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Review

Some synthesized products as alternative drugs to overcome microbial resistance: an updated review

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Abstract

Significant effort has gone into the development of synthetic antibiotics since it is necessary to take into account the structural derivatization of natural molecules and the synthesis of compounds that are comparable to natural products utilizing well-known natural product scaffolds. Furthermore, most of these drugs are derived from bioactive substances that have been employed in the past and are highly susceptible to mechanisms of bacterial resistance. Finding novel therapeutic agents with a variety of modes of action is crucial in light of the growing prevalence of antibiotic resistance.

The three structurally and pharmacologically diverse families of alkaloids, azoles, and coumarins, each with a distinct bioactive potential, are the subject of this work. Coumarins are prized for their diverse biological activity, especially their capacity to disrupt oxidative pathways and microbial enzymatic systems. Azoles are a key component of antifungal treatment because they suppress the formation of ergosterol and exhibit both efficacy and target specificity. They are distinguished by their nitrogen-containing heterocyclic rings.

Through a variety of methods, including DNA intercalation, membrane disruption, and enzyme inhibition, alkaloids, a varied class of naturally occurring nitrogen-containing compounds, display broad-spectrum antimicrobial activities. This study highlights the qualities of each family's representative compounds as viable leads or adjuncts in the development of new antimicrobial drugs by analyzing their structure-activity correlations (SAR), selectivity profiles, and resistance potential.

Keywords:

Synthetic antibiotics, bacterial resistance, azoles, coumarins, alkaloids, antimicrobial drugs.

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1. Introduction

Humans have learned to empirically apply crude formulations for topical treatment of diseases for centuries, and we now believe that these preparations are effective because they contain antibiotics. In addition to their biological immunizing effect, antimicrobials have completely changed the method of treating infectious diseases. They are real therapeutic feats. But in the 21st century, antibiotic resistance has become a major problem due to the abuse of these drugs and the chemically random nature of many bacteria. There are currently microbes that none of the usual antibiotics can kill or stop, so new methods are needed.

Perkin's discovery of mauveine (aniline purple), the first synthetic dye, in 1856, is widely considered the first industrial organic synthesis and a turning point in the history of organic synthesis. Moreover, it is a striking illustration of serendipity. Perkin was attempting to use potassium dichromate to oxidize *N*-allyl toluidine to create quinine, an antimalarial drug [1]. Vuillemin defined antibiosis (literally, "against life") as the biological concept of survival of the fittest, in which one organism destroys another to preserve itself, after Pasteur and Joubert picked up in 1877 that anthrax bacilli were killed when grown in culture in the presence of certain bacteria. Other microbiologists also made similar observations [2].

The corresponding root is the source of the word antibiotic. The phrase has become so widely used by the scientific and medical professions as well as the general public that its original meaning has been lost. The creation of the penicillin antibiotics came after the release of the sulfa medications. Fleming's accidental discovery of the antibacterial properties of the penicillin mold in 1928, followed by Florey and Chain's isolation and identification of its active ingredient in 1940, signaled the start of the antibiotic era, which is still going strong today, as the number of antibiotics added to our therapeutic arsenal has increased significantly [3].

Pasteur and Koch had developed the germ theory of disease by the turn of the 20th century, and the growing pharmaceutical industry was a clear target for chemists looking for new applications for coal tar derivatives that weren't suited as colors. Paul Ehrlich, who first used the phrase "chemotherapy," was a pioneer in this subject. He believed that some substances might serve as "magic bullets" since they are exceedingly harmful to an infecting microorganism but not harmful to the host. As a result, he tested dyes as chemotherapeutic agents and found a successful syphilis therapy. It became common practice to examine all dyes as chemotherapeutic agents because Ehrlich had researched dye molecules as "magic bullets." This method resulted in the above-mentioned discovery of prontosil as an antibacterial agent. As a result, the production of synthetic dyestuffs from coal tar gave rise to the contemporary pharmaceutical industry. These scientific advances, which have highlighted the antimicrobial properties and modes of action of these molecules – which significantly damage the microbial membrane and the cell wall, are largely responsible for the entry into the contemporary era of antibiotics [3]. An antibiotic is defined by Waksman in 1942 as "a substance produced by microorganisms, which has the capacity to inhibit the growth and even of destroying other microorganisms." This description is frequently quoted [4]. Subsequent fundamental proposals have attempted to both expand and constrain the definition to encompass any material generated by a living organism that can, in low concentrations, prevent the growth or survival of one or more microbe species. The addition of semisynthetic and synthetic derivatives in the definition was required due to the progress achieved by medicinal chemists in modifying naturally existing antibiotics and creating synthetic analogs [4]. In general, a synthetic molecule that is made as a structural analog of a naturally occurring antibiotic and then metabolized can be classified as an antibiotic (though it may be replicated or even have been anticipated by chemical synthesis). It can inhibit one or more microorganism species' ability to grow or survive at low concentrations. In addition to standard antibiotics, this review provides a comprehensive list of antimicrobial compounds selected from total synthesis methods, emphasizing their molecular interactions and mechanistic insights in reducing the lethal effects of multidrug-resistant microbes.

The objective of this review is to combine data from the extensive and often scattered literature on antibacterial compounds, as many synthesized compounds serve as scaffold substructures in different drugs. In order to promote the development of various antibacterial drugs using innovative synthetic products, synthetic and semi-synthetic products are included, provided that they have a novel structure and chemotherapeutic or chemoprophylactic potential. In addition, these synthetic substances are still the subject of a great deal of research, with industry, universities, and joint ventures pursuing their development as antibacterial agents. In our work, we reported a whole range of chemical structures of some synthetic products belonging to a very interesting organic family to explore the antimicrobial potential. For this reason, we conducted a structure-

activity relationship (SAR) investigation of a collection of coumarin and alkaloid derivatives that were systematically altered at some structural motifs. These compounds were evaluated with respect to antimicrobial activity, mode of action, target selectivity and their minimum inhibitory concentrations.

2. Main subclasses of synthesized antimicrobials

2.1. Synthesized azoles

Many synthetic and semi-synthetic derivatives of known antibiotics have been added, and very few of the first-generation azole drugs, like ketoconazole, miconazole, and clotrimazole, are used in conventional medical practice despite their potential to both treat and prevent the spread of infections and cancer. It is important to note that these drugs can cause hepatotoxic effects, impairment of gastrointestinal and endocrine functions, and skin irritation. Oral bioavailability and safety characteristics are significantly enhanced by third-generation medications (such as voriconazole and posaconazole) and second-generation azoles (such as fluconazole and itraconazole) [5]. Nevertheless, all three generations of azole antifungals inhibit mammalian cytochrome P450s [6]. The investigation for novel antifungal azole types has been motivated in recent years by the development of antifungal azole resistance cases worldwide and the adverse consequences associated with systemic application of azole antifungals.

