



Recent Advances in Pyrazoline Derivatives: A Review

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ABSTRACT: Pyrazolines and its fused heterocyclic derivatives tested with diverse pharmacological activity constitute an important class of compounds for new drug development. The synthesis of novel pyrazoline derivatives and investigation of their chemical and biological behavior have gained more importance in recent decades. So far, modifications of the pyrazoline ring have proven highly effective with improved potency and lesser toxicity. The present review provides an in depth view of work done so far on pyrazoline and its biological activities covering anticancer, antimycobacterial, antimicrobial, anticonvulsant, antiinflammatory and cardiovascular activities. © 2015 iGlobal Research and Publishing Foundation. All rights reserved.

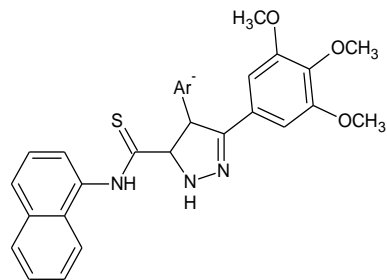
INTRODUCTION

Diversely substituted pyrazolines and their derivative embedded with variety of functional groups are important biological agents and a significant amount of research activity has been directed towards this class. The 2-pyrazolines were synthesized by the reaction of appropriate chalcone derivative and hydrazine hydrate according to the condensation reaction of α,β -unsaturated ketones with hydrazines. They possess antitumor, antidepressant, anticonvulsant, hyperglycemic, malarial, antimicrobial and antituberculosis and. Some of these compounds have potent selective activity such as MAO inhibitors, COX-II inhibitors and Cannabinoid CB1 and CB2 receptor antagonists activity. On the other hand, 1,2,3-triazoles have received much attention due to their interesting bioactivity profile such as anti-biotic, anti-fungal, anti-cancer, anti-HIV, anti-microbial, etc. properties. Also, they serve as potential chemotherapeutic agents for various diseases [1]. So far, modifications of the pyrazoline ring have proven highly effective with improved potency and lesser toxicity. The preceding section of the review is focusing on the recent development on pyrazolines along with their biological properties.

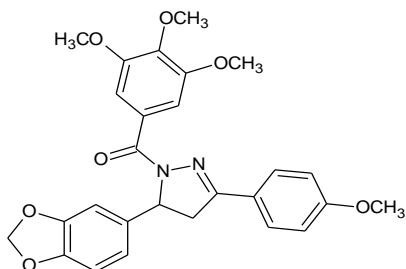
BIOLOGICAL ACTIVITIES OF PYRAZOLINES

Anticancer activity

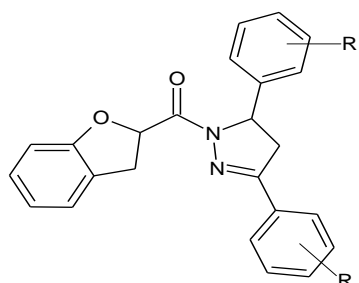
Zhi hui lu et al furnished a new series of pyrazoline analogs and evaluated for their in vitro anticancer efficacies against human non-small-cell lung cancer cell line A549. α -Naphthyl isothiocyanate was prepared from benzoyl chloride and α -naphthyl amine through α -naphthyl thiourea to react with pyrazoline intermediates **1** in good yields and purity. Final compounds revealed that analogs with fluorine and thiomethyl and methoxy functional group demonstrated good potencies against A549 cell lines with reasonable level of cytotoxic nature.[2] Ya juan quin et al designed and synthesized pyrazoline derivatives. Among them, compound **2** displayed the most potent antiproliferative activity against A549, MCF-7 and HepG-2 cells line (IC₅₀ $\frac{1}{4}$ 0.07 mM, 0.05 mM, 0.03 mM, respectively) and the tubulin polymerization inhibitory activity (IC₅₀ $\frac{1}{4}$ 1.88 mM). This compound was a potent inducer of apoptosis in HepG-2 cells and it had cellular effects typical for microtubule interacting agents, causing accumulation of cells in the G2/M phase of the cell cycle. [3]



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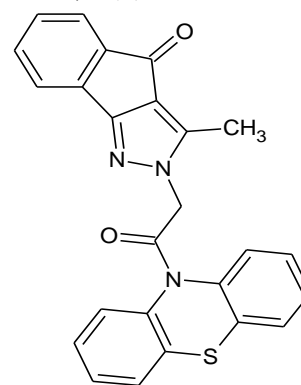


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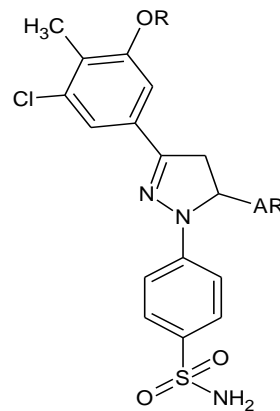


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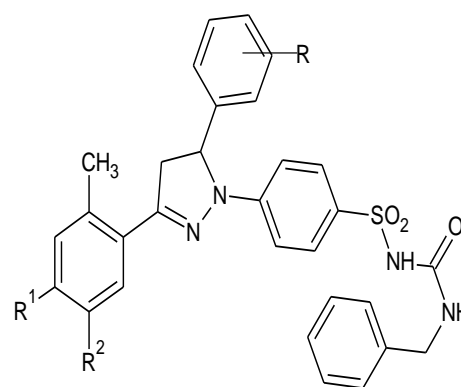
Shrey Parekh et al described a new series of benzofuran-2-yl(4,5-dihydro-3,5-substituted-diphenylpyrazol-1-yl) methanone **3** derivatives by the reaction of the benzofuran-2-carbohydrazides with various chalcone derivatives using microwave irradiation. The effect of synthesized compounds showed good antiproliferative activity against human cancer cell lines and exhibited good reversal activity of multidrug resistance on human MDR1-gene transfected mouse lymphoma cells.[4] Pyrazoline containing phenothiazine ring was designed and synthesized by Lavinia Baciu-Atudosie et al. Compound **4** was the most active against protein farnesyltransferase and growth of HCT-116, LOX IMVI and SK-MEL-5 cell lines.[5] Rafia bashir et al reported 1,3,5 trisubstituted pyrazolines bearing benzene sulphonamide **5** with considerable antitumor activities and growth inhibition GI50.[6] Pooja Rathore et al. designed and synthesized some new pyrazoline substituted benzenesulfonylureas derivatives **6** and tested for anticancer activity.[7]



