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Review Article

A Review on 1,2,3 - Triazole & Piperazine Derivatives with Various Biological Activities

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ABSTRACT

The largest family of organic molecules in organic chemistry are heterocyclic compounds. A heterocyclic compound is created when an oxygen, nitrogen, sulphur, or atom of a similar element is included in place of a carbon atom. Heterocyclic compounds play a crucial role in daily living. It has a wide scope of uses in agrochemicals and medicinal chemistry. One of a pair of chemical compounds known as triazoles and Piperazine, with the molecular formula C2H3N3 and C5H5N. A fundamental aromatic heterocyclic scaffold is 1,2,3-triazole and piperazine. Because of its structural characteristics, these moiety's are valuable in material science and due to its extensive application in chemistry, these can also be synthesized from readily available compounds. This literature review sheds light on the fact that 1,2,3-triazole and piperazine of hetero compounds are profoundly receptive and are known to possess potent diverse activities like, analgesic, anti-HIV, antimalarial, antiviral, anti-inflammatory, anticancer, antibacterial, antifungal, anthelmintic, and so forth. In conclusion numerous biological actions of the Piperazine and 1,2,3-Triazole derivatives of heterocyclic compounds were detailed and reviewed in this review.

Keywords: 1,2,3 - Triazole; Biological activities; Piperazine; Anticancer Activity

INTRODUCTION

The most unpredictable aspects of chemistry are often referred to as heterocyclic chemistry, and heterocyclic molecules hold vital significance for medical chemistry[1]. Heteroatoms are the names for the Sulfur, Nitrogen, and Oxygen found in heterocyclic compounds. They play important roles in the drug development process[2]. These compounds, particularly those with 5 and 6 members, have drawn the attention of the pharmacy network over the years due to their potential for treatment[3], and they are also lavishly used as intermediates in organic synthesis[4–6] and the synthetic routes are observed by the biological assessment of heterocycles containing nitrogen, sulphur, and oxygen[7–13]. Azole subsidiaries have been utilized in the plant security innovation as pesticides. To specifically control the development of weeds, an extensive variety of azole herbicides have been fostered that are displaying 1,2,3 triazole heterocyclic blends are known to have extreme activities like antimicrobial[14,15] anticonvulsant[16], anti-inflammatory[17], analgesic[17], antifungal[18] anthelmintic[19,20] anti-alzheimer's[21], anti-plasmodial[22], antituberculosis[23], anti-malarial[24], anti-HIV[25], and anti-cancer[26–30] activity and so forth. By using 1,2,3 triazole and Piperazine derivatives as a starting point, the ongoing.

- high level of activity
- application flexibility
- crop tolerance
- low levels of toxicity to mammals

Concentrate successfully portrays a study on heterocyclic compounds displaying different biological action.

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PHARMACOLOGICAL ACTIVITIES

Anti-Microbial activity

Lima-Neto RG[31] described a series of 1,2,3-triazole analogues with 10 particular The triazole ring's N-1 substitutes were mixed. 4(a-j), and their antifungal activity was assessed. A total of 42 pathogenic kinds of four different Candida species were tested using all of the mixes. The insignificant inhibitory fixation values are significantly impacted by substituent changes because we can obtain triazole subordinates with no antimycotic movement, moderate antifungal action, and one particle with magnificent action. The results of the antifungal tests reveal that the chloro-substituted triazole subordinate specifically exhibited significant contagious development resistance, indicating that additional adjustments to the 2-(1-aryl-1H-1,2,3-triazol-4-yl) series should make it possible to obtain more powerful models.

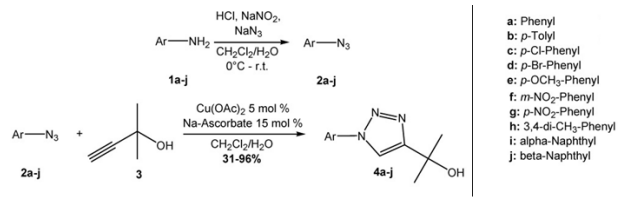


Fig. 1: 1,2,3-triazole analogues

Liu T, Weng Z[32] used the bioisosteric-replacement concept and a fragment-assembly approach, a novel series of piperazine derivatives were created 9(a-h). when the cytotoxicity and CCR5-mediated fusion activities of the target drugs were evaluated. Compound 23 h was evaluated with an IC50 value of 6.29 M as a CC5 antagonist and an IC50 value of 0.44 M as an antiviral agent. The Piperazine compounds created in this study and the SAR that resulted may be useful for further optimisation on the path to developing brand-new CCR5 antagonists for the treatment of HIV.

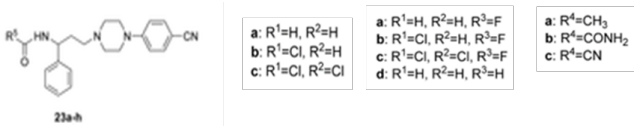


Fig. 2: Piperazine Derivatives

Wang BL[33] Synthesized the Mannich reaction of 1,2,4-Triazole thiol intermediates comprising 1,2,3-triazole with different subbed piperazines and formaldehyde, a number of novel 1,2,4-triazole thione derivatives including 1,2,3-triazole and substituted piperazine moieties were produced in high yields 9(a-h). Melting points, IR, 1H NMR, 13C NMR, and elemental analyses were used to confirm the structures. The results of the bioassay revealed that some of the compounds have significant fungicidal activities at 50 mg/mL against a variety of plant fungi. In particular, the trifluoromethyl containing triazole thione derivative have broad activities and may benefit from further underlying advancement for novel fungicide advancement research.