The researchers recently reported that some azole antifungals localize basically to the mitochondria, depending on their specific structure, via the construction of intrinsically new antifungal azole derivatives [7]. As a result, they concluded that these antifungal azoles do not reach their target at the optimal concentration in the endoplasmic reticulum. In light of this concept, the antifungal azole: 7-(Diethylamino)-*N*-(2-(2,4-difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2- oxo-2*H*-chromene-3-carboxamide was synthesized by affixing a 7-(diethyl)-aminocoumarin segment to the antifungal azole fluconazole pharmacophore (**Fig. 1**) [8]. The antifungal activity of this azole, which mostly localizes to the endoplasmic reticulum in *Candida* cells, was 4-64 times stronger than fluconazole against a panel of *Candida* strains.

The search for efficient antibiotics was prompted by Dubois's identification of the antibacterial tyrocidine from the soil bacterium *Bacillus brevis*, which implied that many antibiotic compounds were likely present in nature. Waksman and colleagues isolated streptomycin from Streptomyces griseus after conducting a systematic search of the order actinomycetales. It was thrilling to learn that this antibiotic has *in vivo* activity against different species of Gram-negative bacilli, including *Mycobacterium tuberculosis*. Antibiotics will be abundant from soil microorganisms; it is now clear. In order to uncover antibiotics that could be used to treat illnesses that were previously resistant to current chemotherapeutic agents and to provide safer and more effective chemotherapy, extensive screening procedures were established.

The remarkable success of this approach as it has been used in research programs around the world is attested to by the discovery of broad-spectrum antibacterial antibiotics like chloramphenicol and the tetracyclines, antifungal antibiotics like nystatin and griseofulvin, and the constantly growing number of antibiotics that may be used to treat infectious agents that have developed resistance to some of the older antibiotics. The chemistry of antibiotics is so diverse that a chemical classification isn't beneficial. However, certain similarities can be observed, suggesting that some antibiotics might be the result of comparable processes in many organisms and that these structurally related compounds might operate similarly. Several important antibiotics, for instance, include a macrolide structure, which is a big lactone ring. Erythromycin and oleandomycin belong to this category. A set of chemically closely related chemicals makes up the tetracycline family. Closely similar amino sugar moieties are present in a number of drugs, including gentamicin, streptomycin, kanamycin, neomycin, and paromomycin. For instance, the conjugated polyene chemicals amphotericin and nystatin are antifungal antibiotics. Many different polypeptides have antibiotic properties, including bacitracin, tyrothricin, and polymyxin. The antibiotics known as cephalosporin and penicillin are made from amino acids and contain *β*-lactam rings.

The incidence of severe fungal infections has risen considerably in recent decades, largely due to a notable rise in the number of patients who are immunosuppressed and/or immunocompromised [17]. Furthermore, drug-resistant forms of the most common fungal pathogens, particularly Candida albicans and Candida glabrata, are increasingly responsible for fungal infections [18]. Development of antifungal drugs is therefore a top goal. The use of a very small number of drugs from three primary classes: azoles, polyenes, and echinocandins, for the

prevention and treatment of fungal infections is significant [19]. Around the world, azole antifungals are frequently used as the first line of treatment for invasive and topical fungal infections [20]. The cytochrome P450 lanosterol 14-demethylase (CYP51), which catalyzes a demethylation step in the synthesis of the fungal plasma-membrane sterol ergosterol, is inhibited by members of the azole class [21]. Particularly, humans express a large number of cytochrome P450 enzymes, and mammals have an orthologue of the fungus CYP51 [22]. Hepatotoxic effects, gastrointestinal and endocrine function impairment, and skin irritation are all possible side effects of first-generation azole drugs such as miconazole, clotrimazole, and ketoconazole. Itraconazole and fluconazole, which are second-generation azoles, and voriconazole and posaconazole, which are third-generation medications, exhibit significantly superior oral bioavailability and safety profiles [23]. Unfortunately, mammalian cytochrome P450s are inhibited by all three generations of azole antifungals [24]. The examination for novel antifungal azole types has been stimulated in recent years by the subsequent expansion of antifungal azole resistance cases worldwide and adverse effects linked to systemic usage of azole antifungals [25].

The disruptions in the functions of heme proteins, particularly P450 isoforms found in human cells, must be minimized or, preferably, prevented while creating new antifungal azoles. The majority of the CYP content in the liver and intestines of humans is made up of the enzyme CYP3A4, which is in charge of the metabolism of several small compounds. CYP3A4's unusually flexible substrate selectivity makes it apart from other main CYPs. This enzyme is thought to be in charge of breaking down more than half of the drugs that are prescribed. Therefore, one of the primary reasons for unfavorable drug-drug and drug-food interactions is CYP3A4 suppression. Regretfully, CYP3A4 is inhibited by all antifungal azoles used in hospitals. The CYP3A4 inhibitory strength of second- and third-generation azole antifungals varies; CYP3A4 is more strongly inhibited by itraconazole and posaconazole than by fluconazole and voriconazole (**Fig. 1**) [26]. The endoplasmic reticulum is where CYP51 and several other enzymes involved in ergosterol production are mainly found [27]. Very recently, some azole antifungals bind predominantly to the mitochondria, depending on their particular structure, by producing azole derivatives that are naturally fluorescent [28]. Many new antifungal azoles were developed by adding a 7-(diethyl)-aminocoumarin fluorescence segment to the antifungal azole fluconazole pharmacophore, since these antifungal azoles in the endoplasmic reticulum do not reach their target at their optimal concentration [29].

The structure activity relationship (SAR) analysis of a group of compound-based azoles, including coumarin-based and 2-quinolone-based azoles that were systematically modified at four structural motifs, was carried out by certain researchers in order to investigate the potential of azole antifungals [30]. The antifungal efficacy, mode of action, subcellular localization, target selectivity, and toxicity to mammalian cells of these drugs were assessed.

By altering one or more of the four distinct chemical functionalities of this azole scaffold, the heteroatom (an NH in the 2-quinolone scaffold or oxygen in the coumarin scaffold), the two halogen atom substituents on the phenyl ring, the azole ring, and the substituent at the C7 position of the coumarin or 2-quinolone, Elieas et *al*. synthesized azole derivatives 2-14 in order to investigate the SAR of endoplasmic reticulum-localizing antifungal azole [31].

Several of the marketed azole antifungals, including ketoconazole, miconazole, and itraconazole (**Table 1**), are racemic mixtures. Computer-simulated docking of the *R* and *S* enantiomers of aminocoumarin-based azole 1 revealed that the interactions with the target CYP51 take place through a similar binding mode [32]; therefore, the azole antifungals in this study were synthesized and evaluated as racemic mixtures.

Table 1. Minimum inhibitory concentrations of clinically used antifungal azoles.