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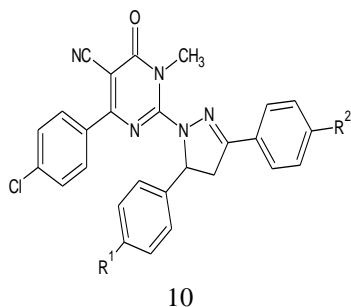
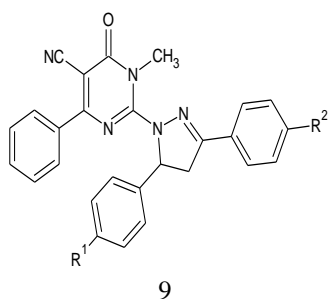
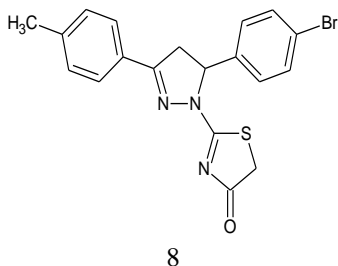
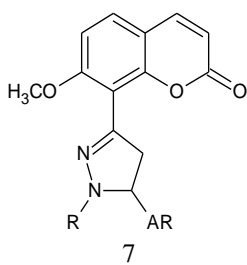


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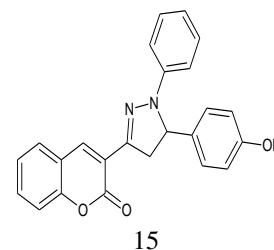
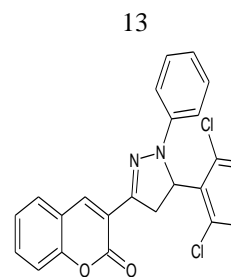
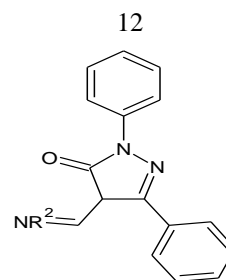
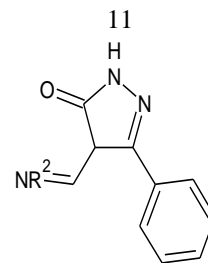
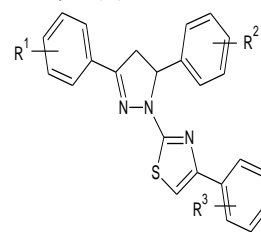


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Kamilia M Amin et al designed and synthesised coumarin derivatives **7** bearing diversely substituted pyrazoline moieties. Cytotoxicity of the synthesized compounds was evaluated in vitro against liver HepG2 cell line. The most active compounds were investigated for their telomerase inhibition and proapoptotic activities. [8] A series of pyrazolyl-thiazolinone derivatives had been designed and synthesized and evaluated as potential EGFR and HER-2 kinase inhibitors. Compound 2-(5-(4-bromophenyl)-3-p-tolyl-4,5-dihydro-1H-pyrazol-1-yl)thiazol-4(5H)-one **8** displayed the most potent inhibitory activity against MCF-7, B16-F10 and HCT-116 in vitro, with IC50 value of 0.30, 0.54, and 0.70 μ M, respectively.[9]

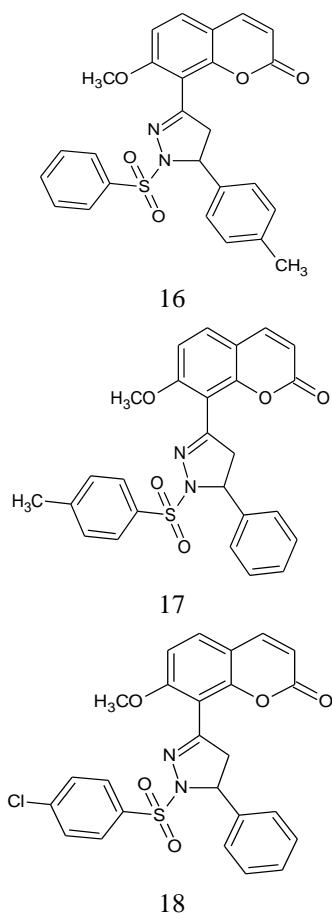


Fadi M Awadallah et al synthesized two series of 2-(3,5-diaryl-4,5-dihydropyrazol-1-yl)-1-methyl-6-oxo-4-phenyl-1,6-dihydropyrimidine-5-carbonitriles **9** and 4-(4-chlorophenyl)-2-(3,5-diaryl-4,5-dihydropyrazol-1-yl)-1-methyl-6-oxo-1,6-dihydropyrimidine-5-carbonitriles **10** and screened for their antiproliferative activity against A 549 (lung), HT 29 (colon), MCF 7 and MDA-MB 231 (breast) cell lines. The 4-unsubstitutedphenylpyrimidine derivatives were more active than their 4-chlorophenylpyrimidine analogs.[10] Peng-Cheng Lv et al reported thiazolyl-pyrazoline derivatives and screened for their EGFR kinase inhibitory activity. Compound 4-(4-chlorophenyl)-2-(3-(3,4-dimethylphenyl)-5-p-tolyl-4,5-dihydro-1H-pyrazol-1-yl)thiazole **11** displayed the most potent EGFR TK inhibitory activity with IC_{50} of 0.06 μ M. Molecular docking results indicated that compound **11** was nicely bound to the EGFR kinase and showed significant antiproliferative activity against MCF-7 with IC_{50} of 0.07 μ M, which would be a potential anticancer agent.[11]