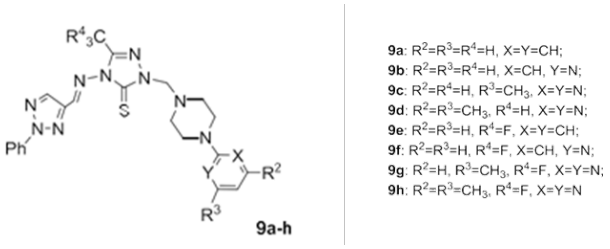


Fig. 3: 1,2,3-triazole and substituted piperazine moieties

Jadhav RP[34] Incorporated two new series of unique compounds, 5-(substituted phenyl)-1,3,4-Oxadiazol-2-yl and 5-(alkylthio)-1,3,4 – Oxadiazol-2-yl, were synthesized 9(a-e). By using 1H NMR, 13C NMR, and mass spectrum analysis, synthesised compounds were examined for their antibacterial properties. It's interesting to note that the majority of the compounds show moderate to good activity against tested fungal and bacterial strains as well as Gram-positive and Gram-negative bacterial strains.

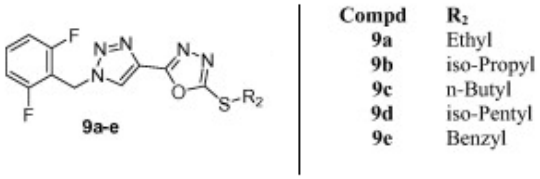


Fig. 4: Piperazine Carboxamides

Wang Y[35] had synthesized triazole with piperazine side chains. The synthesis has demonstrated the use of click chemistry based on the cytochrome P450 14-demethylase active site (CYP51). In order to describe their structures, 1H-NMR, 13C-NMR, MS, and IR were used. Eight human pathogenic fungi were used to investigate the effects of the piperazine moiety on in vitro antifungal activity of all the target compounds.

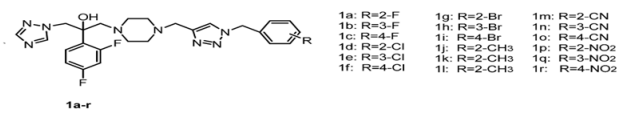


Fig. 5: Piperazine side chains analogues

Danne AB[36] He discussed the plan of a little library of novel 1,2,3-triazole-appended bis-pyrazoles utilising a Molecular hybridization method (a-i). *Aspergillus niger,*

Aspergillus fumigatus, Candida albicans, Cryotococcus neoformans, Candida glabrata, Candida tropicalis, and other fungal strains were examined for their antifungal efficacy using the synthesised hybrids. All of the compounds demonstrated good minimum inhibitory concentration values and broad-spectrum action against the tested fungi strains. The molecular docking research against sterol 14-demethylase (CYP51) may offer important information about the binding affinities and mechanisms of these substances. These substances' antioxidant activity was also examined, and the results were likewise encouraging.

Fig. 6: 1,2,3-triazole-appended bis-pyrazoles

Chen QM[37] Synthesized a potential anticancer and antibacterial medicines, fifteen new dithiocarbamate-derived naphthalimides were created and characterised using spectral and analytical methods. By using X-ray crystallography, the structure of 2b,5a and 7b were established. The MTT technique was used to assess their *in vitro* anticancer activity against MDA-MB-231, HepG-2, PC12, and A549. With an IC50 of 10.86 M, compound 7c with a morpholinyl substituent demonstrated the maximum activity and selectivity for HepG- 2 cancer cells according to the results of the MTT testing. The antibacterial activity of each novel chemical was tested against *C.albicans, E.coli, B.substilis, S.aureus*. A minimal inhibitory concentration value were revealed in the results, that compound 7d (an n-methyl piperazine) had high activity against *B.subtilis*.

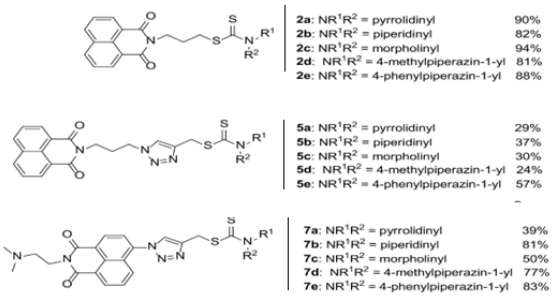


Fig. 7: 1, 2, 3-triazole-dithiocarbamate-naphthalimides

Sriram D et al.,[38] Formaldehyde, secondary amines, and aryl substituted piperazines were combined to create microwave-aided efavirenz Mannich base derivatives. The blends were tested *in vitro* for their ability to fight against HIV and mycobacteria. Among these, fluroquinolone-containing drugs were discovered to be difficult to use and (4i) restricted to *M. tuberculosis* with the most diminished inhibitory obsession.

