

A Review on 1, 2, 4 - Triazoles

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ABSTRACT

The 1, 2, 4-triazole ring is an ubiquitous structural feature of many synthetic compounds with diversified therapeutic efficacy. A huge volume of published literature over the last few decades precludes a comprehensive review. In this review, we have tried to figure out some of the advancement during the last few decades in medicinal chemistry of triazole derivatives with some examples of rational design as anti-fungal, anti-neoplastic, antibacterial agents etc. An emphasis has been given to structure-activity relationship, biological activity and design strategy of various mono as well as poly substituted triazoles to ensure the acceptance level of this heterocyclic ring in the field of medicinal chemistry.

Keywords: 1, 2, 4 - triazoles, Antifungal, Antineoplastic, Antibacterial, Fluconazole, Itraconazole.

INTRODUCTION

In the last few decades, the chemistry of 1, 2, 4-triazoles and their fused heterocyclic derivatives have received considerable attention owing to their synthetic and effective biological importance. 1, 2, 4-triazole moiety has been incorporated into a wide variety of therapeutically interesting drug candidates including antifungal, antibacterial, analgesics and anti-inflammatory, antineoplastic, antiviral, sedatives, anxiolytics, anti-convulsants, antimigraine, anti-histaminics, CNS stimulants and other activities. [1-14]

Triazole units have attracted considerable attention in fields, such as medicinal and agrochemical research as well as in the material sciences due to their unique structure and properties. [15]

Some of the modern-day drugs with triazole nucleus are as follows:

Fluconazole, Itraconazole, Terconazole, Posaconazole, Voriconazole (the powerfulazole antifungal agents),

Ribavirin (antiviral agent), non-nucleoside reverse transcriptase inhibitors, Anastrozole, Letrozole, Virazole (antineoplastics, nonsteroidal competitive aromatase inhibitors), Alprazolam, Triazolam, Estazolam (anxiolytic, hypnotic, sedative, tranquilizer), Rizatriptan (antimigraine agent), Trazodone (antidepressant, anxiolytic), Nefazodone (antidepressant, 5-HT_{2A}-antagonist), Tropicamide (hypotensive), Rilmazafon (hypnotic, anxiolytic, used in the case of neurotic insomnia), Benatradin (diuretic) and Etoposide (antidepressant). In addition to these important biological applications, mercapto- 1, 2, 4-triazoles are also of great utility in preparative organic chemistry, viz, in the presence of various reagents, undergo different types of reactions to yield other heterocyclic compounds, e.g., thiazolotriazoles, triazolothiadiazoles, triazolothiazines, triazolothiazepines and triazolothiadiazines.

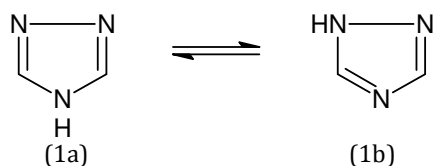
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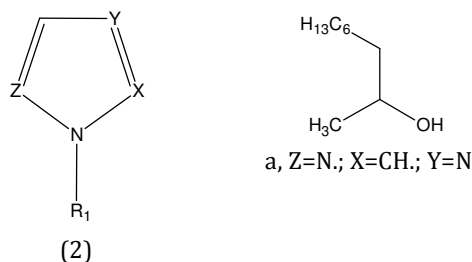
Chemistry and Structure Activity Relationships

1, 2, 4-triazole is one of a pair of isomeric chemical compounds 1 (a and b) with molecular formula C₂H₃N₃, called triazoles, which have a five-membered ring of two carbon atoms and three nitrogen atoms. 1, 2, 4-triazole is a basic aromatic heterocycle.



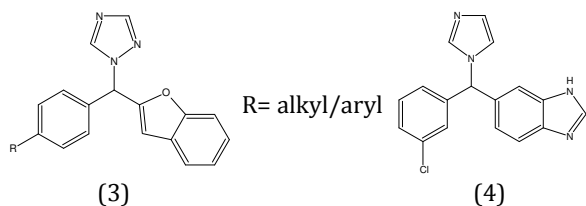
1-substituted-1, 2, 4-triazole

Cristalli *et al* [16] reported the synthesis of a series of erythro-1-(2-hydroxy-3-nonyl) azole derivatives (2) which were evaluated for adenosine deaminase (ADA) inhibitory activity, in order to introduce simplifications in the ADA inhibitor.



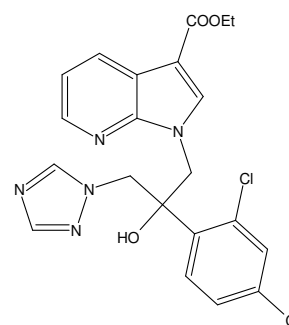
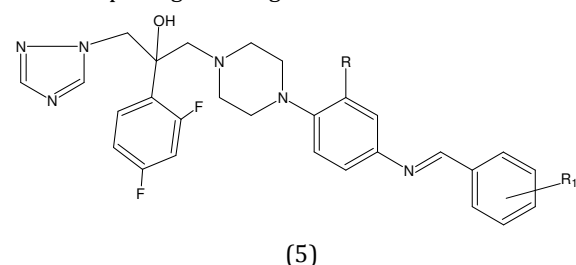
Compound (2a) was the most potent ADA inhibitor in the series with $K_i=0.3\mu\text{M}$.

Pautus *et al* [17] prepared a series of 4-alkyl/aryl - substituted-1-[benzofuran-2-yl-phenylmethyl]-1H-triazoles (3) and evaluated their inhibitory activity against CYP26A1 ($IC_{50}4.5$ and $7\mu\text{M}$ respectively, using a MCF-7 cell based assay).



In this series, 4-ethyl and 4-phenyl-1, 2, 4- triazole derivatives displayed inhibitory activity comparable with that of the CYP26 inhibitor liarozole, $IC_{50}=7\mu\text{M}$.

A series of 1-(1H-1, 2, 4-triazol-1-yl)-2-(2, 4-difluorophenyl)-3-[4-substituted phenyl]-piperazin-1-yl]-propan-2-ols (5) have been designed and synthesized by Sun *et al* [18] and were tested against 6 human pathogenic fungi.