4-aminomethylidene derivatives obtained from 3-phenyl-2-pyrazolin-5-one **12** and 1,3-diphenyl-2-pyrazolin-5-one **13** were synthesized and tested for their antiproliferative activity against human breast cancer MDA-MB-361 and MDA-MB-453 cell lines. The compounds derived from 1,3-diphenyl-2-pyrazolin-5-one exhibited the most remarkable activity in the treatment of both cell lines.[12] Nitin kumar et al prepared a novel series of 3-(4, 5-dihydro-1-phenyl-5-substituted phenyl-1H-pyrazol-3-yl)-2Hchromen-2-one derivatives and tested for anti cancer activity. It was observed that simple coumarin ring derivatives were more effective in inhibiting the growth of

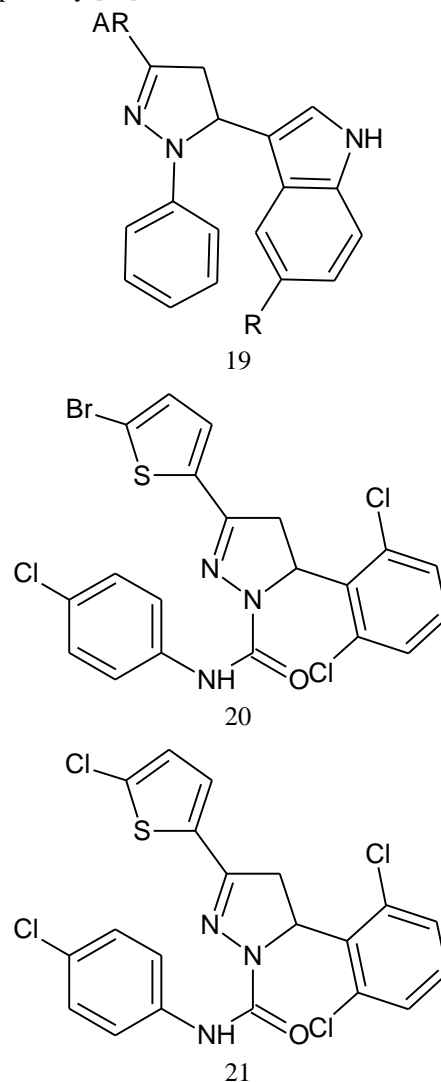
cancerous cell lines, than coumarin-pyrazoline derivatives. Among all the synthesized compounds, irrespective of compounds having simple coumarin ring and coumarin-pyrazoline combination, compounds **14** and **15** were potent anticancer agents [13]. Kamilia M amin et al synthesized two groups of coumarine-pyrazoline hybrids and investigated for their anticancer activity toward 60 cancer cell lines according to US NCI protocol where breast cancer MCF7 and colon cancer HCT-116 were the most susceptible to the influence of compounds **16**, **17** and **18**. The tested compounds exhibited high potency with IC₅₀ ranging from 0.01 mM to 2.8 mM. [14]



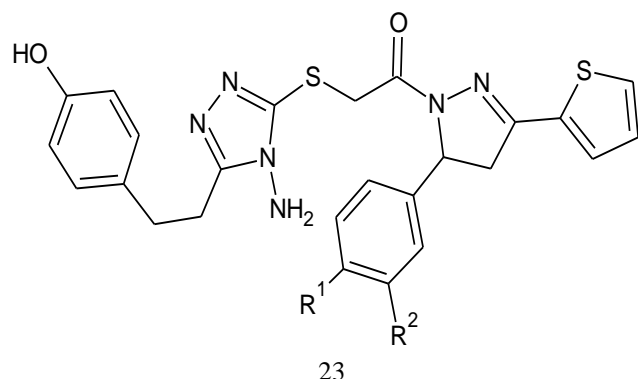
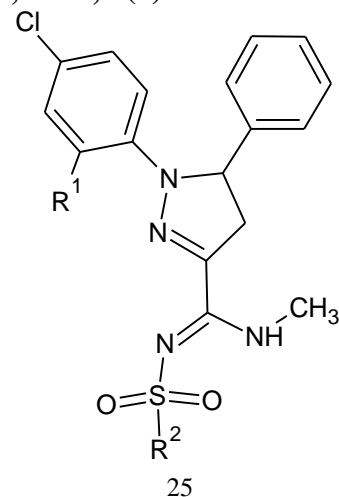
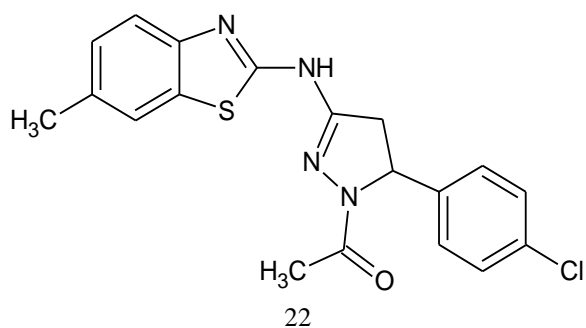
Antidepressant and Anticonvulsant activity

Pravin O patil et al synthesized a series of new substituted 5-(1H-Indol-3-yl)-3-(phenyl)-4,5-dihydropyrazoline derivatives **19** with good yield with the help of microwave and screened for antidepressant and anticonvulsant potentialities. The results revealed that few compounds were found to be potent antidepressant molecules whereas, few showed potent anticonvulsant activity when compared with the reference drug.[15] Carboxamide and carbothioamide derivatives of 2-pyrazolines were reported by Nagihan beyhan et al and found to be more potent due to their ability to form strong hydrogen bonds and their hydrophobic nature. Furthermore, the carboxamide derivatives of **20** and **21** were much more potent