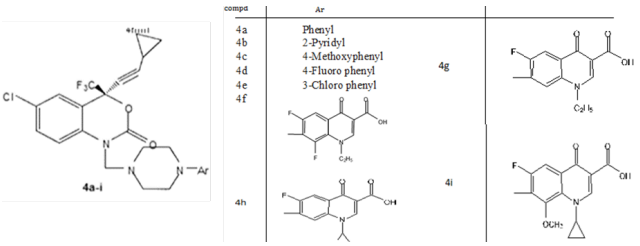


Fig. 8: Efavirenz Mannich bases & derivatives

Bogdanov AV et al.,[39] synthesized formaldehyde, isatin and monosubstituted piperazines were synthesised using the Mannich reaction. They were then changed into derivatives of iso indigo. The structures were verified by analytical and spectral data, and their antibacterial activity was then assessed.

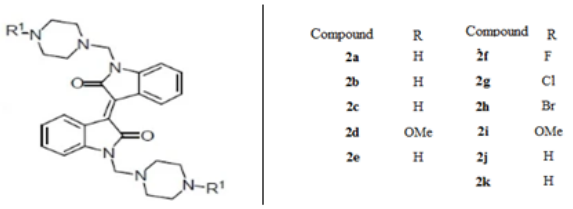
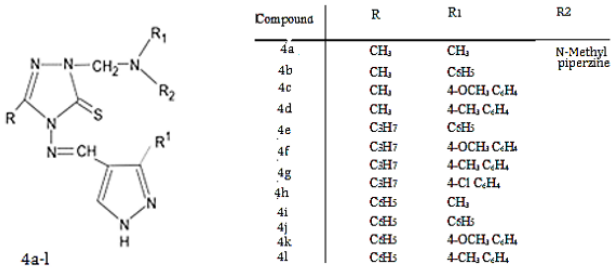


Fig. 9: Piperazine Derivatives

Paneth A et al.,[40] Integrated a number of novel Mannich bases were created and their *in vitro* antibacterial activity was assessed. The findings suggested that for piperazine to have antibacterial action, a phenyl ring appears to be required in position 4 of the compound.

Isloor AM et al.,[41] Produced novel Mannich base derivatives by amino methylating 4-(3-substituted 1H - pyrazol-3-yl) methyl amino-5-substituted 4H-1,2,4-triazole-3-thiols (3) with formaldehyde and N-methyl Piperzine. 4- (3-substituted 1H-pyrazol-4-yl)-methyl amino] - 5 - 2-[(4-methylpiperzine-1-yl) methyl] substituted from 1,2,4-triazoles, -2H-1,2,4-triazole-3(4H)-thione is produced. These recently connected structures were seen by 1H NMR, mass, and IR spectra, and their antibacterial and antifungal activity was assessed. When compared to regular compound, blends 4c, 4e, 4h, and 4k showed higher obstruction.



Compound	R	R1	R2
4a	CH_3	CH_3	N-Methyl piperzine
4b	CH_3	C_6H_5	
4c	CH_3	4-OCH_3 C_6H_4	
4d	CH_3	4-CH_3 C_6H_4	
4e	C_3H_7	C_6H_5	
4f	C_3H_7	4-OCH_3 C_6H_4	
4g	C_3H_7	4-CH_3 C_6H_4	
4h	C_3H_7	4-Cl C_6H_4	
4i	C_6H_5	CH_3	
4j	C_6H_5	C_6H_5	
4k	C_6H_5	4-OCH_3 C_6H_4	
4l	C_6H_5	4-CH_3 C_6H_4	

Fig. 10: Novel Mannich base derivatives

Amani AM et al.,[42] Created a fresh piperazine phenothiazine derivatives. Elemental analysis, FT-IR, (1)H- and 13C-NMR, and Mass Spectroscopy were used to determine the structures of the produced compounds. By using the cup plate, disc diffusion, and Lowenstein-Jensen medium procedures, the compounds' antibacterial, antifungal, and antitubercular activity was assessed, respectively. All the substances shown effective antibacterial action.

Tan W et al.,[43] Synthesized four new Starch-liked-1,2,3-Triazole derivatives, a six-hydroxymethyltriazole-6-deoxy starch (HMTST), six-bromomethyltriazole -6-deoxy starch (BMTST), six-chloromethyltriazole-6-deoxy starch (CMTST), and six-carboxyltriazole-6-deoxy starch. They were tested *in vitro* for their antibacterial efficacy against *E. coli* and *S. aureus*, respectively. The developed amphiprotic starch derivatives significantly outperformed starch in terms of their inhibitory properties. And when the culture times were 8 hours and 16 hours, respectively, the antibacterial indices of the majority of the products were greater than 60% and 40% at 1.0 mg/mL. Additionally, at 1.0 mg/mL, the inhibitory index of CBTST reached 97% higher. The inhibitory action generally declined in the following order: CBTST>CMTST>BMTST>HMTST> starch. Additionally, the sequence in which they exhibited antibacterial action was compatible with the ability of various subbed gatherings of the 1,2,3-triazole gatherings.