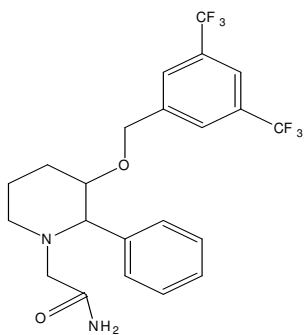


	R	R ₁
a.	H	4-F
b.	H	4-Cl
c.	H	4-Br
d.	H	4-Me
e.	H	4-OH
f.	H	3,4-Methylenedioxy
g.	H	4-(3-Cl-benzyloxy)

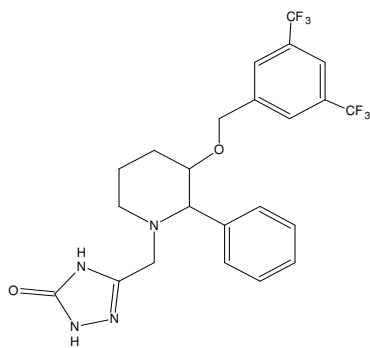
Compound 6 showed high activity against *Candida albicans*, *Candida parapsilosis* and *Candida krusei* as compared to fluconazole, whereas, 5g showed higher activity against *Torulopsis glabrata* than fluconazole. Compound 5(a, c, d, e, f) exhibited higher activities against *C. parapsilosis* than fluconazole.

3-Substituted-1, 2, 4-Triazole

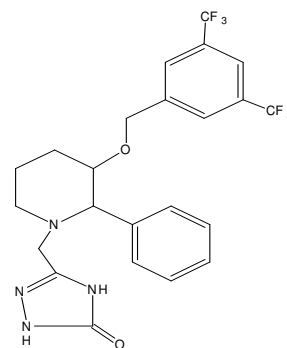
Ladduwahetty *et al* [19] reported the preparation of a series of *N*-heteroaryl piperidine ether-based human NK1 antagonists. Two of the compounds (3-[(2*S*, 3*S*)-3-(((3, 5-bis (trifluoromethyl) phenyl)methyl)oxy)-2-phenylpiperidino)methyl]-1,2,4-triazole (8) and 5-[(2*S*,3*S*)-3-(((3,5-bis (trifluoromethyl)-phenyl) methyl) oxy) -2-phenylpiperidino] methyl]-3-oxo-1,2,4-triazolone (9), in particular, are orally bioavailable and exhibited significant improvements in potency, both *in vitro* and *in vivo*, over the lead carboxamidomethyl)- piperidine ether (7).



(7)



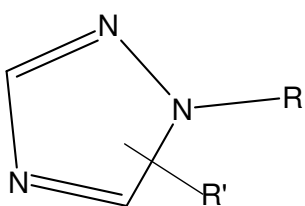
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(9)

4-Substituted-1, 2, 4-Triazole

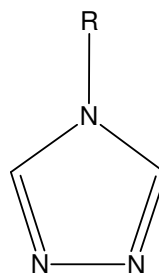
A series of 1- and 4- substituted 1, 2, 4-triazoles have been studied by Ainsworth *et al* [20] for convulsant and anticonvulsant activity by both the maximal electroshock seizure and subcutaneous pentylene tetrazole seizure tests in rats.



(10)

- R**
- $p\text{-NO}_2\text{C}_6\text{H}_4$
 - $p\text{-NH}_2\text{C}_6\text{H}_4$
 - $p\text{-CH}_3\text{CONHC}_6\text{H}_4$
 - $p\text{-ClC}_6\text{H}_4$

- R'**
- H
 - H
 - H
 - H

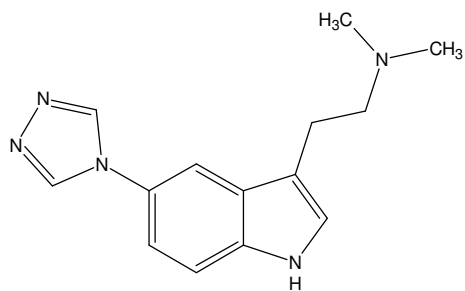


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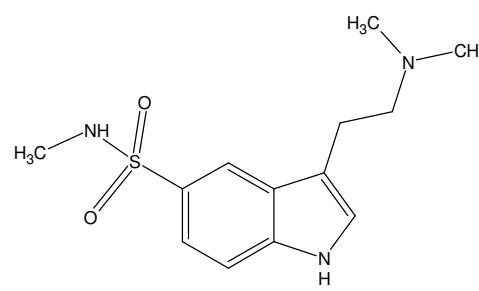
- R**
- $o\text{-CH}_2\text{C}_6\text{H}_4$
 - $m\text{-CH}_3\text{C}_6\text{H}_4$
 - $o\text{-ClC}_6\text{H}_4$

Of the *p*-substituted phenyl compounds (10a-d) 1-*p*-chlorophenyl-1,2,4-triazole is the most active against electroshock seizure but has weak activity against pentylene tetrazole *o*-tolyl (11a) and *o*-chlorophenyl (11b) were convulsants and *o*-methoxyphenyl (11c) was an anticonvulsant even at high dose levels.

Sternfeld *et al* [21] optimized a series of 5-(heterocyclyl) tryptamines led to the identification of the symmetrically substituted, N-4 linked 1,2,4-triazoles as the best indole C-5 substituent for 5-HT_{1D} receptor affinity and selectivity.



(12)



(13)

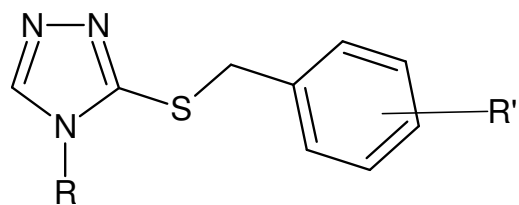
The triazole analog (12) is the most potent and selective, orally bioavailable, 5-HT_{1D} receptor agonist identified to date, showing an order of magnitude greater potency than the clinical compound sumatriptan(13) with improved subtype selectivity.