(90% protection) in PTZ test because of the bulk they own and their lipophilicity.[16]



Nikhil D. Amnerkar et al designed a series of 6-substituted-[3-substituted-prop-2-eneamido] benzothiazole and 6-substituted-2-[(1-acetyl-5-substituted)-2-pyrazolin-3-yl] aminobenzothiazole and evaluated against maximal electroshock test. The most active compound, **22** exhibited an ED₅₀ of 25.49 mmol/kg, TD₅₀ of 123.8mmol/kg and high protective index (PI) of 4.86 compared to standard drug phenytoin.[17]. Some triazolo-pyrazoline derivatives **23** were synthesized to investigate their potential antidepressant activities. The test compounds in the series exhibited different levels of antidepressant activities when compared to reference drug fluoxetine. [18]

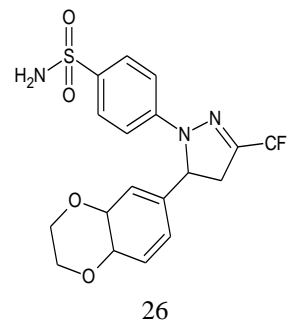
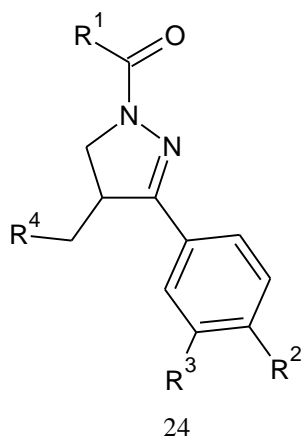


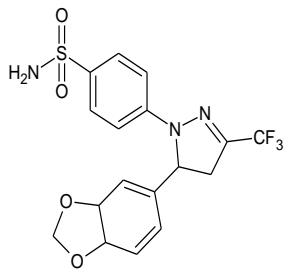
COX-2 inhibitor

Minmin Yu et al designed pyrazoline derivatives modified from Celecoxib and synthesized as bi-inhibitor of COX-2 and B-Raf. They were evaluated for their COX-1/COX-2/B-Raf inhibitory and anti-proliferation activities. Compound 26 displayed the most potent activity against COX-2 ($IC_{50} = 0.008 \mu\text{M}$) and showed superb COX-1/COX-2 selectivity (>500), being more potent and selective than positive control Celecoxib. Compound 27 retained superb bioactivity against COX-2 ($IC_{50} = 0.015 \mu\text{M}$). [21] A series of dihydro-pyrazolyl-thiazolinone derivatives had been synthesized and evaluated as potential cyclooxygenase-2 (COX-2) inhibitors by Ke-Ming Qiu et al. Compound 2-(3-(3,4-dimethylphenyl)-5-phenyl-4,5-dihydro-1H-pyrazol-1-yl)thiazol-4(5H)-one 28 displayed the most potent COX-2 inhibitory activity with IC_{50} of $0.5 \mu\text{M}$, but weak to COX-1. [22] Rossella Fioravanti et al reported new 1-N-substituted-3,5-diphenyl-2-pyrazoline derivatives 29 and cyclooxygenase (COX-1 and COX-2) inhibitory activities had been evaluated. The results showed that all of new derivatives were not endowed with improved anti-inflammatory activity against COX-1, but some of them showed a good activity against COX-2. [23]

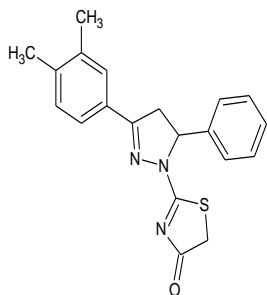
Cannabinoid receptor antagonist

Vincent Gembus et al established a new class of C4-benzyl pyrazolines 24 with the use of a resin base reagent strategy having significant CB2/CB1 selectivity in favor of CB2 receptors, although an agonist behavior was mainly measured. [19] Jos H. M. Lange et al described the structure-activity relationship (SAR) studies and intramolecular hydrogen bonding pattern of synthesized 1,3,5-trisubstituted 4,5-dihydropyrazoles 25. The target compounds represented a novel class of potent and selective CB1 receptor antagonists. [20]

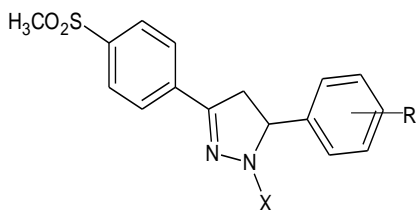




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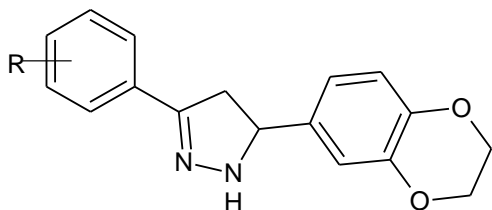
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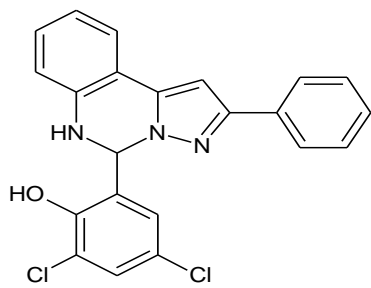
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Antihepatotoxic activity

Habibullah Khalilullah et al synthesized novel pyrazoline derivatives 30 containing 1,4-dioxane ring system from 3-(2,3-dihydro-1,4-benzodioxane-6-yl)-1-substituted-phenylprop-2-en-1-one. Some of the synthesized compounds were evaluated for antihepatotoxic activity against CCl₄-induced hepatotoxicity and showed significant antihepatotoxic activity comparable to standard drug silymarin.[24]



