certainly due to the varied biological responses they evoke in fighting a number of bodily illnesses. This family of chemicals is employed for more than only antimicrobial activities; their unique heteroring bonded derivatives had piqued the interest of researchers owing to their own diverse biology or even therapeutic features. Because of potential valuable biological as well as medicinal [21] features, heterocyclic molecule equivalents, as well as compounds, had also sparked a lot of attention in previous generations. This benzothiazole centre is found in chemicals used in studies to examine innovative brands with biological functions including antiglutamate, anti-convulsant, anti-microbial, anti-inflammatory properties, anthelmintic, antirheumatic, anti-tumour, or even anti-leishmania, among others. Benzothiazoles are such a bicyclic linear combination with several uses. Whenever the pharmacological characteristic of such a sequence has been identified, biologists were intrigued by it. Following this, benzothiazole derivatives were intensively researched as well as discovered to exhibit a variety of chemical interactions as well as a broad range of biologically active compounds.

V. CONCLUSION

The benzothiazole structure appears recognized to have a diverse set of pharmacologic characteristics. Given the wide variety of actions of such molecules, it became thought useful to investigate the synthesis for heterocyclic complexes comprising the aforementioned nuclei united towards the benzothiazole frameworks inside the current study. It became thought that such production of such compressed heterocyclic complexes plus an examination of underlying biological features could give a systematic framework for the analysis of such compounds' structure-activity connection.

VI. RECOMMENDATION

- Inside the science of synthesis of heteroring annelated Benzothiazole derivatives, there's also a bunch of interesting material to acquire or rather memorise, just like in every other discipline (Ma et al., 2019). In reality, there will constantly be so much original stuff offered to students when users start to recollect equations that individuals will rapidly become weighed down when individuals become tangled up with attempting to recall these all intricacies. Initially, concentrate on grasping essential ideas. After users acquire a firm grasp upon those principles, readers may devote effort to memorising the intricacies.
- There's really no alternative for practical studying knowledge whenever it pertains to comprehending or studying chemistry because there is certainly no greater method of obtaining this knowledge than via visiting chemical laboratories (Gupta, A. (2019). Reap the benefits of any possibility of working inside the laboratory that comes your way. Thinking with chemistry difficulties including carrying out chemical investigations inside a realistic context would improve overall comprehension and cognitive domain.
- A well-organized research team would be an excellent

approach to handling almost difficult topics, especially chemistry. Analytical chemists may use research projects to communicate unique thoughts, debate things, clarify complicated issues to others, convey whatever they have studied, compare documents, prepare for examinations, and explore extra content.

REFERENCES

[1] Andrade, C. (2021). The inconvenient truth about convenience and purposive samples. *Indian Journal of Psychological Medicine*, *43*(1), 86-88. DOI: https://journals.sagepub.com/doi/full/10.1177/0253717620977000

[2] Archibald, M. M., Ambagtsheer, R. C., Casey, M. G., & Lawless, M. (2019). Using zoom videoconferencing for qualitative data collection: perceptions and experiences of researchers and participants. *International journal of qualitative methods*, *18*, 1609406919874596. DOI: https://journals.sagepub.com/doi/pdf/10.1177/1609406919874596

[3] Ballari, M. S., Cano, N. H., Wunderlin, D. A., Feresin, G. E., & Santiago, A. N. (2019). One-pot sequential synthesis and antifungal activity of 2-(benzylsulfonyl) benzothiazole derivatives. *RSC advances*, *9*(50), 29405-29413. DOI: 10.1039/C9RA04488D

[4] Chakraborty, B. B., Anwar, S., Das, S., Paul, S. B., Mohiuddin, G., De, J., & Choudhury, S. (2018). Aggregation dependent fluorescence switching in benzothiazole derivative based H-bonded mesogen. *Liquid Crystals*, *45*(11), 1644-1653. DOI: https://www.tandfonline.com/doi/full/10.1080/02678292.2018.1468499

[5] Djuidje, E. N., Sciabica, S., Buzzi, R., Dissette, V., Balzarini, J., Liekens, S., ... & Baldisserotto, A. (2020). Design, synthesis and evaluation of benzothiazole derivatives as multifunctional agents. *Bioorganic Chemistry*, *101*, 103960. DOI: https://doi.org/10.1016/j.bioorg.2020.103960