Gan LL et al.,[44] Synthesized a new diphenyl Piperazine 1,2,3-triazole derivatives. The synthesised compounds' were examined for *in vitro* antibacterial, antifungal, and cytotoxic properties. According to preliminary findings, Nitroimidazole Piperazine were only moderately affected by *Candida albicans* and *Saccharomyces cerevisiae*, whereas *B.subtilis, Micrococcus luteus, B.proteus, E.coli,* and *B.typhi* were all substantially affected. Furthermore, it was demonstrated that the 1,2,3-triazole-linked nitroimidazole piperazine compound and benzimidazole piperazine compound were efficient *in vitro* against the PC-3 cell line, at a concentration of 100 M. The nitro and hydroxyl groups of chemicals may also be able to insert into base pairs of DNA hexamer duplexes by forming hydrogen bonds with DNA's guanine, according to molecular docking investigations.

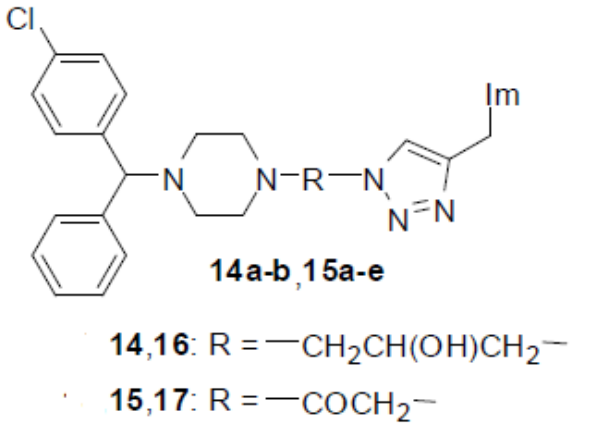


Fig. 11: Diphenyl piperazine 1,2,3-triazole derivatives

Thriveni KS et al.,[45] Synthesised 4-substituted 2-(4-phenylpiperazin-1-yl)-6-(thiophen-2-yl) pyrimidines (5a-e). The newly synthesised compounds 4b, 4d, 5a, and 5b all exhibited strong antibacterial activity at a concentration of 40 g/ml, and 4a, 4d, 4e, 5c, and 5e had effective antifungal activity at a concentration of 40 g/ml.

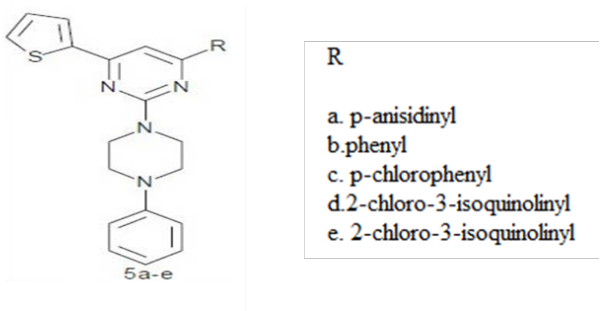


Fig. 12: Pyrimidine incorporated piperazine derivatives

Tamer El Malah et al.,[46] Cu(I)-catalyzedazide-alkyne cycloaddition with a variety of alkyne-functionalized sugars producedsix novel aryl-subbed 1,2,3 triazoles connected to sugar units with an end goal to create naturally dynamic antibacterial and antifungal medicationsnoval subsidiaries were affirmed utilizing various spectroscopic procedures. New 1,2,3-triazoles' *in vitro* protection from Gram-positive *S.aureus* and Gram-negative *P. aeruginosa* was compared with the movement of the standard antibiotic niger was investigated using the drug "Nystatin" as a model and as a reference. *Staphylococcus aureus* was found to be more susceptible to each of the chemicals under investigation than the other microorganisms under investigation, according to the results of the biological evaluation. A portion of the substances that were inspected likewise showed positive antifungal movement.

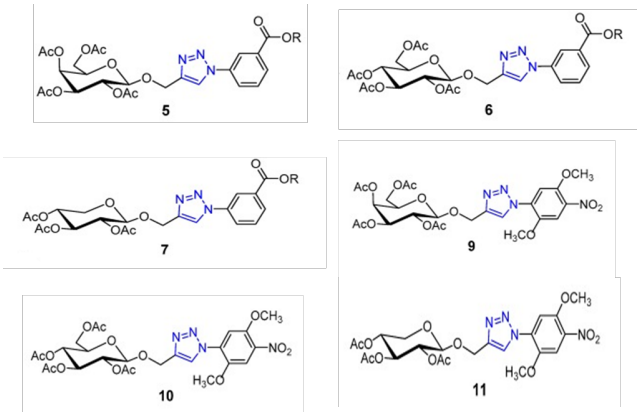


Fig. 13: Aryl-substituted-1,2,3-triazoles

Analgesic activity

Shantaram Gajanan Khanage[47] pain-relieving activity was shown by chloropain-relieving movement was shown by dimethylamino, furan, and phenyl subbed subordinates in the two methodologies. The compounds IIIa, IIId, IIIf, IIIi, IIIj, IVa, IVb, IVd, IVf, IVh, IVj, IV3a, and IIj were found to be superior analgesics after being screened using the acetic acid-induced writhing method. Compounds IIIb, IIId, IIIf, IIIh, IIIj, IVa, IVb, IVd, IVf, IVh, IVi, IV3c, IV3e, and IIj demonstrated their potential as analgesics after being tested on a hot plate. Pyrimidine, tetrazole, isoxazole, and all 1,2,4-triazole-containing compounds tested were found to be effective analgesics; consequently, this activity may be supported by these compounds.