Compound	Fungal strain	MIC (µg/mL)
Ketoconazole [33]	*Candida albicans* 90028,	0.007
	C. albicans P-87,	0.007
	C. albicans SN152,	0.007
	C. glabrata 66032,	1
	C. glabrata 2001,	1
	C. glabrata 192,	0.06
	C. parapsilosis 90018,	0.007
	C. parapsilosis 22019,	0.007
	C. guilliermondii T-47,	0.007
	C. dubliniensis T-99.	
Miconazole [33]	*Candida albicans* 90028,	0.007
	C. albicans P-87,	0.007
	C. albicans SN152,	0.007
	C. glabrata 66032,	2
	C. glabrata 2001,	1
	C. glabrata 192,	0.06
	C. parapsilosis 90018,	0.06
	C. parapsilosis 22019,	0.003
	C. guilliermondii T-47,	0.06
	C. dubliniensis T-99.	0.06
Clotrimazole [33]	*Candida albicans* 90028,	0.007
	C. albicans P-87,	0.007
	C. albicans SN152,	0.007
	C. glabrata 66032,	4
	C. glabrata 2001,	0.5
	C. glabrata 192,	0.06
	C. parapsilosis 90018,	0.007
	C. parapsilosis 22019,	0.007
	C. guilliermondii T-47,	0.007
	C. dubliniensis T-99.	0.007
Itraconazole [33]	*Candida albicans* 90028,	0.007
	C. albicans P-87,	0.007
	C. albicans SN152,	0.007
	C. glabrata 66032,	1
	C. glabrata 2001,	1
	C. glabrata 192,	0.125
	C. parapsilosis 90018,	0.007
	C. parapsilosis 22019,	0.03
	C. guilliermondii T-47,	0.03
	C. dubliniensis T-99.	0.06
Fluconazole [33]	*Candida albicans* 90028,	0.5
	C. albicans P-87,	0.25
	C. albicans SN152,	0.25
	C. glabrata 66032,	64
	C. glabrata 2001,	64
	C. glabrata 192,	8
	C. parapsilosis 90018,	1
	C. parapsilosis 22019,	2
	C. guilliermondii T-47,	4
	C. dubliniensis T-99.	4

Continued

Voriconazole [33]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.007 0.007 0.007 0.5 2 0.125 0.015 0.03 0.06 0.06
Posaconazole [33]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.007 0.007 0.007 1 1 0.125 0.015 0.03 0.03 0.03

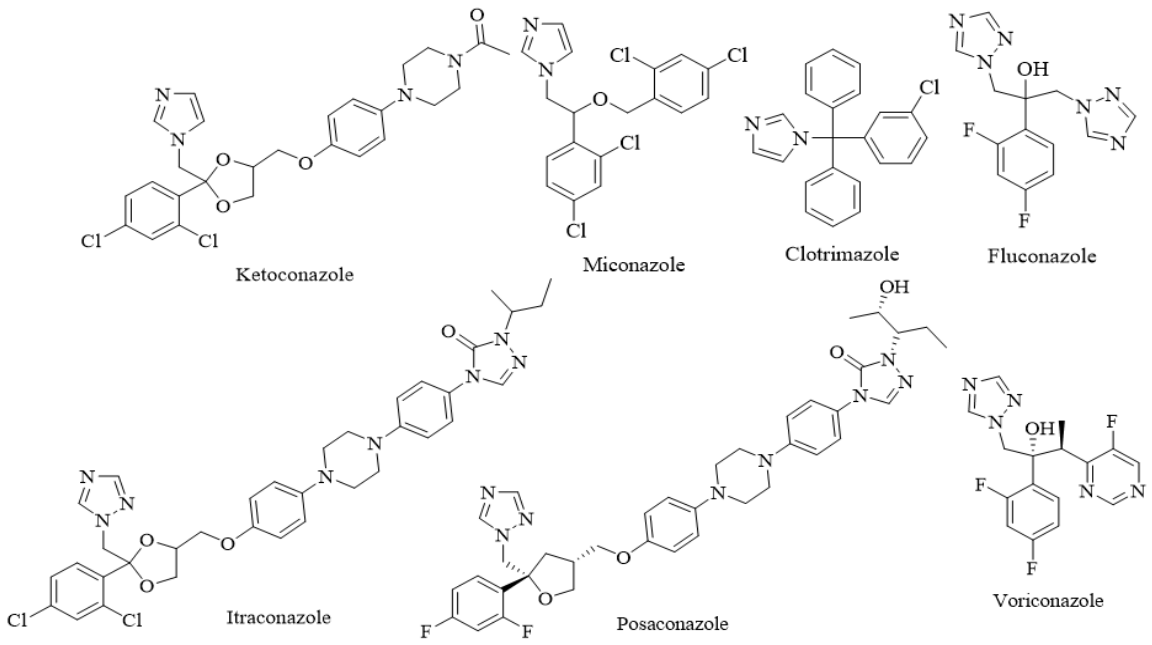

Figure 1. Structures of clinically used antifungal azoles.

2.2. Synthesized coumarin derivatives

Using a synthetic coumarin called 3-acetyl-4-hydroxycoumarin, Ukita and colleagues [34] established significant antibacterial action against *Staphylococcus aureus* and *Mycobacterium tuberculosis* (avian type). They reported that the action of this coumarin is related to other potent antibacterial coumarins containing a tricarbonyl-methane unit, [CH(-C=O)$_3$], as a common effective structure. Among the interesting non-coumarinic natural compounds containing this structural property is the antibacterial lichen pigment, usnic acid. These researchers found that 3-n-decanoyl-4-hydroxymumarin is more active when they examined the effect of

increasing the chain length of the 3-acyl group. The same findings were reported by Toda et *al* [35]. Other studies have focused on the use of metal-coumarin complexes as constituents of sol-gel coatings, as sol-gel layers have recently been the subject of increased interest due to their technical applicability, homogeneity, and chemical stability (e.g., storage systems for sustained release of antimicrobial compounds). The synthesis of silver-coumarin complexes that could be used as antibacterial agents in sol-gel coatings was proposed in 2013 by Jaiswal and colleagues [36]. These complexes were based on coumarin-3-carboxylatosilver and its hydroxylated derivatives in 3-hydroxy-6*H*,7*H*-chromeno [3,4-*c*] chromene-6,7-dione; 1,3-dihydroxy-6*H*,7*H*-chromeno [3,4-*c*] chromene-6,7-dione and 2,4-dihydroxy-6*H*,7*H*-chromeno [3,4-*c*] chromene-6,7-dione. Antimicrobial activity has been detected at concentrations less than 0.3% (w/w). These results are encouraging from the perspective of applying Ag-coumarin complexes as biomedical coatings because the most active molecule demonstrated excellent antibiofilm activity at 0.5% and 0.7% (w/w).

Generally, homologous products in which simple long-chain hydrocarbons are connected to the furanocoumarin skeleton of angelicin were found to be more active than other furanocoumarins. The long chain alkylamines 8-(decylamino)-2*H*-furo [2,3-*h*] chromen-2-one and 8-(hexadecylamino)-2*H*-furo [2,3-*h*] chromen-2-one themselves are found to be potent inhibitors. Another study by Nagamallu et al., focusing on the synthesis of a new series of pyrazole-containing coumarins and subsequent evaluation of their antibacterial activities [37], showed that two compounds, 3,3'-(7-hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(4-formyl-1*H*-pyrazole-1-carboxamide) and 3,3'-(7-hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(4-formyl-1H-pyrazole-1-carbothioamide) have good antibacterial and antifungal activities, with MIC values comparable to those of ciprofloxacin (positive control against bacterial species) and fluconazole (positive control against fungal strains).

A list of some synthesized coumarin compounds with antibacterial properties is reported in **Table 2**, while their inhibitory parameters concentrations are summarized in **Table 3**.

Table 2. List of some synthesized coumarin derivatives used as antimicrobial agents.