A Series of 3-benzylsulfanyl derivatives of 1, 2, 4-triazole and 4-methyl-1, 2, 4-triazole were synthesized by alkylation of starting triazole-3- thiol with appropriately substituted benzylhalide by Klimesova *et al* [5]. All members of the set were evaluated for *in vitro* antimycobacterial activity

5-Substituted-1, 2, 4-Triazole

against *Mycobacterium tuberculosis*, *M. avium*, and two

strains of *M. kansasii*.

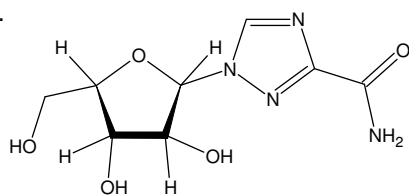


(14)

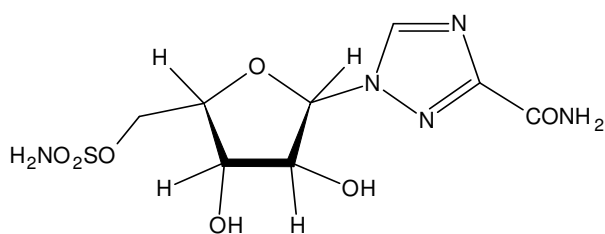
3-(2, 4-dinitrobenzylsulfanyl)-1, 2, 4- triazole (14f) and 3-(3, 5-dinitrobenzylsulfanyl)-1, 2, 4-triazole (14g) are the most active compounds in the set, their activities ranging from 32 to 500 $\mu\text{mol/l}$.

1, 3-disubstituted-1, 2, 4-triazole

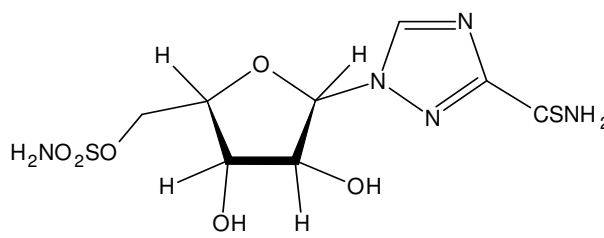
Witkowski *et al* [22] reported the preparation and evaluation of 1st synthetic broad-spectrum, noninterferon-inducing, antiviral agent 1- β -D-ribofuranosyl-1, 2, 4-triazole-3-carboxamide (15) against variety of both RNA and DNA viruses in tissue culture.



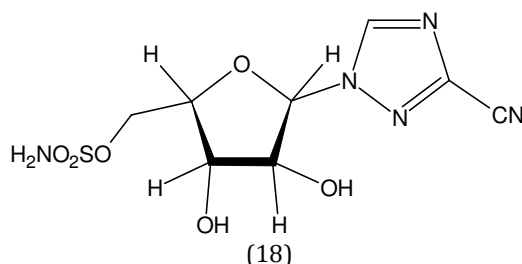
(15)



(16)



(17)



(18)

All three compounds showed significant activity *in vitro* while (16) showed significant activity *in vivo* against *Leishmania donovani* and *Trypanosoma brucei*.

1, 4-Disubstituted-1, 2, 4-Triazole

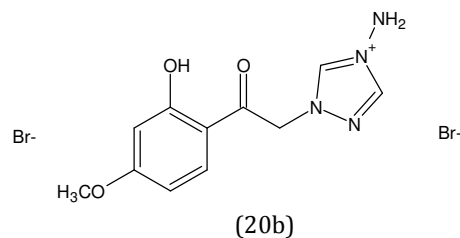
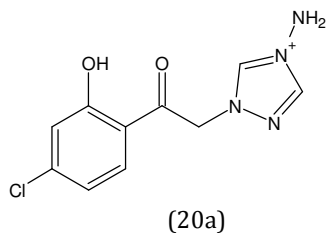
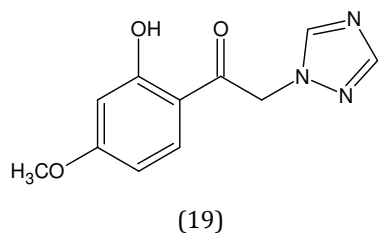
Reproducible broad spectrum antiviral activity both *in vitro* and *in vivo* at nontoxic dosage levels was shown by (15).

The triazole nucleoside derivatives 1-(5'-O-sulfamoyl- β -D-ribofuranosyl)[1, 2, 4] triazole-3-carboxamide (16), 1-(5'-O-sulfamoyl- β -D-ribofuranosyl) [1, 2, 4] triazole-3-thiocarboxamide (17), 1-(5'-O-sulfamoyl- β -D-ribofuranosyl) [1, 2, 4] triazole-3-carbonitrile (18), were synthesized by Kini *et al* [23].

	R'
a.	H
b.	4-Cl
c.	4-Br
d.	3-Br
e.	2-NO ₂
f.	2, 4-(NO ₂) ₂
g.	3, 5-(NO ₂) ₂

2-Hydroxyphenacyl azole (19) and 2-hydroxyphenacyl azolium compounds (20a and 20b) have been described as a new class of azole antifungals by Emami *et al* [24]. Most target compounds showed significant *in vitro* antifungal

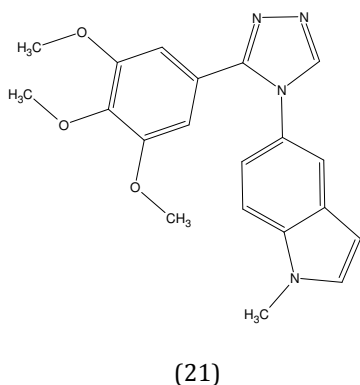
activities against tested fungi (*Candida albicans*, *Saccharomyces cerevisiae*, *Aspergillus niger*, and *Microsporium gypseum*) with low MICs values included



2-hydroxyphenacyl-azoles (19) and 2-hydroxyphenacyl-4-aminotriazoliums (20a and 20b) may be considered promising for the development of new antifungal agents with their biological activity and toxicity screening.