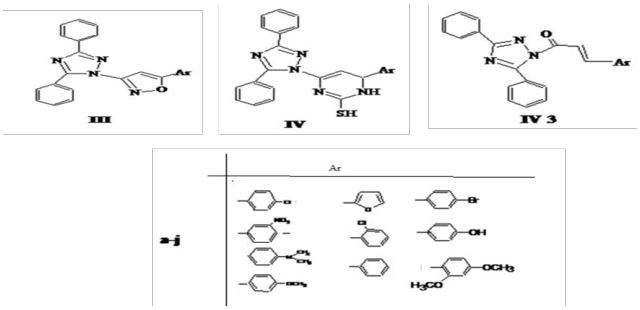


Fig. 14: 1,2,4 triazole clubbed with heterocyclic Componds

Antioxidant activity

Josefa Lima et al .,[48] He created a novel class of 1,4-disubstituted 1,2,3-triazoles, and their antioxidant activity is described in this study. These chemicals were produced semi-synthetically by using the Cu(I)-catalyzed azide-alkyne cycloaddition (CuAAC) reaction between ethyl 2-azidoacetate and terminal acetylenes taken from the natural products carvacrol, eugenol, isovanillin, thymol, and vanillin. He got 50-80 % yield, and the structures were confirmed by spectrographic characterisation. Antioxidant activity (ABTS) was measured using 2,2-diphenyl-1-picryhydrazyl (DPPH) and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid). Among the 1,4-disubstituted 1,2,3-triazoles produced, ethyl 2-(4-(4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl) acetate had the highest antioxidant capacity (EC50 = 75.5 g/mL). The antioxidant activity of the products was only moderate.

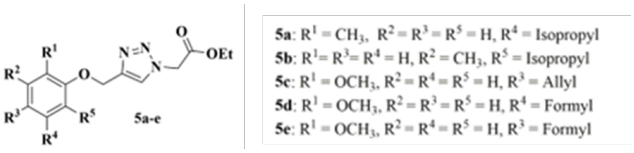


Fig. 15: 1,4-disubstituted 1,2,3-triazole derivatives

Sánchez JS et al.,[49] Novel 1-benzyl-1,2,3-triazole were synthesized and tested for poisoning, cancer prevention, and antibacterial activity with salt water shrimp and the stock microdilution method. Although *Escherichia coli* AO11, E. coli AO15, and *Salmonella enterica serovar Typhi* were also immune to a similar effect, the substance 1-(1-Benzyl-1H-1,2,3-triazol-4-yl) cyclopentanol had no effect on Staphylococcus aureus . 5g-I compounds displayed the most severe DPPH● examination venging. The evaluation of manufactured 1,2,3-triazole intensifies arrangements that range from moderately harmful to harmless.

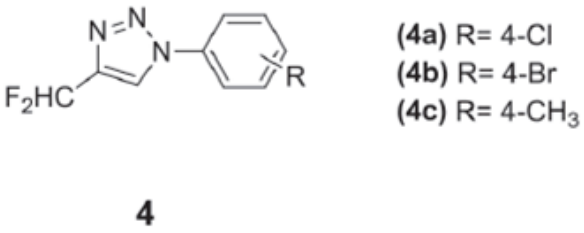


Fig. 16: 1-benzyl-1,2,3-triazoles

Deshmukh TR et al.,[50] Unique piperazine-tethered dimeric 1,2,3-triazoles were synthesized by combining piperazine and 1,2,3-triazoles within a single molecular architectural framework. By 1,3-dipolar cycloaddition of 1,4-di(prop-2-yn-1-yl)piperazine (1) and various azides, the named compounds (3a-m) were produced in high yields. All of the produced compounds (3a-m) have been tested for their *in vitro* antitubercular, antifungal, and antioxidant activity against their respective strains. Three of them, 3b, 3d, and 3i, have demonstrated encouraging antitubercular efficacy against *Mycobacterium tuberculosis* (Mtb) H37Rv with a MIC of 12.5 g/mL. The findings of molecular docking (InhA) provided a firm foundation for these compounds' binding to the Mtb enoyl reductase active site. In addition,

it was demonstrated that the majority of synthetic chemicals may have antifungal and antioxidant properties.