Compound	Bioactivity	Bacterial strain	Ref
(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(ethan-1-yl-1- ylidene)) bis (hydrazine-1-carboxamide)	Antibacterial	*S.aureus*, *E.coli*, *P.aeruginosa*,	[37]
	Antifungal	*A.niger*, *A.flavus*, *C.albicans*,	[37]
(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis (ethan-1-yl-1-ylidene)) bis(hydrazine-1-carbothioamide)	Antibacterial	*S.aureus*, *E.coli*, *P.aeruginosa*,	[37]
	Antifungal	*A.niger*, *A.flavus*, *C.albicans*,	[37]
2-Amino-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-5-oxo-4*a*,10*b*-dihydro-4*H*,5*H*-pyrano [3,2-*c*] chromene-3-carbonitrile	Antibacterial	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	[38]

Continued

Ethyl-6-methyl-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate	Antibacterial	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	[39]
(*E*)-4-(((2-((6-Chloro-2-oxo-2*H*-chromen-4-yl) methoxy) naphthalen-1-yl) methylene) amino)-1,5-dimethyl-2-phenyl-1,2-dihydro-3*H*-pyrazol-3-one	Antibacterial	*S. aureus*	[40]
Ethyl-5-(2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate	Antibacterial	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	[40]
7,7'-((1,4-Phenylene-bis-(methylene))bis(oxy))bis(4-methyl-2*H*-chromen-2-one)	Antibacterial	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484) , *S. dysenteriae* (ATCC 49550),	[41]
	Antifungal	*C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763) , *A. fumigatus* (ATCC 96918)	
Ethyl-7-((1-(4-aminobenzyl)-1*H*-1,2,3-triazol-4-yl)-methoxy)-2-oxo-2*H*-chromene-3-carboxylate	Antifungal	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*,	[42]
3-((Dicyclohexylamino)-(2,4-difluorophenyl)methyl)-4-hydroxy-2*H*-chromen-2-one	Antibacterial	*E.coli*, *B.subtilis*, *S.aureus*,	[43]
	Antifungal	*C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *C. neoformans*	

Continued

3-((Dicyclohexylamino)-(4-hydroxy-3-methoxyphenyl) methyl)-4-hydroxy-2*H*-chromen-2-one	Antibacterial	*E.coli*, *B.subtilis*, *S.aureus*,	[43]
	Antifungal	*C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	
7-(Diethylamino)-*N*-(2-(2,4-difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-2*H*-chromene-3-carboxamide	Antifungal	*Candida albicans 90028*, *C. albicans P-87*, *C. albicans SN152*, *C. glabrata 66032*, *C. glabrata 2001*, *C. glabrata 192*, *C. parapsilosis 90018*, *C. parapsilosis 22019*, *C. guilliermondii T-47*, *C. dubliniensis T-99*.	[44]
3-(4-Fluorophenyl)-4-methyl-7-(prop-2-yn-1-yloxy)-2*H*-chromen-2-one	Antibacterial	*S. aureus*, *B.subtilis*, *E.coli*, *K.pneumoniae*	[45]
3-(4-Fluorophenyl)-7-((1-(4-methoxyphenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-4-methyl-2*H*-chromen-2-one	Antibacterial	*S. aureus*, *B.subtilis*, *E.coli*, *K.pneumoniae*	[45]

Table 3. Inhibitory parameters concentrations of bioactive coumarin derivatives.

Compound	Bacterial strain	MIC (µg/mL) /ZI (mm)/IC_{50}
Allopsoralen [46]	*Candida albicans* (ATCC 14053), *Aspergillus niger* PLM 1140, *Cryptococcus neoformans* KF-33, *Saccharomyces cerevisiae* PLM 454,	>250 62.5 >250 125
Pseudoisopsoralen [46]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	250 62.5 62.5 62.5
Isopseudopsoralen [46]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	250 62.5 >250 62.5

Continued

8-(Propylamino)-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	125 >500 62.5 250
8-(Decylamino)-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	<7.8 15.6 <7.8 <7.8
8-(Hexadecylamino)-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	15.6 7.8 <1.9 <1.9
7-Hydroxy-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33),	1000 500 500
2-Oxo-2*H*-furo [2,3-*h*] chromene-8-carboxylic acid [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33),	>2000 2000 2000
Ethyl-2-oxo-2*H*-furo [2,3-*h*] chromene-8-carboxylate [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33),	1000 1000 250
2-Oxo-*N*-propyl-2*H*-furo [2,3-*h*] chromene-8-carboxamide [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	250 >250 125 62.5
N-Decyl-2-oxo-2*H*-furo [2,3-*h*] chromene-8-carboxamide [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	250 125 31.3 62.5
N-Hexadecyl-2-oxo-2*H*-furo [2,3-*h*] chromene-8-carboxamide [47]	*Candida albicans* (ATCC 14053), *Aspergillus niger* (PLM 1140), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>250 250 31.3 125
7-Hydroxy-6-[1-(*B*-*D*-(glucopyranosyloxy))]-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>1000 >1000 >1000
6-[1-(*B*-*D*- (glucopyranosyloxy))]-7- (3-allyloxy)-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>1000 >1000 >1000
6-[1-(*B*-*D*-(2',3',4',6'-Tetra-*O*-acetylglucopyranosyloxy))]-7-(3-allyloxy)-2*H*-1-benzopyran-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>1000 >1000 >1000
7-(Allyloxy)-6-hydroxy-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>1000 250 250

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7-(Allyloxy)-6-(benzyloxy)-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>1000 >1000 >1000
6-Benzyloxy-7-[2-(oxo)ethoxy]-2*H*-1-benzopyran-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33),	1000 500
6-Benzyloxy-7-[2,3-(dihydroxy)propoxy]-2*H*-1-benzopyran-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>500 250 250
8-Allyl-6-(benzyloxy)-7-hydroxy-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>1000 500 1000
6,7-Dihydroxy-8-propyl-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	250 125 62.5
8-(2,3-Dihydroxypropyl)-6,7-dihydroxy-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>1000 1000 1000
6-(Benzyloxy)-8-(2,2-dimethoxyethyl)-7-hydroxy-2*H*-chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	1000 125 250
6-Hydroxy-2*H*-furo[2,3-*h*]chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	250 125 250
6-(Benzyloxy)-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	500 250 500
5-Benzyl-6-hydroxy-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	500 125 500
6-Methoxy-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33),	500 250
5,6-Dimethoxy-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>500 500 500
2-Oxo-2*H*-furo [2,3-*h*]chromen-6-yl- acetate [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	250 62.5 250
6-Allyl-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	500 500 250
6-Propoxy-2*H*-furo [2,3-*h*] chromen-2-one [47]	*Candida albicans* (ATCC 14053), *Cryptococcus neoformans* (KF-33), *Saccharomyces cerevisiae* (PLM 454),	>500 250 250
(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis(ethan-1-yl-1-ylidene))bis(hydrazine-1-carboxamide) [48]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	25 ± 0.2 12.5 ± 0.45 12.5 ± 0.3 12.5 ± 0.46 25 ± 0.6 25 ± 0.97