3, 4-Disubstituted-1, 2, 4-Triazole

Zhang *et al* [8] described the synthesis and biological evaluation of a series of tubulin polymerization inhibitors that contain the 1, 2, 4-triazole ring to retain the bioactive configuration afforded by the *cis* double bond in combretastatin A-4 (CA-4).

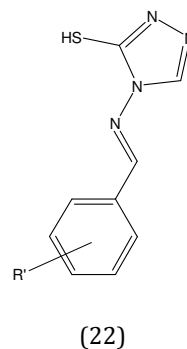


Several of the compounds exhibited potent tubulin polymerization inhibitory activity as well as cytotoxicity against a variety of cancer cells including multi-drug-resistant (MDR) cancer cell lines. Attachment of the *N*-methyl-5-indolyl moiety to the 1, 2, 4-triazole core, as exemplified by compound (21), conferred optimal properties among this series.

Khanmohammadi *et al* [25] synthesized a series of new Schiff base hydrazones (22) by condensation reaction of 4-amino-3-(4-pyridine)-5-mercapto-1,2,4-triazole with various aldehydes and/or dialdehydes. All the synthesized compounds were assayed for antibacterial (*Escherichia coli* and *Staphylococcus*

in the range of 0.25–32 lg/mL comparable to reference drug fluconazole.

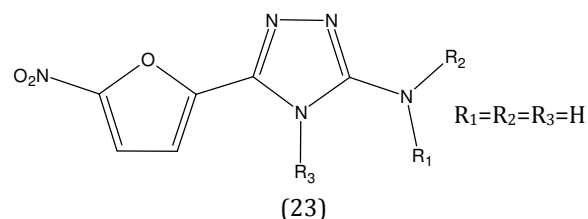
aureus) and antifungal (*Candida albicans*) activities by disc diffusion method.



Compounds 22 a-e containing 4-Cl, 4-Me, 4-OMe, 2,4-di-Cl and 2-OH substituted phenyl moiety, respectively, showed good inhibition against *S. aureus* as compare to standard drugs.

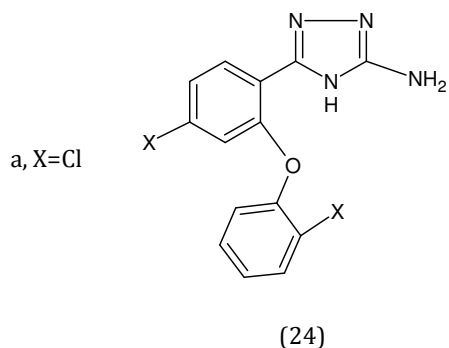
3, 5-disubstituted-1, 2, 4-Triazole

Akerblom *et al* [26] synthesized a series of 5-(5-nitro-2-furyl)-1, 2, 4-triazole (23) and their activity as potential urinary tract antibacterial agents was tested. Many of the compounds showed a higher antibacterial activity than nitrofurantoin especially against gram-ve bacteria.



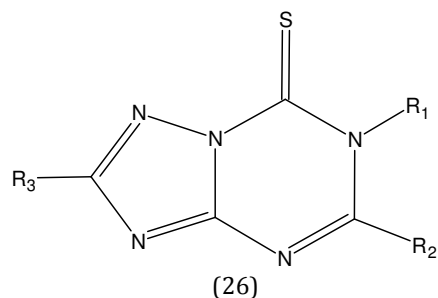
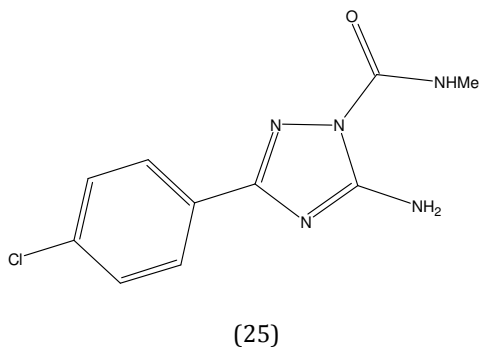
A series of new 5-substituted analogues of 4H-3-(2-phenoxy) phenyl-1,2,4-triazole (24) and its chlorinated derivatives was designed and prepared by Akbarzadeh *et al* [27]. Rotarod and pentylenetetrazole-induced lethal convulsion tests showed that the introduction of an amino group in position 5 of 1,2,4-triazole ring especially in

chlorinated derivatives had the best effect which was comparable with diazepam.



1, 5-Disubstituted-1, 2, 4-Triazole

In continuation of their previous work on eosinophilia inhibitors, Akahoshi *et al* [28] synthesized an additional series of inhibitors, which consisted of 5-amino-1-[(methylamino) thiocarbonyl]-1*H*-1,2,4-triazole derivatives(25) and a newly developed series of 1,2,4-triazolo[1,5-*a*]-1,3,5-triazine derivatives(26).

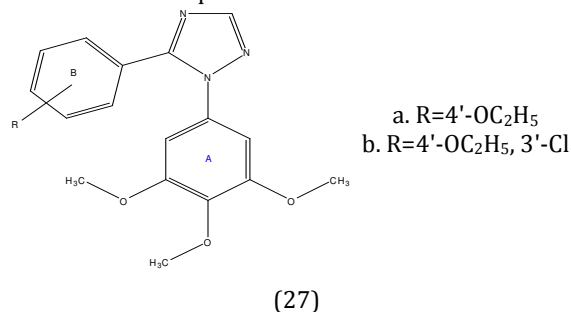


R₁ R₂ R₃

a. CH₃ H C₆H₄(4-Cl)

In the triazolo-[1,5-*a*]triazine series, 2-(4-chlorophenyl)-6-methyl-1,2,4-triazolo[1,5-*a*]-1,3,5-triazine-7(6*H*)-thione (26a) was highly potent, and when given orally it had an ID₅₀ value of 0.3 mg/kg, which is comparable to that of GCC-AP0341(25).

