frontiers | Frontiers in Molecular Biosciences

MINI REVIEW
published: 25 April 2022
doi: 10.3389/fmolb.2022.864286

Triazoles and Their Derivatives: Chemistry, Synthesis, and Therapeutic Applications

Mohammed M. Matin[1], Priyanka Matin[1], Md. Rezaur Rahman[2], Taibi Ben Hadda[3], Faisal A. Almalki[3], Shafi Mahmud[4], Mohammed M. Ghoneim[5], Maha Alruwaily[5] and Sultan Alshehri[6]*

[1]Bioorganic and Medicinal Chemistry Laboratory, Faculty of Science, Department of Chemistry, University of Chittagong, Hathajari, Chittagong, Bangladesh, [2]Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak, Kuching, Malaysia, [3]Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Umm Al-Qura University, Makkah, Saudi Arabia, [4]Genetic Engineering and Biotechnology, University of Rajshahi, Rajshahi, Bangladesh, [5]Department of Pharmacy Practice, College of Pharmacy, AlMaarefa University, Ad Diriyah, Saudi Arabia, [6]Department of Pharmaceutics, College of Pharmacy, King Saud University, Riyadh, Saudi Arabia

Among the nitrogen-containing heterocyclic compounds, triazoles emerge with superior pharmacological applications. Structurally, there are two types of five-membered triazoles: 1,2,3-triazole and 1,2,4-triazole. Due to the structural characteristics, both 1,2,3- and 1,2,4-triazoles are able to accommodate a broad range of substituents (electrophiles and nucleophiles) around the core structures and pave the way for the construction of diverse novel bioactive molecules. Both the triazoles and their derivatives have significant biological properties including antimicrobial, antiviral, antitubercular, anticancer, anticonvulsant, analgesic, antioxidant, anti-inflammatory, and antidepressant activities. These are also important in organocatalysis, agrochemicals, and materials science. Thus, they have a broad range of therapeutic applications with ever-widening future scope across scientific disciplines. However, adverse events such as hepatotoxicity and hormonal problems lead to a careful revision of the azole family to obtain higher efficacy with minimum side effects. This review focuses on the structural features, synthesis, and notable therapeutic applications of triazoles and related compounds.

Keywords: anticancer agents, azide–alkyne cycloaddition, cefatrizine, isomeric triazoles, microwave-assisted green synthesis, pharmacological applications, SARS-CoV-2, triazole–thiazole hybrids

OPEN ACCESS

Edited by:
Mohammad Arshad, Shaqra University, Saudi Arabia

Reviewed by:
Zhe-shan Quan, Yanbian University, China
Afzal Basha Shaik, Jawaharlal Nehru Technological University, India

****Correspondence:***
Mohammed M. Matin
mahbubchem@cu.ac.bd

Specialty section:
This article was submitted to Molecular Diagnostics and Therapeutics, a section of the journal Frontiers in Molecular Biosciences

Received: *28 January 2022*
Accepted: *08 March 2022*
Published: *25 April 2022*

Citation:
Matin MM, Matin P, Rahman MR, Ben Hadda T, Almalki FA, Mahmud S, Ghoneim MM, Alruwaily M and Alshehri S (2022) Triazoles and Their Derivatives: Chemistry, Synthesis, and Therapeutic Applications. Front. Mol. Biosci. 9:864286. doi: 10.3389/fmolb.2022.864286

INTRODUCTION

The name triazole was first coined by Bladin in 1885 to assign the five-membered three nitrogen–containing heterocyclic aromatic ring system having molecular formula $C_2H_3N_3$ (Bladin, 1885). After the discovery of triazole, its chemistry was developed gradually and speeded up with the establishment of several facile and convenient synthetic techniques along with its versatile interaction with biological systems (Aneja et al., 2018; Shafiei et al., 2020; Farooq, 2021). For example, discovery of antifungal activities of azole derivatives in 1944 (Woolley, 1944) led to the invention of fluconazole, itraconazole, voriconazole, posaconazole, efinaconazole, *etc.* (**Figure 1**; Zonios and Bennett, 2008). Of these, voriconazole and posaconazole are active against fluconazole-resistant strains of *Candida*. The mechanism of such antifungal action is also well-established which involves the inhibition of ergosterol synthesis and blocking of the P450-dependent enzyme (CYP 51) (Odds et al., 2003).