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(2*Z*,2*'E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis(ethan-1-yl-1-ylidene)) bis(hydrazine-1-carbothioamide) [48]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	25 ± 0.25 12.5 ± 0.5 6.25 ± 0.76 12.5 ± 0.3 12.5 ± 0.45 25 ± 0.85
7-Hydroxy-4-methyl-8-((*E*)-1-(2-phenylhydrazineylidene) ethyl)-6-((*Z*)-1-(2-phenylhydrazineylidene) ethyl)-2*H*-chromen-2-one [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	50 ± 0.11 25 ± 0.40 25 ± 0.45 50 ± 0.50 50 ± 0.4 50 ± 0.56
7-Hydroxy-4-methyl-8-((*E*)-1-(2-(*p*-tolyl) hydrazineylidene) ethyl)-6-((*Z*)-1-(2-(*p*-tolyl) hydrazineylidene) ethyl)-2*H*-chromen-2-one [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	25 ± 0.17 25 ± 0.3 25 ± 0.15 50 ± 0.66 25 ± 0.70 50 ± 0.70
7-Hydroxy-4-methyl-8-((*E*)-1-(2-(*m*- tolyl)hydrazineylidene)ethyl)-6-((*Z*)-1-(2-(*m*-tolyl)hydrazineylidene) ethyl)-2*H*-chromen-2-one [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	50 ± 0.35 50 ± 0.28 25 ± 0.25 75 ± 0.61 50 ± 0.75 50 ± 0.66
7-Hydroxy-8-((*E*)-1-(2-(4-methoxyphenyl)hydrazineylidene)ethyl)-6-((*Z*)-1-(2-(4-methoxyphenyl)hydrazineylidene)ethyl)-4-methyl-2*H*- chromen-2-one [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	25 ± 0.45 12.5 ± 0.25 12.5 ± 0.56 12.5 ± 0.62 25 ± 0.94 50 ± 0.61
8-((*E*)-1-(2-(4-Fluorophenyl) hydrazineylidene)ethyl)-6-((*Z*)-1-(2-(4-fluorophenyl)hydrazineylidene)ethyl)-7-hydroxy-4-methyl-2*H*-chromen-2-one [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	75 ± 0.65 50 ± 0.45 50 ± 0.40 50 ± 0.51 75 ± 0.25 75 ± 0.23
8-((*E*)-1-(2-(4-Chlorophenyl) hydrazineylidene)ethyl)-6-((*Z*)-1-(2-(4-chlorophenyl)hydrazineylidene)ethyl)-7-hydroxy-4-methyl-2*H*-chromen-2- one [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	50 ± 0.40 50 ± 0.45 25 ± 0.35 25 ± 0.55 50 ± 0.40 50 ± 0.15

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(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(ethan-1-yl-1-ylidene))bis(hydrazine-1-carboxamide) [39]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	25 ± 0.51 12.5 ± 0.50 6.25 ± 0.76 12.5 ± 0.30 12.5 ± 0.45 25 ± 0.85
(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(ethan-1-yl-1-ylidene))bis(hydrazine-1-carbothioamide) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	25 ± 0.51 12.5 ± 0.50 6.25 ± 0.76 12.5 ± 0.30 12.5 ± 0.45 25 ± 0.85
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-phenyl-1*H*-pyrazole-4-carbaldehyde) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	50 ± 0.50 50 ± 0.52 50 ± 0.36 50 ± 0.36 75 ± 0.5 50 ± 0.42
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-(*p*-tolyl)-1*H*-pyrazole-4-carbaldehyde) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	75 ± 0.28 50 ± 0.70 25 ± 0.40 50 ± 0.36 75 ± 0.45 50 ± 0.79
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-(*m*-tolyl)-1*H*-pyrazole-4-carbaldehyde) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	75 ± 0.79 50 ± 0.41 25 ± 0.9 75 ± 0.55 75 ± 0.4 50 ± 0.60
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-(4-methoxyphenyl)-1*H*-pyrazole-4-carbaldehyde) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	50 ± 0.61 50 ± 0.55 12.5 ± 0.45 25 ± 0.56 50 ± 0.3 50 ± 0.17
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis 1-(4-fluorophenyl)-1*H*-pyrazole-4-carbaldehyde) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	75 ± 0.65 75 ± 0.28 50 ± 0.60 75 ± 0.25 75 ± 0.45 100 ± 0.36
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis(1-(4-chlorophenyl)-1*H*-pyrazole-4-carbaldehyde) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*	50 ± 0.50 25 ± 0.65 25 ± 0.15 50 ± 0.3 50 ± 0.61 100 ± 0.21

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3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis(4-formyl-1*H*-pyrazole-1-carboxamide) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*	50 ± 0.17 12.5 ± 0.81 25 ± 0.70 25 ± 0.41 25 ± 0.21 50 ± 0.46
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis(4-formyl-1*H*-pyrazole-1-carbothioamide) [49]	*S.aureus*, *E.coli*, *P.aeruginosa*, *A.niger*, *A.flavus*, *C.albicans*,	25 ± 0.41 25 ± 0.41 12.5 ± 0.37 12.5 ± 0.45 25 ± 0.3 50 ± 0.29
2-Amino-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-5-oxo-4a,10b-dihydro-4*H*,5*H*-pyrano [3,2-*c*] chromene-3-carbonitrile [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	6.25 1.56 6.25 6.25 25 6.25
2-Amino-4-(6-methoxy-2-oxo-2*H*-chromen-4-yl)-5-oxo-4*a*,10*b*-dihydro-4*H*,5*H*-pyrano[3,2-*c*]chromene-3-carbonitrile [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	12.5 3.25 6.25 1.56 1.56 6.25
2-Amino-4-(6-chloro-2-oxo-2*H*-chromen-4-yl)-5-oxo-4*a*,10*b*-dihydro-4*H*,5*H*-pyrano[3,2-*c*]chromene-3-carbonitrile [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	25 3.25 25 6.25 6.25 6.25
2-Amino-4-(7-methyl-2-oxo-2*H*-chromen-4-yl)-5-oxo-4*H*,5*H*-pyrano [3,2-*c*] chromene-3-carbonitrile [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	1.56 6.25 1.56 1.56 1.56 6.25
2-Amino-5-oxo-4-(2-oxo-2*H*-benzo[*h*]chromen-4-yl)-4*H*,5*H*-pyrano [3,2-*c*] chromene-3-carbonitrile [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	3.25 1.56 1.56 6.25 25 1.56
Ethyl-2-amino-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-5-oxo-4*a*,10*b*-dihydro-4*H*,5*H*-pyrano [3,2-*c*] chromene-3-carboxylate [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	3.25 6.25 6.25 1.56 6.25 6.25