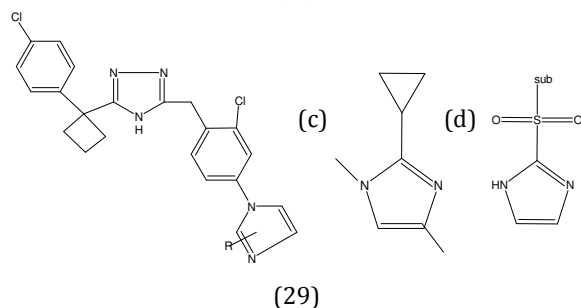
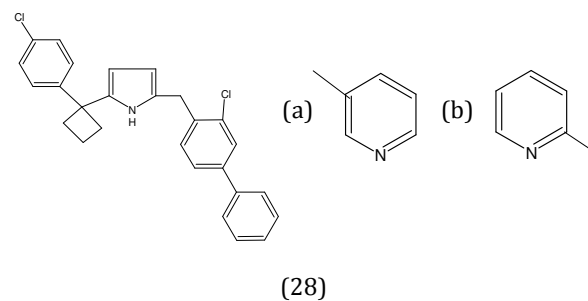
A series of 1-(3', 4', 5'-trimethoxyphenyl)-5-aryl-1, 2, 4-triazoles (27), designed as *cis*-restricted combretastatin analogues, were synthesized and evaluated for antiproliferative activity, inhibitory effects on tubulin polymerization, cell cycle effects, and apoptosis induction by Romagnoli *et al* [29]. Their activity was greater than, or comparable with, that of the reference compound.



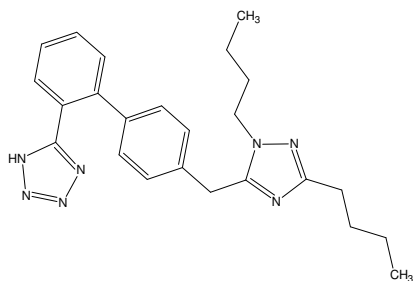
The most active compounds 27a and 27b were arresting the growth in the G₂/M phase of the cell cycle in a concentration dependent manner. Compound 27b was also shown to have potential antivasular activity, since it induced endothelial cell shape change *in vitro* and disrupted the sprouting of endothelial cells in the chick aortic ring assay.

4, 5-Disubstituted-1, 2, 4-Triazole

Zhu *et al* [12] identified 4-methyl-5-phenyl-(1, 2, 4) triazoles (28, 29) as selective inhibitors of 11 β -hydroxysteroid dehydrogenase type1 (11 β -HSD1) and found them active *in vitro* and *in vivo* mouse pharmacodynamic model.

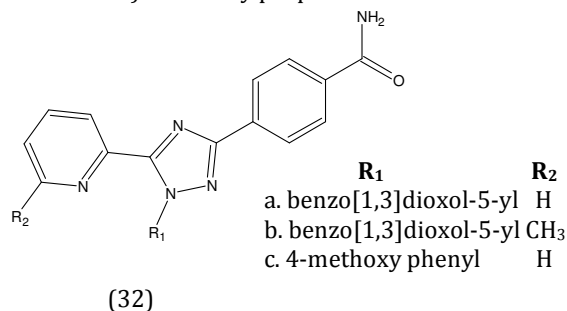


It was found that pharmacodynamic activity of compound 28 was much improved compared to the earlier one. Unfortunately this analog was a full and potent pregnane X receptor (PXR) agonist, suggesting CYP450 induction might be an issue at pharmacologically relevant exposures. SAR studies revealed that sulfone substitution in compound 29(d, e) helped to decrease PXR activity. It was also found that small group substitution at 'o' position and larger group substitution at 'p' position increase *in vivo*



(30)

Kim *et al* [31] synthesized a series of 2- pyridinyl-[1, 2, 4]-triazoles (32) and evaluated their ALK5 (Activin like kinase 5) inhibitory properties.

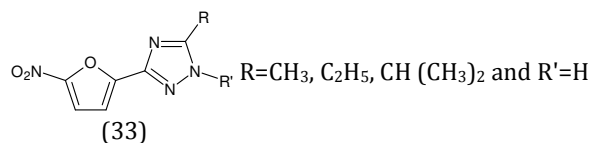


(32)

In the entire series, compound 32b showed significant ALK5 inhibition.

2, 3, 5-Trisubstituted-1, 2, 4-Triazole

The synthesis of several 3-alkyl-5-(5-nitro-2-furyl)-1, 2, 4-triazoles (33) were described by Burch *et al* [32].



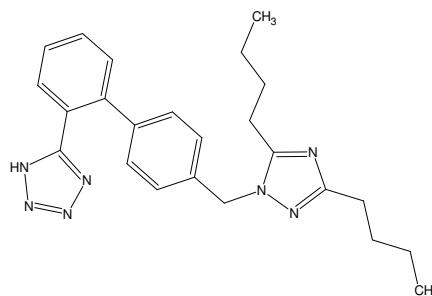
(33)

Most of the compounds possessed broad antibacterial activity *in vitro* against both gram positive and gram negative bacteria, except *Pseudomonas aeruginosa*. Compounds with the above substituents showed maximum effectivity.

activity. By introducing polar group at the end of the molecule PXR activity can be success fully eliminated.

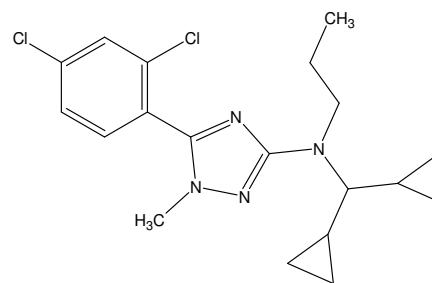
1, 3, 5-trisubstituted-1, 2, 4-triazole

Reitz *et al* [30] reported some novel 1H-1, 2, 4-triazole analogs in which the biphenylmethyl group was attached to carbon and the butyl group was attached to the adjacent nitrogen were found to be potent angiotensin II receptor antagonists. The *in vivo* properties of dibutyl analog SC-51757(30) was found to be similar to SC-50560(31).