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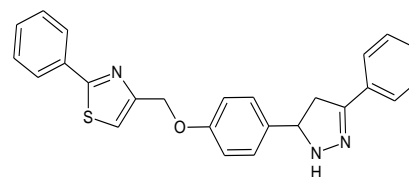
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Xanthine oxidase inhibitor

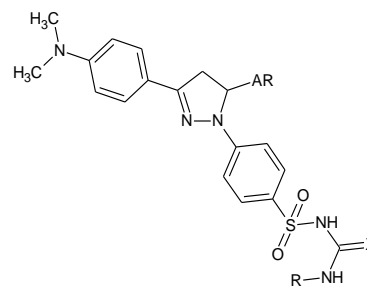
Deependra Kumar et al designed and synthesized some 5,6-dihydropyrazolo/pyrazolo[1,5-c]quinazoline derivatives and evaluated for in vitro xanthine oxidase inhibitory activity. The compounds 31 were found to be the most potent XO inhibitor as compared to allopurinol and free radical scavenger.[25]

Antihyperglycemic activity

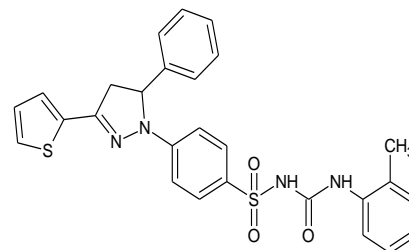
Manisha R. Bhosle et al reported thiazolylmethoxyphenyl pyrazolines with better yields. Among those compound 32 had displayed noticeable antihyperglycemic activity.[26] Syed Ovais et al synthesized seventeen new pyrazoline substituted benzenesulfonylurea/thiourea derivatives 33. Thirteen compounds showed moderate to good anti-hyperglycaemic activity in glucose fed hyperglycaemic normal rats at the dose of 0.05 mM/kg body weight. Out of these some compounds were found more effective than the known ARI sorbinil. Five compounds showed significant dual action (antihyperglycaemic and aldose reductase inhibition).[27] Twenty six benzenesulfonylureas containing thiophenylpyrazoline moiety had been synthesized and evaluated for their antidiabetic effect by oral glucose tolerance test. In vitro PPAR- γ transactivation assay was performed on active compounds in order to validate docking results and the most active compound 34 was also shown to elevate gene expression of PPAR- γ . [28]



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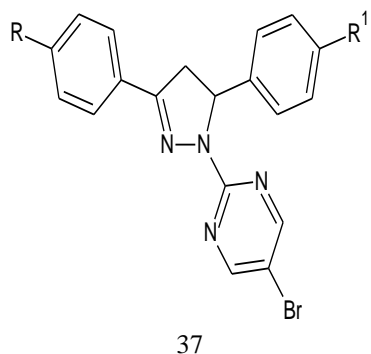
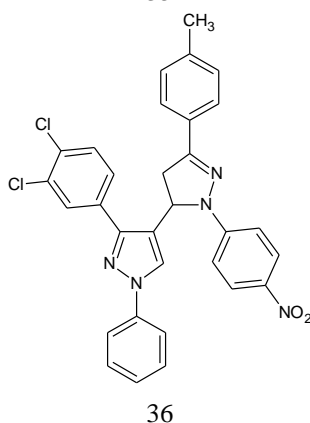
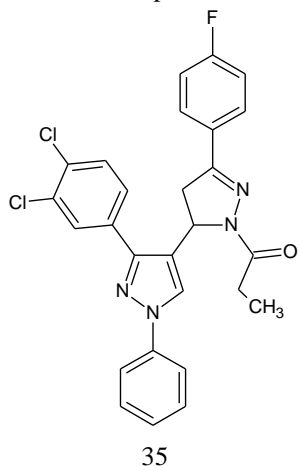
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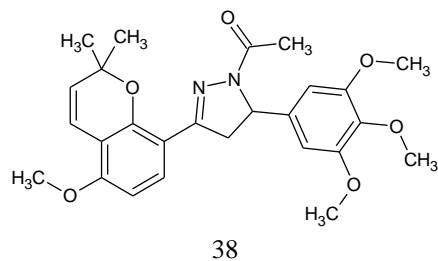
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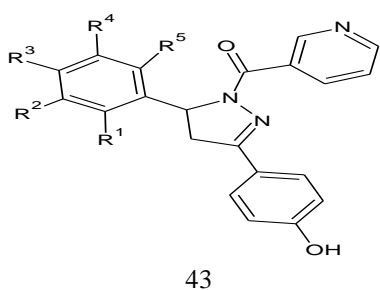
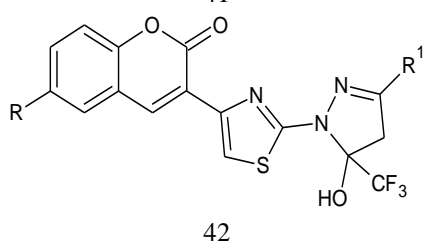
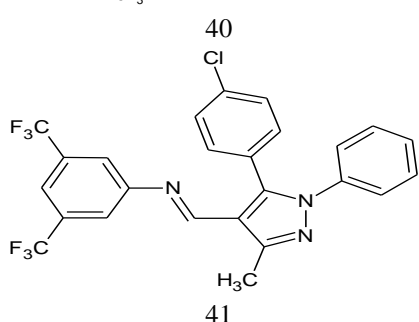
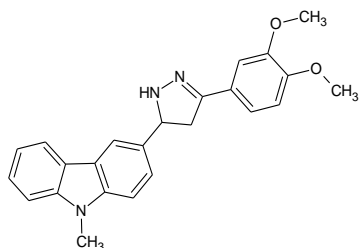
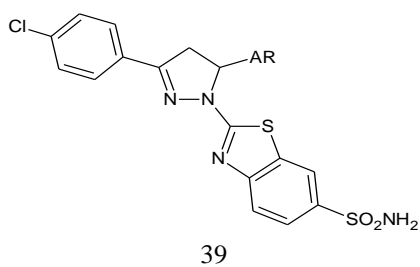
Antiinflammatory and Analgesic activity