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Ethyl-2-amino-4-(6-methoxy-2-oxo-2*H*-chromen-4-yl)-5-oxo-4*a*,10*b*-dihydro-4*H*,5*H*-pyrano[3,2-*c*] chromene-3-carboxylate [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	6.25 6.25 6.25 6.25 25 1.56
Ethyl-2-amino-4-(6-chloro-2-oxo-2*H*-chromen-4-yl)-5-oxo-4*a*,10*b*-dihydro-4*H*,5*H*-pyrano [3,2-*c*] chromene-3-carboxylate [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	12.5 1.56 25 6.25 1.56 1.56
Ethyl-2-amino-4-(7-methyl-2-oxo-2*H*-chromen-4-yl)-5-oxo-4*H*,5*H*-pyrano [3,2-*c*]chromene-3-carboxylate [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	12.5 6.25 25 6.25 6.25 6.25
Ethyl-2-amino-5-oxo-4-(2-oxo-2*H*-benzo [*h*]chromen-4-yl)-4*H*,5*H*-pyrano [3,2-*c*] chromene-3-carboxylate [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	6.25 6.25 6.25 1.56 1.56 6.25
3-(6-Chloro-2-oxo-2*H*-chromen-4-yl)-3-(4-hydroxy-2-oxo-2*H*-chromen-3-yl) propanoic acid [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	1.56 1.56 25 3.25 25 6.25
3-(4-Hydroxy-2-oxo-2*H*-chromen-3-yl)-3-(6-methoxy-2-oxo-2*H*-chromen-4-yl) propanoic acid [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	3.25 1.56 6.25 1.56 1.56 6.25
3-(6-Chloro-2-oxo-2*H*-chromen-4-yl)-3-(4-hydroxy-2-oxo-2*H*-chromen-3-yl) propanoic acid [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	3.25 1.56 25 1.56 25 3.25
3-(4-Hydroxy-2-oxo-2*H*-chromen-3-yl)-3-(7-methyl-2-oxo-2*H*-chromen-4-yl) propanoic acid [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	3.25 3.25 6.25 3.25 6.25 25

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3-(4-Hydroxy-2-oxo-2*H*-chromen-3-yl)-3-(2-oxo-2*H*-benzo [*h*] chromen-4-yl) propanoic acid [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	6.25 1.56 6.25 3.25 6.25 25
4-(6-Methyl-2-oxo-2*H*-chromen-4-yl)-3,4-dihydro-2*H*,5*H*-pyrano[3,2-*c*] chromene-2,5-dione [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	12.5 6.25 50 1.56 25 3.25
4-(6-Methoxy-2-oxo-2*H*-chromen-4-yl)-3,4-dihydro-2*H*,5*H*-pyrano[3,2-*c*] chromene-2,5-dione [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	6.25 6.25 6.25 3.25 6.25 25
4-(6-Chloro-2-oxo-2*H*-chromen-4-yl)-3,4-dihydro-2*H*,5*H*-pyrano[3,2-*c*] chromene-2,5-dione [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	6.25 3.25 25 6.25 25 6.25
4-(7-Methyl-2-oxo-2*H*-chromen-4-yl)-3,4-dihydro-2*H*,5*H*-pyrano[3,2-*c*] chromene-2,5-dione [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	6.25 3.25 6.25 1.56 25 3.25
4-(2-Oxo-2*H*-benzo[*h*]chromen-4-yl)-3,4-dihydro-2*H*,5*H*-pyrano[3,2-*c*] chromene-2,5-dione [50]	*Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Prevotella intermedia*,	25 6.25 25 6.25 1.56 25
Ethyl-6-methyl-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	0.4 12.5 50 100
Ethyl-4-(6-methoxy-2-oxo-2*H*-chromen-4-yl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	0.8 100 50 25
Ethyl-4-(6-chloro-2-oxo-2*H*-chromen-4-yl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	3.12 100 25 50

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Ethyl-6-methyl-4-(7-methyl-2-oxo-2*H*-chromen-4-yl)-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	0.2 50 12.5 100
Ethyl-6-methyl-2-oxo-4-(2-oxo-2*H*-benzo[*h*]chromen-4-yl)-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	0.4 100 25 25
Ethyl-6-methyl-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	0.4 100 1.6 100
Ethyl-4-(6-methoxy-2-oxo-2*H*-chromen-4-yl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	0.8 50 25 100
Ethyl-4-(6-chloro-2-oxo-2*H*-chromen-4-yl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	0.8 50 0.4 100
Ethyl-6-methyl-4-(7-methyl-2-oxo-2*H*-chromen-4-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [41]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	6.25 50 25 100
Ethyl-6-methyl-4-(2-oxo-2*H*-benzo[*h*]chromen-4-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate [51]	*S. aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa*,	0.4 100 0.4 100
(*E*)-4-(((2-((6-Chloro-2-oxo-2*H*-chromen-4-yl)methoxy) naphthalen-1-yl)methylene) amino)-1,5-dimethyl-2-phenyl-1,2-dihydro-3*H*-pyrazol-3-one [52]	*S. aureus*,	0.78
(*E*)-1,5-Dimethyl-4- (((2-((2-oxo-2*H*-benzo [*h*] chromen-4-yl) methoxy)naphthalen-1-yl) methylene)amino)-2-phenyl-1,2-dihydro-3*H*-pyrazol-3-one [52]	*S. aureus*,	1.56
Ethyl-5-(2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	16 64 64 2
Ethyl-1-(4-fluorophenyl)-5-(2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	>128 >128 >128 >128

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Ethyl-1-(4-chlorophenyl)-5-(2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	16 64 64 16
Ethyl-5-(2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	>128 32 >128 >128
N-(4-Cyano-1-phenyl-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	16 64 64 32
N-(4-Cyano-1-(4-fluorophenyl)-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [43]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	>128 64 >128 >128
N-(1-(4-Chlorophenyl)-4-cyano-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	4 32 32 16
N-(4-Cyano-1-(*p*-tolyl)-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	8 >128 32 >128
5-(2-Oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	>128 32 >128 >128
1-(4-Fluorophenyl)-5-(2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	32 32 64 32
1-(4-Chlorophenyl)-5-(2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	32 32 64 32
5-(2-Oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	64 >128 64 >128
Ethyl-5-(6-bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	16 16 16 64
Ethyl-5-(6-bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-fluorophenyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	64 >128 4 >128

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Ethyl-5-(6-bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-chlorophenyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	4 1 8 32
Ethyl-5-(6-bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	32 2 32 2
6-Bromo-*N*-(4-cyano-1-phenyl-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	>128 >128 >128 >128
6-Bromo-*N*-(4-cyano-1-(4-fluorophenyl)-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	2 64 64 >128
6-Bromo-*N*-(1-(4-chlorophenyl)-4-cyano-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	4 16 8 0.25
6-Bromo-*N*-(4-cyano-1-(*p*-tolyl)-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	>128 8 >128 64
5-(6-Bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	>128 >128 >128 >128
5-(6-Bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-fluorophenyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	>128 32 4 32
5-(6-Bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-chlorophenyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184),	32 32 4 32
5-(6-Bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 >128 64 >128
Ethyl-5-(6-chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	4 64 16 64

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Ethyl-5-(6-chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-fluorophenyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 64 64
Ethyl-5-(6-chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-chlorophenyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	2 32 4 32
Ethyl-5-(6-chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	4 2 64 >128
6-Chloro-*N*-(4-cyano-1-phenyl-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	16 32 32 64
6-Chloro-*N*-(4-cyano-1-(4-fluorophenyl)-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 32 32 64
6-Chloro-*N*-(1-(4-chlorophenyl)-4-cyano-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3- carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	4 8 4 64
6-Chloro-*N*-(4-cyano-1-(*p*-tolyl)-1*H*-pyrazol-5-yl)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
5-(6-Chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 32 32 >128
5-(6-Chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-fluorophenyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 32 32 >128
5-(6-Chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-chlorophenyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	0.5 0.5 0.25 4
5-(6-Chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 16 >128 >128