(31)

Chen *et al* [33] described the synthesis of 1-alkyl-3-dialkylamino-5-phenyltriazoles (34) as major products. Significant binding affinity on the human CRF1 receptor was observed with this series of compounds.



(34)

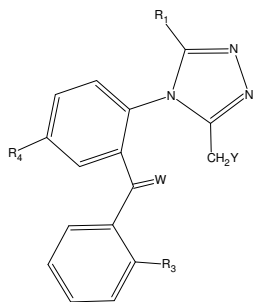
Among them, 1- methyl-3-[N-bis(cyclopropyl)methyl-N-propylamino]-5-(2,4-dichlorophenyl)-1H-[1, 2, 4]triazole (34) had the best binding affinity for the CRF1 receptor (K_i=9 nM).

3, 4, 5-trisubstituted-1, 2, 4-triazole

Gall *et al* [34] prepared a series of 2-[(alkylaminomethyl)-4H-1, 2, 4-triazole-4-yl] benzophenones, which were found to possess potential sedative and muscle relaxing activity which might function, in part as prodrugs of triazolobenzodiazepines. In addition, compound 35a

antagonized the clonic convulsions induced in mice by

the administration of pentylene tetrazole.

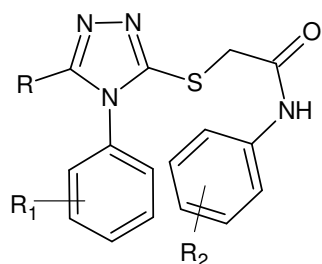


	X	R ₁	R ₂	R ₃	R ₄	Y	W
a.	N	CH ₃	-	H	Cl	N(CH ₃) ₂	O
b.	N	CH ₃	-	Cl	Cl	N(CH ₃) ₂	O
c.	N	CH ₃	-	H	Cl	C-N-C ₄ H ₈	O
d.	N	CH ₃	-	H	Cl	-	O
e.	N	CH ₃	-	H	Cl	-	O
f.	N	CH ₃	-	H	Cl	-	O
g.	-	-	CH ₂ OH	Cl	Cl	N(CH ₃) ₂	O

(35)

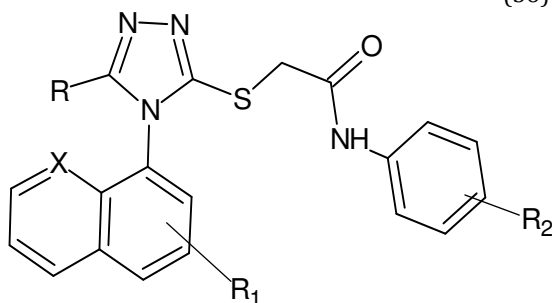
In 2 or more tests the Rosa *et al* [35] synthesized a new series of 1,2,4- triazoles (36) and (37).and tested them against several NNRTI resistant HIV-1 isolates. Several of these compounds exhibited potent antiviral

activities against efavirenz and nevirapine resistant viruses containing K103N, and/or Y181C mutations or Y188L mutation.



	R	R ₁	R ₂
a.	CH ₃	4-CF ₃	2-Cl-4-CH ₃
b.	2, 4- diCH ₃	2-Br	CH
c.	4-C ₂ H ₅	2-Br	CH
d.	3, 4-di CH ₃	2-Br	CH
e.	4, 5-di CH ₃	2-Br	CH

(36)



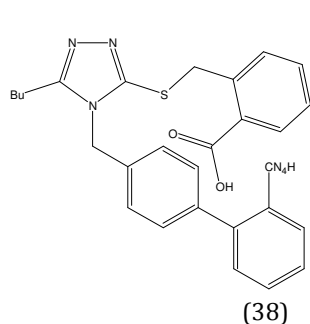
	R ₁	R ₂	X
a.	4-CH ₃	2-Br	CH
b.	CH ₃	4-CH ₃	2-Cl-4- CH ₃
c.	CH ₃	4- C ₂ H ₅	2-Cl-4- CH ₃
d.	CH ₃	4- CH ₃	2-Cl
e.	CH ₃	4- CH ₃	3-Cl
f.	CH ₃	4- CH ₃	2-S CH ₃
g.	CH ₃	4- CH ₃	2, 3-diCl
h.	CH ₃	4- CH ₃	2, 4-diCl
i.	CH ₃	4- CH ₃	2, 3-di CH ₃
j.	CH ₃	4- CH ₃	4-OC ₆ H ₅

(37)

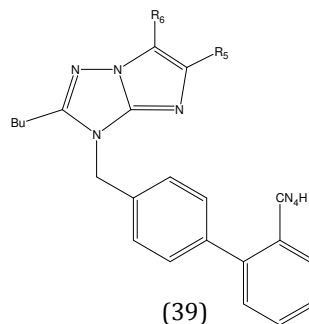
Substitution at 4th position of triazole with substituted quinoline resulted in compounds with moderate activity.

A series of 3, 4, 5-trisubstituted-4H-1,2,4-triazoles(38) and a related series of 3H- imidazo [1,2-b][1,2,4] triazoles(38) were synthesised by Wallace *et al* [36] and were evaluated *in vitro* and *in vivo* as

angiotensin II (AII)antagonists. Compound with noteworthy activity was 3-n-butyl-5-[(2-carboxybenzyl)thio]-4-[[2'-(1H-tetrazol-5-yl) biphenyl-4-yl]methyl]-4H-1,2,4-triazole(38). IC₅₀ 1.4 nM), which blocked the AII pressor response in conscious rats, similar to that of DUP 753.