[6] Emerson, R. W. (2021). Convenience sampling revisited: Embracing its limitations through thoughtful study design. *Journal of Visual Impairment & Blindness*, *115*(1), 76-77. DOI: https://journals.sagepub.com/doi/pdf/10.1177/JVBA_115_1#page=78

[7] Gupta, A. (2019). Synthesis of novel nitro substituted benzothiazole derivatives and antibacterial activity against pseudomonas aeruginosa. *Research Journal of Pharmacy and Technology*, *12*(10), 4663-4668. Retrieved from: https://www.researchgate.net/profile/Akhilesh_Gupta17/publication/336284521_Synthesis_of_Novel_Nitro_Substituted_Benzothiazole_Derivatives_and_Antibacterial_activity_against_Pseudomonas_aeruginosa/links/5d99864f299bf1c363fb31ed/Synthesis-of-Novel-Nitro-Substituted-Benzothiazole-Derivatives-and-Antibacterial-activity-against-Pseudomonas-aeruginosa.pdf

[8] Ikpa, C. B., Onoja, S. O., & Okwaraji, A. O. (2020). Synthesis and antibacterial activities of benzothiazole derivatives of sulphonamides. *Acta Chemica Malaysia*, *4*(2), 55-57. Retrieved from: https://www.researchgate.net/profile/Samuel-Onoja-2/publication/342556558_Synthesis_And_Antibacterial_Activities_Of_Benzothiazole_Derivatives_Of_Sulphonamides/links/5efb2dfe45851550507e26bf/Synthesis-And-Antibacterial-Activities-Of-Benzothiazole-Derivatives-Of-Sulphonamides.pdf

[9] Irfan, A., Batool, F., Zahra Naqvi, S. A., Islam, A., Osman, S. M., Nocentini, A., ... & Supuran, C. T. (2020). Benzothiazole derivatives as anticancer agents. *Journal of enzyme inhibition and medicinal chemistry*, *35*(1), 265-279. DOI: https://www.tandfonline.com/doi/full/10.1080/14756366.2019.1698036?af=R&utm_source=researcher_app&utm_medium=referral&utm_campaign=RESR_MRKT_Researcher_inbound

[10] Kumar, S., Mittal, A., Pathak, A., & Sahu, S. K. (2020). Biological assessments of substituted benzothiazole derivatives in streptozocin induced diabetes rats. *Plant. Arch*, *20*, 3250-3253. Retrieved from: http://www.plantarchives.org/SPL%20ISSUE%2020-2/535__3250-3253_.pdf

[11] Kundu, A., Karthikeyan, S., Sagara, Y., Moon, D., & Anthony, S. P. (2019). Temperature-Controlled Locally Excited and Twisted Intramolecular Charge-Transfer State-Dependent Fluorescence Switching in Triphenylamine–Benzothiazole Derivatives. *ACS omega*, *4*(3), 5147-5154. DOI: https://doi.org/10.1021/acsomega.8b03

[12] Lobe, B., Morgan, D., & Hoffman, K. A. (2020). Qualitative data collection in an era of social distancing. *International journal of qualitative methods*, *19*, 1609406920937875. DOI: https://journals.sagepub.com/doi/pdf/10.1177/1609406920937875?%5D

[13] Ma, J., Ni, X., Gao, Y., Huang, K., Liu, J., Wang, Y., ... & Wang, C. (2019). Identification and biological evaluation of novel benzothiazole derivatives bearing a pyridine-semicarbazone moiety as apoptosis inducers via activation of procaspase-3 to caspase-3. *Medchemcomm*, *10*(3), 465-477. DOI: 10.1039/c8md00624e

[14] Majalakere, K., Kunhana, S. B., Rao, S., Kalal, B. S., Badiadka, N., Sanjeev, G., & Holla, B. S. (2020). Studies on imidazo [2, 1-b][1, 3] benzothiazole derivatives as new radiosensitizers. *SN Applied Sciences*, *2*(11), 1-8. DOI: https://link.springer.com/article/10.1007/s42452-020-03726-7

[15] Mohapatra, R. K., Dhama, K., El–Arabey, A. A., Sarangi, A. K., Tiwari, R., Emran, T. B., ... & Abdalla, M. (2021). Repurposing benzimidazole and benzothiazole derivatives as potential inhibitors of SARS-CoV-2: DFT, QSAR, molecular docking, molecular dynamics simulation, and in-silico pharmacokinetic and toxicity studies. *Journal of King Saud University-Science*, *33*(8), 101637. DOI: https://doi.org/10.1016/j.jksus.2021.101637