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Ethyl-5-(6-nitro-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
Ethyl-1-(4-fluorophenyl)-5-(6-nitro-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 8 64 >128
Ethyl-1-(4-chlorophenyl)-5-(6-nitro-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 32 64 64
Ethyl-5-(6-nitro-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
N-(4-Cyano-1-phenyl-1*H*-pyrazol-5-yl)-6-nitro-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
N-(4-Cyano-1-(4-fluorophenyl)-1*H*-pyrazol-5-yl)-6-nitro-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
N-(1-(4-Chlorophenyl)-4-cyano-1*H*-pyrazol-5-yl)-6-nitro-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	16 8 4 0.125
N-(4-Cyano-1-(*p*-tolyl)-1*H*-pyrazol-5-yl)-6-nitro-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
5-(6-Nitro-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 >128 64 64
1-(4-Fluorophenyl)-5-(6-nitro-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
1-(4-Chlorophenyl)-5-(6-nitro-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 32 32 32

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5-(6-Nitro-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 4 64
Ethyl-5-(7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 64 64 64
Ethyl-5-(7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-fluorophenyl)-1*H*- pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
Ethyl-1-(4-chlorophenyl)-5-(7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	1 0.5 2 0.05
Ethyl-5-(7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
N-(4-Cyano-1-phenyl-1*H*-pyrazol-5-yl)-7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	4 16 32 32
N-(4-Cyano-1-(4-fluorophenyl)-1*H*-pyrazol-5- yl)-7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 >128 64 64
N-(1-(4-Chlorophenyl)-4-cyano-1*H*-pyrazol-5-yl)-7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	2 8 2 16
N-(4-Cyano-1-(*p*-tolyl)-1*H*-pyrazol-5-yl)-7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
5-(7-(Diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	2 4 8 0.25
5-(7-(Diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-(4-fluorophenyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 16 32 16

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1-(4-Chlorophenyl)-5-(7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	2 2 4 0.125
5-(7-(Diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 64 64 64
5-(7-(Diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 32 16 16
Ethyl-1-(4-chlorophenyl)-5-(6-methyl-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	8 16 4 8
Ethyl-5-(6-methyl-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylate [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 >128 64 >128
N-(4-Cyano-1-phenyl-1*H*-pyrazol-5-yl)-6-methyl-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 64 8 8
N-(4-Cyano-1-(4-fluorophenyl)-1*H*-pyrazol-5- yl)-6-methyl-2-oxo-2*H*-chromene-3-carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	>128 >128 >128 >128
N-(1-(4-Chlorophenyl)-4-cyano-1*H*-pyrazol-5-yl)-6-methyl-2-oxo-2*H*-chromene-3- carboxamide [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	2 16 4 2
5-(6-Methyl-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 32 32 32
1-(4-Fluorophenyl)-5-(6-methyl-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	64 32 4 32
1-(4-Chlorophenyl)-5-(6-methyl-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	16 16 8 16
5-(6-Methyl-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid [53]	*S.aureus* (ATCC-12600), *L.monocytogenes* (ATCC-15313), *E.coli* (ATCC-25922), *Salmonella* (ATCC-9184)	32 >128 64 >128

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7-Hydroxy-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	32 64 32 32 128 256 128 512 64 128 128
5,7-Dihydroxy-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	32 64 64 64 128 128 256 256 64 256 256
7-(4-Bromobutoxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484, *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	128 256 128 128 256 256 256 512 128 256 512
7-((5-Bromopentyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896),	128 256 128 256 512 512
	S. typhi (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	512 256 256 512
7-((6-Bromohexyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550),	64 256 128 64 512 256 256 512

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	C. albican (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	256 256 512
7-((4-(Bromomethyl)benzyl)-oxy)-4-methyl-2*H*-chromen-2- one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484, *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	256 512 256 256 512 512 512 512 256 256 256
5,7-Bis(3-bromopropoxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	256 512 128 256 512 256 256 256 128 256 256
5,7-Bis((5-bromopentyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	128 256 128 128 512 256 256 256 128 256 128
5,7-Bis((6-bromohexyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	256 512 128 128 512 512 512 512 128 128 128

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5,7-Bis((4-(bromomethyl)-benzyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	256 512 128 256 512 512 256 512 256 256 256
7-(4-(1*H*-1,2,4-Triazol-1-yl)-butoxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	2 8 2 4 8 16 16 16 2 4 16
7-((5-(1*H*-1,2,4-Triazol-1-yl)-pentyl) oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	4 16 4 8 32 32 16 32 8 16 16
7-((6-(1*H*-1,2,4-Triazol-1-yl)-hexyl) oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	8 16 8 8 32 32 32 32 16 32 32

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7-((4-((1*H*-1,2,4-Triazol-1-yl) ethyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	32 64 32 32 64 64 64 64 32 64 64
5,7-Bis(4-(1*H*-1,2,4-triazol-1-yl) butoxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	1 2 2 1 1 2 1 1 1 2 4
5,7-Bis((5-(1*H*-1,2,4-triazol-1-yl) pentyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	2 8 4 4 8 4 4 4 2 4 32
5,7-Bis((6-(1*H*-1,2,4-triazol-1-yl) hexyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albican* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	8 16 4 8 8 8 16 8 4 4 32

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5,7-Bis((4-((1*H*-1,2,4-triazol-1-yl) methyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	32 64 64 64 64 32 32 64 32 32 64
7-(4-(1*H*-1,2,4-Triazol-1-yl)-butoxy)-4-methyl-2*H*-chromen-2-one hydrochloride [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	2 8 2 2 4 8 16 16 2 4 8
7-((4-((1*H*-1,2,4-Triazol-1-yl) methyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one hydrochloride [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	8 16 8 8 16 16 16 16 8 16 16
5,7-Bis(4-(1*H*-1,2,4-triazol-1-yl) butoxy)-4-methyl-2*H*-chromen-2-one bihydrochloride [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	1 2 1 1 1 2 1 1 1 2 2

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5,7-Bis((4-((1*H*-1,2,4-triazol-1- yl) methyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one bihydrochloride [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	8 16 16 16 8 16 16 16 8 16 16
7,7'-(Butane-1,4-diylbis(oxy))-bis(4-methyl-2*H*-chromen-2-one) [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	128 512 128 128 256 256 256 512 512 256 512
7,7'-(Pentane-1,5-diylbis(oxy))bis (4-methyl-2*H*-chromen-2-one) [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	128 256 256 128 256 512 512 512 512 256 512
4-Methyl-7-((6-((4-methyl-2*H*-chromen-7-yl)oxy)hexyl)oxy)-2*H*-chromen-2-one [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	256 512 128 128 256 256 512 512 512 256 512