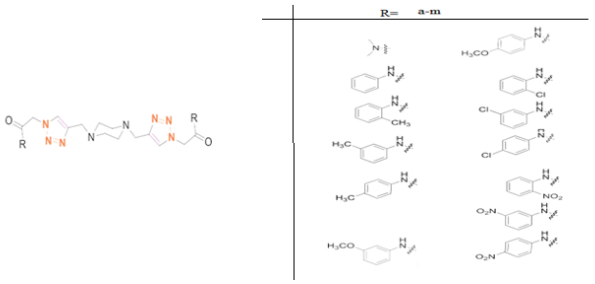


Fig. 17: New piperazine and amide linked dimeric 1, 2, 3-triazoles

Anthelmintic activities

Gupta JK et al.,[51] Investigated for antibacterial ,antifungal , and Antihelmintic activity . In that T71, T73, and T75 all shown antibacterial activity, and T71 further exhibited antifungal action. To explore their vermifuge and vermicidal impact, the mixtures were regulated to *Pheretima posthuma* at differed portions. The activity of the triazole when combined with 1-methylpiperazine was found to be comparable to that of reference standards. Triazoles are a group of antifungal agents that work well. In this investigation, the chemical T71 demonstrated positive antibacterial and antihelminthic activity.

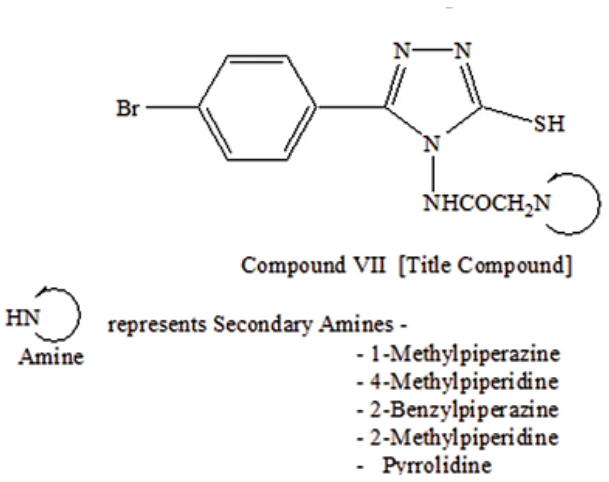


Fig. 18: Triazole Derivatives

Madhu Kumar Dogganal Jayappa et al.,[52] The synthesis of -thione (6a-e) and (7a-h) involved by treating formaldehyde and various substituted primary/secondary amines with 3-methyl-1H-1,2,4-triazole 5(4H)-thione. Synthesized new Mannich bases (E) - -4-((3,4-((3,4-dimthoxybenzyliden) amino). The Schiff base was made by combining 3-methyl-4-amino-5-mercapto-1,2,4-triazole (3) and 3,4-dimethoxybenzaldehyde with an acid catalyst. The triazole (3) was made by combining acetic acid (1) with thio-carbohydrazide (2) at reflux temperature. Spectroscopy was used to investigate the compounds' for antibacterial and antihelminthic properties.

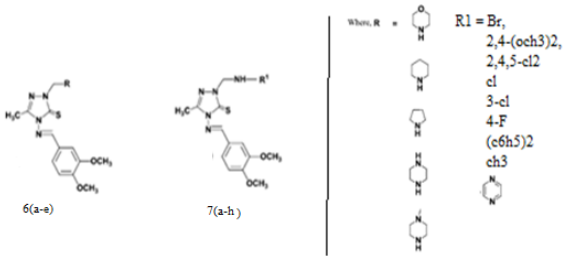


Fig. 19: Novel Triazole Schiff and Mannich Bases

Anti-diabetic activity

Dastjerdi et al.,[53] The inhibitors of the dipeptidyl peptidase type 4 (DPP-4) enzyme, which is a potent activator of insulin production and an inhibitor of glucagon secretion from the pancreas, have been proposed as a promising class of drugs for the treatment of type 2 diabetes mellitus. A new class of 1, 2, 3-triazole-5-carboximidamide subordinates were tested for their ability to inhibit the DPP-4 protein in this study. Compounds 6a, 6b, and 6c specifically demonstrated helpful DPP-4 inhibitory action with respective IC50 values of 14.75nM, 6.75nM, and 6.57nM. At a dose of 10 mg/kg, compound 6a improved glucose resistance in NMRI mice during the oral glucose tolerance test (OGTT).

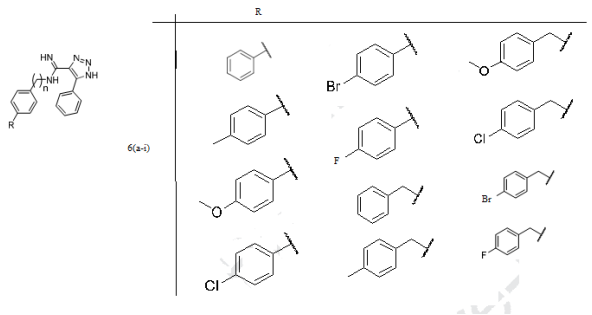


Fig. 20:

Anticholinesterase activities

Faraz KM et al.,[54] Investigated the derivatives of hydrazine. A series of eleven new mixtures of N′-(2,4-disubstitutedbenzylidene)- 2-(4-nitrophenyl) acetohydrazide subordinates were delivered by the reaction of 2-[4-(4-nitrophenyl)piperazin-1-yl] acetohydrazide with fragrant aldehydes. The spectral data from HRMS (ESI) and FT-IR, 1H-NMR, 13C-NMR, and ESI were used to clarify

the chemical structures of the compounds. Compound 3c was found to be the most active derivative of the chemicals examined, and its efficacy against AChE and BuChE was quantified and evaluated using a modified version of Ellman's spectrophotometric method. Galantamine was a drug that was frequently prescribed.