[16] Moser, A., & Korstjens, I. (2018). Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. *European journal of general practice*, *24*(1), 9-18. DOI: https://www.tandfonline.com/doi/pdf/10.1080/13814788.2017.1375091

[17] Pathak, N., Rathi, E., Kumar, N., Kini, S. G., & Rao, C. M. (2020). A review on anticancer potentials of benzothiazole derivatives. *Mini reviews in medicinal chemistry*, *20*(1), 12-23. Retrieved from: https://www.researchgate.net/profile/Suvarna-Kini/publication/334080502_A_Review_on_Anticancer_Potentials_of_Benzothiazole_Derivatives/links/623aa5c495678e261284981c/A-Review-on-Anticancer-Potentials-of-Benzothiazole-Derivatives.pdf

[18] Payaz, D. Ü., Küçükbay, F. Z., Küçükbay, H., Angeli, A., & Supuran, C. T. (2019). Synthesis carbonic anhydrase enzyme inhibition and antioxidant activity of novel benzothiazole derivatives incorporating glycine, methionine, alanine, and phenylalanine moieties. *Journal of enzyme inhibition and*

medicinal chemistry, *34*(1), 343-349. DOI: https://www.tandfonline.com/doi/pdf/10.1080/14756366.2018.1553040

[19] Prabha, K., Satheeshkumar, R., & Prasad, K. R. (2021). Synthesis and Cytotoxicity of Novel Indoloquinolines and Benzonaphthyridines from 4- Chloro- 2, 8- dimethylquinoline and Variety of Hetero Amines. *ChemistrySelect*, *6*(28), 7136-7142. DOI: https://chemistry-europe.onlinelibrary.wiley.com/doi/10.1002/slct.202101269

[20] Sankar, V., Karthik, P., Neppolian, B., & Sivakumar, B. (2020). Metal–organic framework mediated expeditious synthesis of benzimidazole and benzothiazole derivatives through an oxidative cyclization pathway. *New Journal of Chemistry*, *44*(3), 1021-1027. Retrieved from: https://www.researchgate.net/profile/Sankar-Velayutham/publication/337893086_Metal-organic_framework_mediated_expeditious_synthesis_of_benzimidazole_and_benzothiazole_derivatives_through_oxidative_cyclization_pathway/links/5fa440e8a6fdcc062415ad45/Metal-organic-framework-mediated-expeditious-synthesis-of-benzimidazole-and-benzothiazole-derivatives-through-oxidative-cyclization-pathway.pdf

[21] Sever, B., Altıntop, M. D., Özdemir, A., Tabanca, N., Estep, A. S., Becnel, J. J., & Bloomquist, J. R. (2019). Biological evaluation of a series of benzothiazole derivatives as mosquitocidal agents. *Open Chemistry*, *17*(1), 288-294. DOI: https://www.degruyter.com/document/doi/10.1515/chem-2019-0027/html

[22] Strus, P., Borensztejn, K., Szczepankiewicz, A. A., Lisiecki, K., Czarnocki, Z., Nieznanska, H., ... & Mlynarczuk-Bialy, I. (2021). Novel podophyllotoxin and benzothiazole derivative induces transitional morphological and functional changes in HaCaT cells. *Toxicology in Vitro*, *73*, 105144. DOI: https://doi.org/10.1016/j.tiv.2021.105144

[23] Subramanyam, M., Sreenivasulu, R., Gundla, R., Rao, M. V., & Rao, K. P. (2018). Synthesis, biological evaluation and docking studies of 1, 3, 4-oxadiazole fused benzothiazole derivatives for anticancer drugs. *Letters in Drug Design & Discovery*, *15*(12), 1299-1307. Retrieved from: https://drive.google.com/file/d/19Rl4RUPds3DHnWLjJuuAULXtLIthJCCr/view

[24] Woiceshyn, J., & Daellenbach, U. (2018). Evaluating inductive vs deductive research in management studies: Implications for authors, editors, and reviewers. *Qualitative Research in Organizations and Management: An International Journal*. DOI: https://www.emerald.com/insight/content/doi/10.1108/QROM-06-2017-1538/full/html