(38)



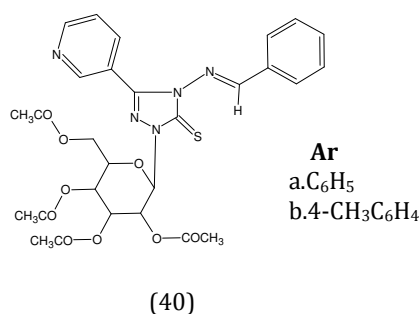
(39)

R₅ = CH₃ R₆ = CH₃

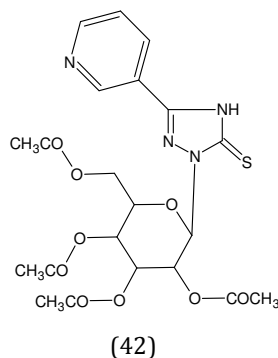
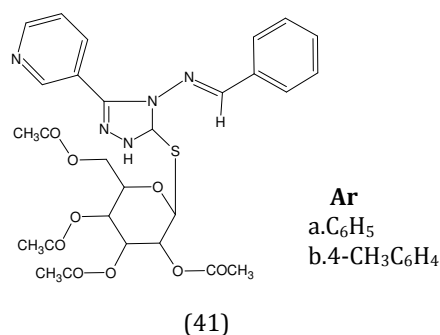
Most potent among the bicyclic derivatives was 2-n-butyl-5,6-dimethyl-3-[[2'-(1H-tetrazol-5-yl)biphenyl-4-yl]methyl]]3H-imidazo[1,2-b][1,2,4] triazole (39a, IC₅₀ 7.8nM).

1, 3, 4, 5-Tetrasubstituted-1, 2, 4-Triazole

Nasser *et al* [37] revealed that glucosidation of some 4-amino- and 4-arylideneamino-5-(pyridin-3-yl)-2,4-



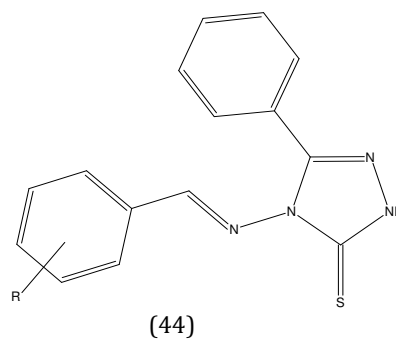
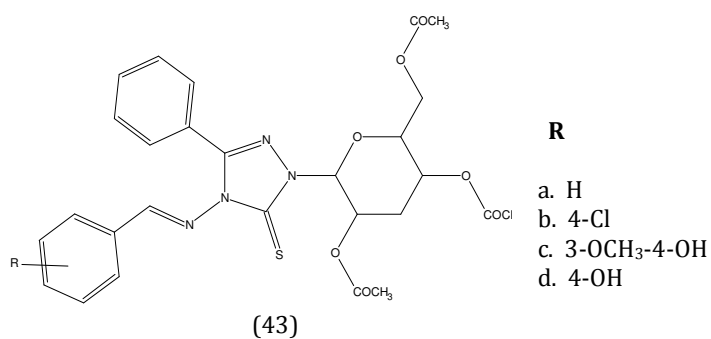
dihydro-[1, 2, 4]-triazole-3-thiones with 2, 3, 4, 6-tetra-*o*-acetyl- α -D-glucopyranosyl bromide followed by a chromatographic separation gave the corresponding N- and S- β -D-glucosides. Compound 40a showed higher inhibitory effect against *Aspergillus fumigatus*, *Candida albicans*, *Staphylococcus aureus*, *Bacillus subtilis*, and *Escherichia coli*, compared to compound 41a.



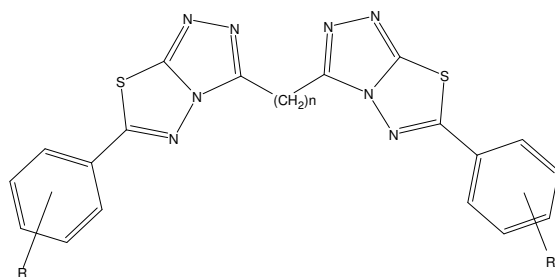
Compound 40b showed higher inhibitory effect against *Aspergillus fumigatus*, *Candida albicans*, *Pseudomonas aeruginosa*, and *Escherichia coli*, compared to compound 41b. Compound 42 exhibited higher inhibitory effect against *Aspergillus fumigatus*, *Penicillium italicum*, *Pseudomonas aeruginosa*, and *Bacillus subtilis* as well as lower inhibitory effect against *Syncephalastrum racemosum*.

Li *et al* [38] synthesized a series of D-glucopyranosyl-1, 2, 4-triazole-3-thione derivatives (43a-d), The Schiff bases thus obtained subsequently afforded the compounds 44 with the similar substituents as inserted in its previous congeners. Analogues 43 and 44 exhibited cytotoxic activity against human MCF-7 and Bel-7402 malignant cell lines. The glycosyl esters 43a-d showed similar activity against MCF-7 and Bel-7402 cells when compared to 5-fluorouracil.

2, 3, 4, 5-tetrasubstituted-1, 2, 4-Triazole

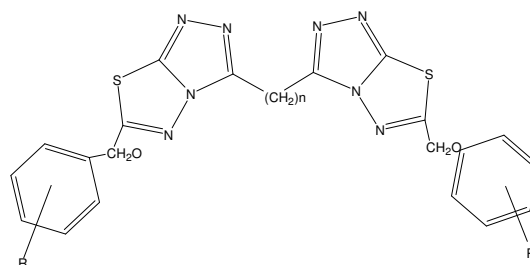


Compounds 43a-d showed higher antiproliferative activity as compared to Schiff bases 44a-d. Interestingly, 43c showed more potent cytotoxic activity against MCF-7 cells being 2.7-fold more potent than the reference compound 30c.



(45)

R **n**
45a. 4-Cl 4



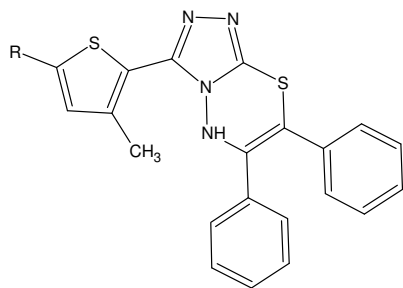
(46)

R **n**
46a. 2-Cl 2

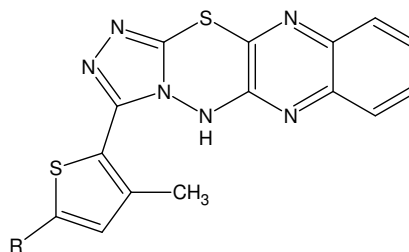
Compounds 45a and 46a were the most active and particularly showed very good activity against *B.subtilis*.