Shivapura viveka et al synthesized some new substituted pyrazoline derivatives and was screened for their anti-inflammatory, analgesic and antibacterial activities. The preliminary results revealed that the N-acylated 35 and nitro substituted N-phenyl 36 pyrazolyl-pyrazolines derivatives exhibited a very promising anti-inflammatory activity whereas both were showing interesting analgesic property.[29] A series of 5-bromo-2-(3,5-diaryl-4,5-dihydro-1H-pyrazol-1-yl)pyrimidine 37 were prepared under conventional heating as well as microwave reaction condition. These new compounds were screened for their antioxidant, anti-inflammatory and analgesic activities. Some of these compounds exhibited potent biological activities compared to the standard drug.[30]



Jiqiang He et al reported twenty-eight pyrazoline derivatives and evaluated for their inhibitory potency on the production of inflammatory mediator nitric oxide (NO) in LPS-stimulated RAW 264.7 cells. Among them, 38 exhibited potent inhibitory effects on NO production and iNOS activity superior to positive control Indomethacin. Furthermore, it could suppress the progress of carrageenan-induced hind paw edema at a dosage of 50 mg/kg/day and dose-dependently ameliorate the development of adjuvant-induced arthritis.[31] Chetna Kharbanda et al presented the synthesis of pyrazolines bearing benzothiazole and their evaluation as anti-inflammatory agents. The compound 39 found to be the most potent anti-inflammatory agents attributing to the suppression of the COX-2 enzyme activity and TNF- α production without being either cytotoxic or ulcerogenic.[32] A novel series of 3-(substituted)-aryl-5-(9-methyl-3-carbazole)-1H-2-pyrazolines had been synthesized and evaluated for their anti-inflammatory activity, and for their antioxidant activity by Babasaheb P. Bandgar. Compound 40 was found to be selective COX-2 inhibitors and potent inhibitor of the carrageenin induced paw edema in rats.[33] Magda A.-A. El-Sayed et al synthesized new pyrazole and pyrazoline derivatives and their ability to inhibit ovine COX-1/COX-2 isozymes was evaluated using in vitro cyclooxygenase (COX) inhibition assay. Among the tested compounds, N-((5-(4-chlorophenyl)-1-phenyl-3-(trifluoromethyl)-1H-pyrazol-4-yl)methylene)-3,5-bis(trifluoromethyl)aniline 41 exhibit optimal COX-2 inhibitory potency ($IC_{50} = 0.26 \mu M$) and selectivity ($SI = >192.3$) comparable with reference drug celecoxib (IC_{50} value of $0.28 \mu M$ and selectivity index of 178.57).[34] Ranjana Aggarwal et al synthesized a series of novel 2-(5-hydroxy-5-trifluoromethyl-4,5-dihydropyrazol-1-yl)-4-(coumarin-3-yl)thiazoles 42 by condensing 3-(2-bromoacetyl)coumarins with various 5-hydroxy-5-trifluoromethyl-4,5-dihydropyrazol-1-thiocarboxamides. All the tested compounds displayed significant to moderate in vivo anti-inflammatory activity when compared to the standard drug indomethacin.[35]





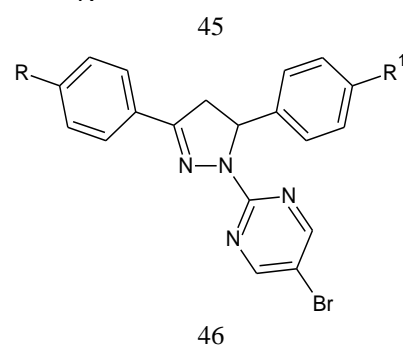
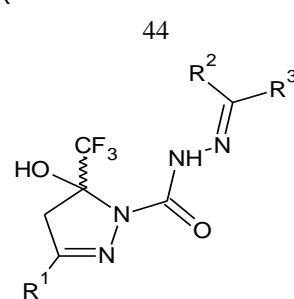
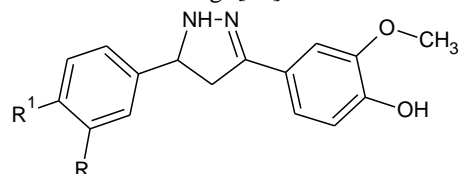
Antimalarial activity

A series of 1,3,5-trisubstituted pyrazolines 43 were synthesized and evaluated for in vitro antimalarial efficacy against chloroquine sensitive (MRC-02) as well as chloroquine resistant (RKL9) strains of Plasmodium falciparum by Badri Narayan Acharya et al. β -hematin formation inhibition activity (BHIA50) of the pyrazolines were determined and correlated with antimalarial activity. A reasonably good correlation ($r^{1/4}$ 0.62) was observed between antimalarial activity (IC_{50}) and BHIA50. Some of the compounds were showing better antimalarial activity than

chloroquine against resistant strain of *P. falciparum* and were also found active in the in vivo experiment.[36]