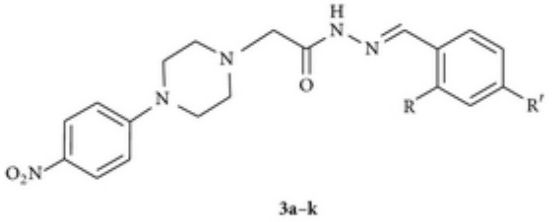


Fig. 21: Hydrazone Derivatives

Anti-inflammatory activity

Shalom Pôrto et al.,[55] Developed four novel, potently anti-inflammatory 1,2,3-triazole phthalimide derivatives. The calming movement was discovered by injecting carrageenan into the plantar tissue of the right rear paw of Swiss white mice to cause irritation. The mixtures 3b and 5c uncovered to have the option to lessen carrageenan-actuated edema in mice by 69% and 56.2%, separately. Every single one of the compounds 3a-c and 5a-c had a significant anti-inflammatory effect. As new anti-inflammatory medications in the future, these substances may also hold promise.

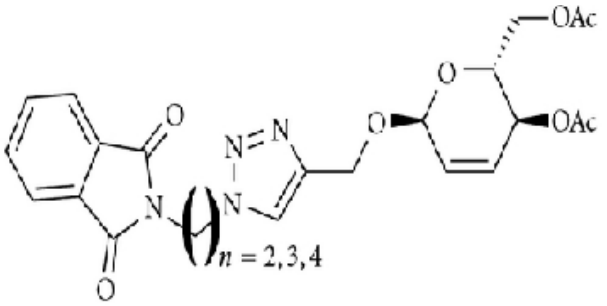


Fig. 22: 1,2,3-triazole phthalimide derivatives

Anti-tuburculosis activity

Stefely JA et al.,[56] N-((1-benzyl-1H-1,2,3-triazol-4-yl)methyl)arylamides were synthesized, which served as growth inhibitors for cancer cells. Studies of the structure-activity relationship (SAR) revealed that a meta-phenoxy substitution of the N-1-benzyl group is required for antiproliferative action, while a variety of heterocyclic substitutions for the aryl group of the arylamide are tolerated. For instance, compound 13e's IC50 value for the human breast cancer cell line MCF-7 was 46 nM. In silico compare analysis revealed a connection between antiproliferative activity against the NCI-60 human tumor cell line panel and clinically relevant anti-microtubule medications like vincristine and paclitaxel.

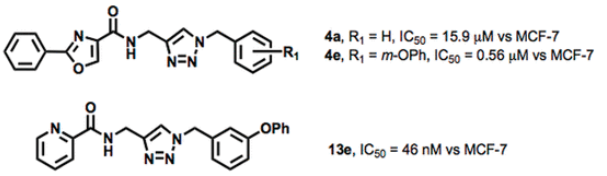


Fig. 23: 1,2,3-triazol-arylamides

Pulipati L et al.,[57] The noval compounds have been tested for antimycobacterial activity after being synthesized as dibenzo [b, d]thiophene-1,2,3-triazoles with piperidine, piperazine, morpholine, and thiomorpholine. The necessary azide building block 6a-e was delivered from business dibenzo[b,d]thiophene in great yields through a five phase compound cycle. NMR and mass spectral methods were used to characterize each of the new analogues 8a-f, 9a-f, 10a-f, 11a-f, and 12a-f. Every one of the thirty new mixtures were considered in contrast to Mycobacterium tuberculosis H37Rv, and 8a, 8f, and 11e were viewed as strong analogs with MICs of 0.78 g/mL, 0.78 g/mL, and 1.56 g/mL, separately. Additionally, the cytotoxicity of these substances was lessened. The data provided some indication of Mycobacterium tuberculosis, and it is interesting to note that all six piperazine-applied dibenzo[b, d]thiophene-1,2,3-triazoles 11a-f suppressed Mtb with MICs ranging from 1.56 to 12.5 g/mL.

Zhang S et al.,[58] 1,2,3, and 1,2,4-triazoles were synthesized. Triazole derivatives are recognized as a novel class of potent anti-TB options because of their potential effectiveness. Consequently, compounds containing a triazole moiety may be able to prevent the development of drug resistance to some extent and exhibit positive anti-TB activity both *in vitro* and *in vivo*. The structure-activity relationship of these derivatives is also discussed, as are the advancements made in the use of triazole-containing hybrids as anti-TB medications.