Shiradkar *et al* [40] based on their earlier in-house database and compound library designed a series of

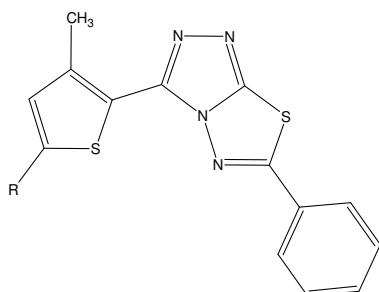
novel clubbed thienyl triazoles (47-54) considered to be potential cdk5/p25 inhibitors for the treatment of Alzheimer's disease.



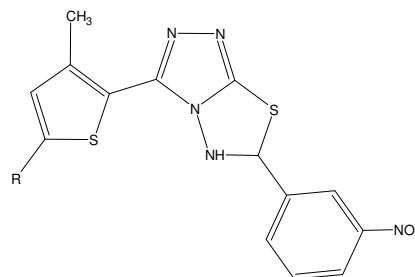
(47)



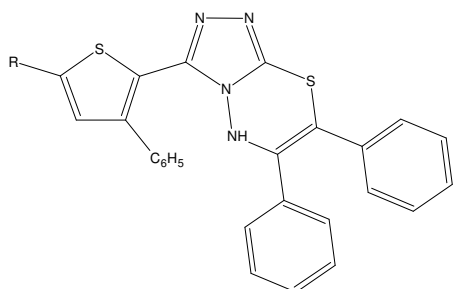
(48)



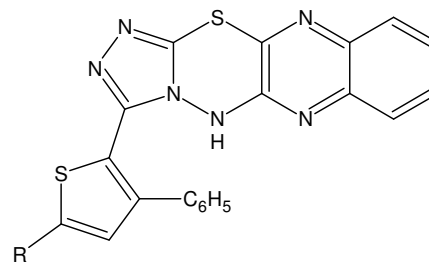
(49)



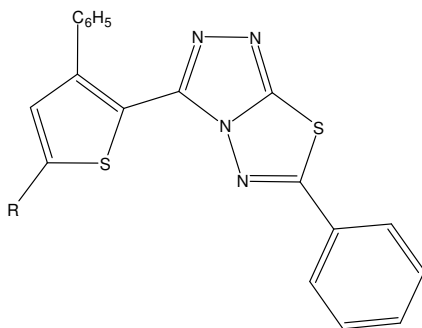
(50)



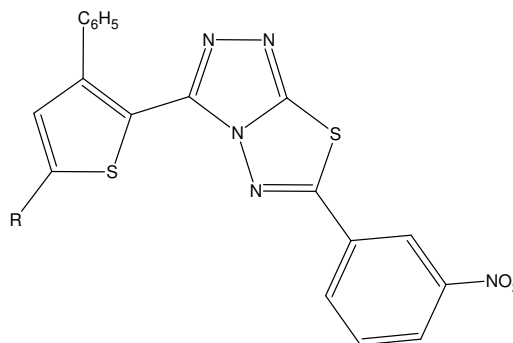
(51)



(52)



(53)

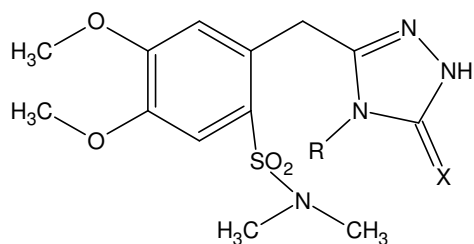


(54)

47a,48a,49a,50a, **R**=NHCOCH₃
51a,52a,53a,54a

Following their studies, compounds (47-54) were considered as significant cdk5/ p25 inhibitors and thus had the potential to be a possible remedy for Alzheimer's disease.

SULPHONAMIDE LINKED TRIAZOLES



(55)

X= O, S

X=S
R

X=O
R

a. CH₃

b. C₂H₅

c. C₃H₇

d. *i*-C₃H₇

e. C₄H₉

f. *t*-C₄H₉

-

g. C₂H₅

h. C₃H₇

i. *i*-C₃H₇

j. C₄H₉

k. *t*-C₄H₉

The best antifungal potential could be seen for few members of triazole series, whereas compounds 55(a-f), 55i and 55k possessed better antibacterial activity than ampicillin against *Enterobacter cloacae* and *S. typhimurium*. All compounds tested showed stronger antibacterial potential than ampicillin against *E. coli* and *P. aeruginosa*. The outcome of their work depicted that increase of the length of aliphatic chain increased lipophilicity which is mandatory for antibacterial

A significant antimicrobial activity of a series of sulfonamide 1, 2, 4-triazole and its derivatives against a series of micromycetes was reported by Zoumpoulkis *et al* [41]. Owing to its therapeutic efficacy, bifonazole was considered as control for antifungal evaluation.

activity. On the other hand, larger alkyl groups (butyl/*t*-butyl/*iso*-propyl) gave better results against fungi. Triazole-3-thiones exhibited best activities against all fungal species.

CONCLUSION

Great strides have been made in improving the quality of life of individuals affected with so many disorders. The current review clearly demonstrates that there is

a huge range in the structural diversity of compounds with the common core as 1,2,4-triazole, which have shown its robust therapeutic potential in combating various disorders. We hope the synthetic feasibility and suitable insertion into many other structural frameworks will surely prompt the researchers to synthesize a huge number of compounds considering 1,2,4-triazole as an effective scaffold, which will not only be useful in modulating the existing efficacy in a better way, but also may explore certain targets which are yet to be touched.

CONFLICT OF INTEREST

None

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