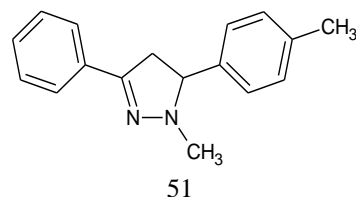
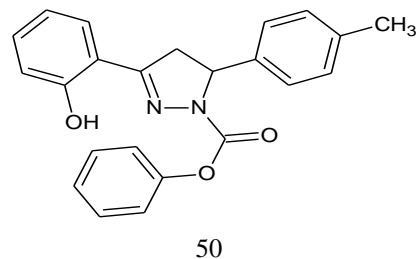
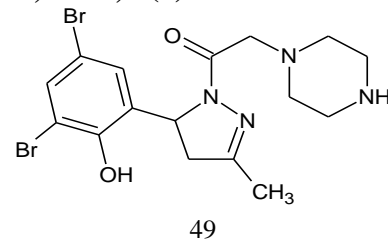
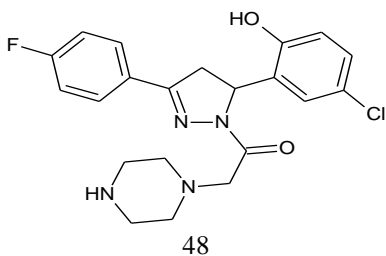
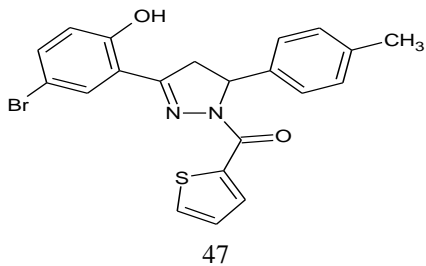
Antioxidation property

Akshay Kumar et al synthesized 2-pyrazolines 44 by the condensation of various substituted chalcones and hydrazine hydrate in the presence of ethanol and screened for antioxidant activity using DPPH radical scavenging method, NO scavenging assay, superoxide radical scavenging assay and hydrogen peroxide radical scavenging assay. All the compounds showed good free radical scavenging activity which is comparable to that of the standard ascorbic acid, out of which ATP-1, ATP-2 and ATP-3 come out to be the best molecules with an IC_{50} less than 40 mcg/ml.[37] A new series of twenty-one trifluoromethyl-containing (E)-N'-arylidene-1H-pyrazole-1-carbohydrazides 45 was synthesized by Helio G. Bonacorso et al and screened for their antioxidant and evaluated by DPPH methods. All compounds showed ability to capture DPPH free radical for IC_{50} from 47.57 to 487 mg/mL.[38] Adithya Adhikari et al prepared a series of 5-bromo-2-(3,5-diaryl-4,5-dihydro-1H-pyrazol-1-yl)pyrimidine 46 under conventional heating as well as microwave reaction condition. These new compounds were screened for their antioxidant, anti-inflammatory and analgesic activities. Some of these compounds exhibited potent biological activities compared to the standard drug. [39]



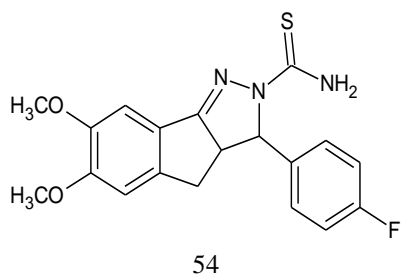
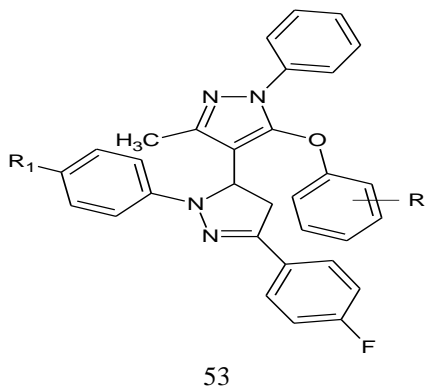
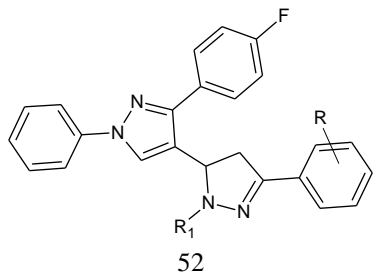
MAO Inhibitors

Begum Evranos-Aksoz et al synthesized a novel series of 2-pyrazoline and investigated for their human monoamine oxidase (hMAO) inhibitory activity. All compounds inhibited the hMAO-A isoform competitively and reversibly. According to the experimental K_i values, compound 47, which carries a bromine atom at R^4 of the A ring of the pyrazoline, appeared to be the most selective MAO-A inhibitor.[40] Xu Tong et al designed and synthesized thirty seven novel 2-pyrazoline-1-ethanone derivatives and evaluated as selective hMAO inhibitors. Among them, compounds 48 ($IC_{50} = 2.40 \mu M$) and 49 ($IC_{50} = 2.00 \mu M$) exhibited best inhibitory activity and selectivity against hMAO-A, surpassing that of the positive control Clorgyline ($IC_{50} = 2.76 \mu M$). Based on selective activity of hMAO-A, SAR analysis showed that the order of N_1 substituent contribution was bromo > piperidinyl > morpholinyl > imidazolyl, and compounds with electron-withdrawing substituents (-F, -Cl) at C3 or C5 phenyl ring of 2-pyrazoline nucleus dedicated stronger MAO-A inhibitory activity.[41] Ethyl and phenyl carbamate derivatives of pyrazoline were synthesized by B. Vishnu Nayak et al and tested for their MAO inhibitory activity. All the compounds were found to be selective towards MAO-A. Phenyl carbamates were better than ethyl carbamates and displayed the best selectivity index. Compound 50 (K_{iMAO-A} : 4.96 ± 0.21 nM) was found to be equally potent as that of standard drug, Moclobemide (K_{iMAO-A} : 5.01 ± 0.13 nM) but with best selectivity index (8.86×10^5).[42] Rossella Fioravanti et al designed and synthesized a series of 1-methyl-3,5-diphenyl-4,5-dihydro-1H-pyrazoles, and evaluated for their inhibitory efficacy towards the two hMAO isoforms. Most of the derivatives were found to be potent and selective hMAO-B inhibitors. In particular, derivative 51 showed greater hMAO-B affinity than selective inhibitor selegiline coupled with high selectivity index ($SI = 145$). [43]