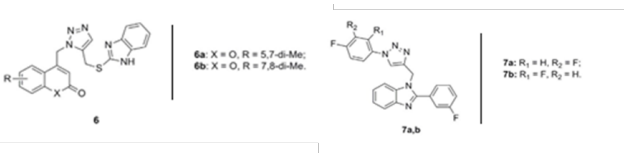


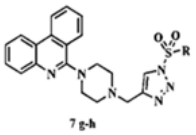
Fig. 24: 1,2,3, and 1,2,4-triazoles

Ali AA et al.,[59] A collection of seventeen brand-new 1,2,3-triazole derivatives was successfully synthesized with high yields, and their anti-tubercular activity against *Mycobacterium* TB H37Ra (ATCC 25177 strain) was evaluated in vitro. With MIC values against MBMDMQs ranging from 3.12 to 0.78 g/mL and no discernible cytotoxicity, six of the series' compounds had significant action. The molecular docking of the DprE1 (Decaprenylphosphoryl-D-ribose-2′-epimerase) enzyme's active site with the target molecules sheds light on the probable binding interactions.

Anti-cancer activity

Yan SJ et al.,[60] He made numerous heterocycle-melded 1,2,3-triazoles in a one-pot process at room temperature without the need of an impetus, which were then inspected *in vitro* against an assortment of human cancer cell lines. Compared to 1,3-diazoheterocycle fused 1,2,3-triazoles, the cancer cell lines Skov-3, HL-60, A431, A549, and HepG-2 were more responsive to 1,3-oxyazoheterocycle fused 1,2,3-triazoles. Against the human tumor cell lines A431 and K562, the 4-methoxyphenyl substituted 1,3-oxazoheterocycle fused 1,2,3-triazole 6j was found to be the most effective derivative, with IC(50) values of less than 1.9 microg/mL.

Nagesh HN et al.,[61] The MTT assay was used to evaluate a number of novel 6-(4-((substituted-1H-1,2,3-triazol-4-yl)piperazin-1-yl) phenanthridine analogues as antiproliferative agents against four cancer cell lines. The synthesised substances 7g and 7h were effective against all types of test cells. 7g (IC50 = 9.73 4.09 M) was effective against the THP1 cancer cell line, while 7h (IC50 = 7.22 0.32 M) was more effective than the reference medication etoposide against the HL60 cancer cell line.



Compound ID	R
7a	$PhCH_2$
7b	2-ClPh
7c	3-ClPh
7d	$3\text{-}CF_3Ph$
7e	3-OMePh
7f	4-OMePh
7g	Ph
7h	4-MePh
Etoposide	

Fig. 25: Piperazin Derivatives

Farooq S et al.,[62] New triazoles linked to 7-hydroxycoumarins were synthesized.With IC50 upsides of 5.1, 22.7, 14.3, and 10.2 M against the bosom (MCF-7), lung (NCI-H322), prostate (PC-3) and skin (A-431) disease cell lines, separately, compound 5 outflanked any remaining tried analogs. It was eight times more sensitive than the parent substance, 7-hydroxycoumarin, against MCF-7. Compound 5 also induced apoptosis and G1 phase arrest in breast cancer cells, which had cytotoxic and cytostatic effects, respectively (MCF-7). At 8 M, the apoptotic cell population increased to 18.8% from 9.8% in the case of negative control, while G1 phase arrest increased to 54.4% from 48.1% in the negative control. In addition, Compound 5 showed a remarkable decrease in mitochondria.

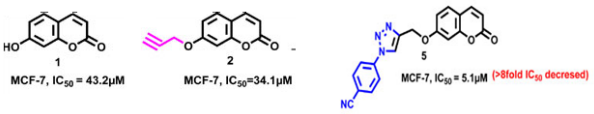


Fig. 26: Novel Triazoles Linked 7-hydroxycoumarin Derivatives

Venkata SR et al.,[63] Utilizing a CuAAC (Copper catalysed azide-alkyne cycloaddition) method, a novel 8-bromo-1H-1,2,3-triazol-4-yl-2-methylquinoline derivative series and its Suzuki coupling products were created, establishing a new class of anticancer medications. The synthesised compounds' *invitro* anticancer properties (B16F10) were evaluated in human breast cancer (MDA-MB-231) and melanoma cell lines. The new chemicals' cellular toxicity was also evaluated using common human embryonic kidney (HEK) cell lines. The substances 5c (Azetidine), 5e (Nitro benzoate), 5f (fluorobenzyl)-1H-pyrazole), 5g (Boc piperidine), 6a (cyclo propyl), 6c (5-fluoro-6-methoxypyridin-3-yl), and 6d (2-methoxypyridin-3).

	IC50 in μM	
	MDA-MB-231	B16F10
5c	32.185	16.395
5e	24.156	14.189
5f	30.510	13.446
5g	17.063	22.702
6a	38.215	18.882
6c	20.699	22.416
6d	19.767	35.249

Fig. 27: Quinoline Consists of 1H-1, 2, 3-Triazole Hybrids

Agricultural Applications

RESULT AND DISCUSSION

As validated through the body of work reviewed in this paper, 1,2,3 triazole and piperazine in heterocyclic compounds have amazing biological activities. This review shall give researchers access and detailed understanding on various application of 1,2,3 triazole and piperazine a novel heterocyclic subsidiary into diverse areas for new process or application. This review provides an overview to 1,2,3 triazole subordinates of heterocyclic compounds and highlights their different biological properties.

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