Antitubercular activity

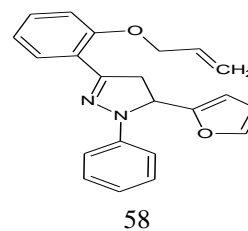
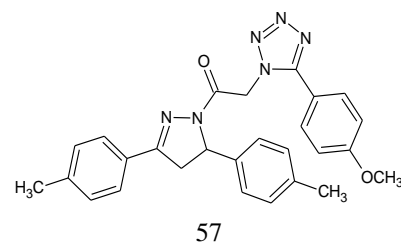
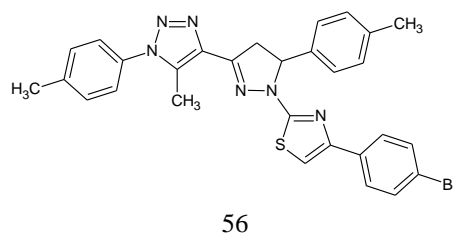
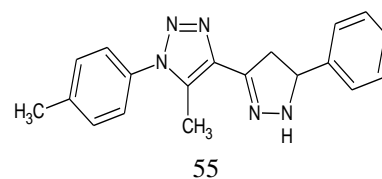
R.C. Khunt et al synthesized a series of N-phenyl-3-(4-fluorophenyl)-4-substituted pyrazoles 52 and tested for antimycobacterial activity in vitro against Mycobacterium tuberculosis H37Rv strain using the BACTEC 460 radiometric system. [44] Sharad C. Karad et al synthesized a novel series of fluoro substituted pyrazolylpyrazolines 53 was in good to excellent yield from pyrazole chalcones and substituted phenyl hydrazine hydrochlorides under microwave irradiation. The newly synthesized compounds were screened for their preliminary in vitro antibacterial activity against a panel of pathogenic strains of bacteria and fungi, antituberculosis activity against Mycobacterium tuberculosis H37Rv. Some of the compounds showed good antitubercular activity.[45] Mohamed Jawed Ahsan et al reported a series of 4-dihydro-3H-indeno[1,2-c]pyrazole-2-carboxamide/carbothioamide analogues and evaluated for antitubercular activity by two fold serial dilution technique. All the newly synthesized compounds showed low to high inhibitory activities against Mycobacterium tuberculosis H37Rv and INH resistant M. tuberculosis. The compound 3-(4-fluorophenyl)-6,7-dimethoxy-3a,4-dihydro-3H-indeno[1,2-c]pyrazole-2-carbothioamide 54 was found to be the most promising compound active against M. tuberculosis H37Rv and isoniazid resistant M. tuberculosis with minimum inhibitory concentration $3.12 \mu M$ and $6.25 \mu M$, respectively.[46]

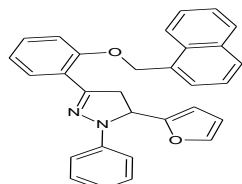


Antimicrobial activity

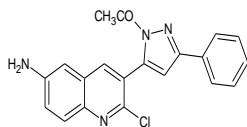
Bakr F. Abdel-Wahab et al synthesized New pyrazolyl-1,2,3-triazoles and 1,2,3-triazol-4-yl-pyrazolylthiazoles through multistep reactions using 1-tolyl-4-acetyl-5-methyl-1,2,3-triazole as a precursor. The newly synthesized compounds were evaluated for their antimicrobial activities and also their minimum inhibitory concentration (MIC) against most of test organisms was performed. Amongst the tested compounds 55 and 56 displayed excellent antimicrobial activity. [47] Mohammad Younus Wani et al reported a series of pyrazoline derivatives by cyclization of chalcones with 2-[5-(4-methoxyphenyl)-1H-tetrazol-1-yl]acetohydrazide under basic conditions and were screened in vitro, to find out effect on the growth of HM1: IMSS strain of *Entamoeba histolytica*. However compound 57 showed most promising results with IC_{50} - 0.86 mM which is half of the metronidazole, the standard drug used for protozoal infection. Cell viability test in human hepatocellular carcinoma cell line (HepG2) revealed non-toxic nature of new synthesized compounds. Safety index calculations prevailed compound 57 as highly antiamebic and least cytotoxic (S.I. >116.28), almost twice than metronidazole. [48]

Novel compounds with antibacterial properties, pyrazoline derivatives were synthesized by Mamta Rani et al and was evaluated against two Gram-positive and two Gram-negative bacteria *Aeromonas hydrophila*, *Yersinia enterocolitica*, *Listeria monocytogenes*, and *Staphylococcus aureus* by microdilution method and then the minimum inhibitory concentration (MIC) of compounds were determined. The results Revealed that compounds (5R)-5-(furan-2-yl)-1-phenyl-3-[2-(benzyloxy)phenyl]-4, 5-dihydro-1Hpyrazole, 58 and (5R)-5-(furan-2-yl)-1-phenyl-3-[2-(naphthalen-2-ylmethoxy prop-2-en-1-yloxy) phenyl]-4,5-dihydro-1H-pyrazole 59 showed most promising antibacterial activities as compared to Gentamicin and Tetracycline. [49] Pankaj B. Miniyar et al synthesized a novel series of 2-Chloroquinoline nucleus clubbed with the pyrazole ring and screened for antibacterial and antifungal activity. The results obtained were promising against both bacterial and fungal strains. Among the series, compound 60 was found moderately active against *Aspergillus fumigatus*, *Penicillium notatum* and *Bacillus subtilis* having MIC 48, 46 and 44 $\mu\text{g/ml}$, respectively whereas compound 61 was found active against *P. notatum*, *B. subtilis* and *Escherichia coli* having MIC 57, 54 and 43 $\mu\text{g/ml}$, respectively as compared to standard.

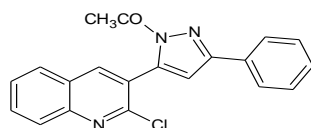




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