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7,7'-((1,4-Phenylene-bis-(methylene))bis(oxy))bis-(4-methyl-2*H*-chromen-2-one) [54]	*S. aureus* (ATCC 25923), *S. aureus* N 315, *B. subtilis* (ATCC 6633), *M. luteus* (ATCC 4698), *E. coli* (ATCC 25922), *P. vulgaris* (ATCC 6896), *S. typhi* (ATCC 9484), *S. dysenteriae* (ATCC 49550), *C. albicans* (ATCC 76615), *S. cerevisiae* (ATCC 9763), *A. fumigatus* (ATCC 96918)	> 512 > 512 > 512 > 512 > 512 > 512 > 512 > 512 > 512 > 512 > 512
Ethyl-7-hydroxy-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*,	100 150
Ethyl-2-oxo-7-(prop-2-yn-1-yloxy)-2*H*-chromene-3-carboxylate [55]	*Aspergillus flavus*, *Cryptococcus neoformans*,	175 175
Ethyl-7-((1-(4-aminobenzyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*	50 100 125 50 150
Ethyl-7-((1-(3-nitrobenzyl)-1*H*-1,2,3- triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*	50 100 125 150 150
Ethyl-7-((1-(4-chlorobenzyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*	25 50 25 100 150
Ethyl-7-((1-(3-chlorobenzyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*	25 25 100 25 100
Ethyl-7-((1-(2-chlorobenzyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*	25 12.5 150 175 150
Ethyl-7-((1-(4-fluorobenzyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*	12.5 50 50 25 100
Ethyl-7-((1-(4-bromobenzyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*	50 50 125 125 150

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Ethyl-7-((1-benzyl-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate [55]	*Candida albicans*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Cryptococcus neoformans*	25 50 50 100 150
3-((Dicyclohexylamino)-(phenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	70 68 65 66 58 55 84 38 43 54
3-((4-Chlorophenyl)-(dicyclohexylamino)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	52 50 54 30 32 34 30 14 15 15
3-((2,6-Dichlorophenyl)-(dicyclohexylamino)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	50 48 50 30 28 35 28 15 18 14
3-((Dicyclohexylamino)-(4-fluorophenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	50 49 50 28 30 30 28 15 20 18

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3-((Dicyclohexylamino)-(2,4-difluorophenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	48 50 52 28 26 30 28 12 12 12
3-((Dicyclohexylamino)-(4-methoxyphenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	64 58 55 43 57 39 44 20 22 20
3-((Dicyclohexylamino)(3,4-dimethoxyphenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	62 60 62 50 57 35 52 24 20 26
3-((Dicyclohexylamino)(3,4,5-trimethoxyphenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	68 68 66 48 64 45 50 38 34 34
3-((Dicyclohexylamino)(4-hydroxyphenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	64 66 67 32 35 35 42 25 28 24

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3-((Dicyclohexylamino)(2-hydroxyphenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*,	68 72 72 46 47 38 55 32 30 35
3-((Dicyclohexylamino)(4-hydroxy-3-methoxyphenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoformans*	55 55 54 25 30 28 38 12 15 15
3-((Dicyclohexylamino)(3-ethoxy-4- hydroxyphenyl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoforman*	56 54 54 25 28 28 36 15 12 12
3-((Dicyclohexylamino)-(pyridin-2-yl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoforman*	68 74 78 48 46 40 45 25 22 28
3-((Dicyclohexylamino)-(thiophen-2-yl)methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoforman*	65 74 72 55 53 58 67 32 38 33

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3-((Dicyclohexylamino)-(furan-2-yl) methyl)-4-hydroxy-2*H*-chromen-2-one [55]	*E.coli*, *B.subtilis*, *S.aureus*, *C. albicans*, *C. glabrata*, *F. oxysporum*, *Aspergillus fumigatus* (NCIM-902), *Aspergillus flavus* (NCIM-539), *Aspergillus niger* (NCIM-1196), *Cryptococcus neoforman*	66 74 70 56 55 55 65 46 49 48
7-(Diethylamino)-*N*-(2-(2,4-difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2- oxo-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.06 0.06 0.03 4 16 8 0.125 1 1 1
N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-imidazol-1-yl)propyl)-7-(ethyl (methyl)-amino)-2-oxo-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.015 0.06 0.06 8 8 2 0.015 0.125 0.5 0.5
N-(2-(2,4-Dichlorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-7-(diethylamino)-2- oxo-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.03 0.03 0.03 4 16 4 0.06 0.5 0.25 0.5
N-(2-(2,4-Dichlorophenyl)-2-hydroxy-3-(1*H*-imidazol-1-yl)propyl)-7-(ethyl (methyl)-amino)-2-oxo-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.015 0.03 0.03 4 2 0.25 0.015 0.06 0.125 0.25

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N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl) propyl)-2-oxo-7-(pentan-3-yloxy)-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.125 0.125 0.25 >64 32 4 0.5 2 2 2
N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-imidazol-1-yl)propyl)-2-oxo-7-(pentan-3-yloxy)-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.03 0.015 0.03 2 4 1 0.125 0.25 0.125 0.25
N-(2-(2,4-Dichlorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-7-(pentan-3-yloxy)-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.06 0.03 0.06 >64 >64 2 0.25 0.5 0.5 0.5
N-(2-(2,4-Dichlorophenyl)-2-hydroxy-3-(1*H*-imidazol-1-yl)propyl)-2-oxo-7-(pentan-3-yloxy)-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.03 0.06 0.06 2 2 0.5 0.125 0.5 0.25 0.25
N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.25 0.125 0.25 1 4 1 0.25 2 1 0.5

Continued

N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-1,2-dihydroquinoline-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	2 1 0.5 >64 64 16 2 8 8 8
N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-7-methoxy-2-oxo-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	0.25 0.125 0.5 32 8 4 0.25 2 1 4
N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-7-methoxy-2-oxo-1,2-dihydroquinoline-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	1 2 4 >64 >64 >64 2 >64 >64 >64
7-Chloro-*N*-(2-(2,4-difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-1,2-dihydroquinoline-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	1 1 0.5 64 >64 16 1 8 8 8
N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-7-hydroxy-2-oxo-2*H*-chromene-3-carboxamide [56]	*Candida albicans* 90028, *C. albicans* P-87, *C. albicans* SN152, *C. glabrata* 66032, *C. glabrata* 2001, *C. glabrata* 192, *C. parapsilosis* 90018, *C. parapsilosis* 22019, *C. guilliermondii* T-47, *C. dubliniensis* T-99.	64 64 >64 >64 64 >64 >64 >64 >64 >64
3-(4-Fluorophenyl)-4-methyl-7-(prop-2-yn-1-yloxy)-2*H*-chromen-	*S. aureus*,(zone of inhibition at 10-20 µg/mL)	12-18mm 11-21mm

Continued

2-one [57]	*B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	8-11mm 6-10mm
3-(4-Chlorophenyl)-4-methyl-7-(prop-2-yn-1-yloxy)-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	9-19mm 12-19mm 10-12mm 4-11mm
3-(4-Bromophenyl)-4-methyl-7-(prop-2-yn-1-yloxy)-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	10-20mm 10-22mm 11-15mm 7-9mm
3-(4-Methoxyphenyl)-4-methyl-7-(prop-2-yn-1-yloxy)-2*H*- chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	12-17mm 9-18mm 9-12mm 12-14mm
3-(4-Fluorophenyl)-7-((1-(4-methoxyphenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-4-methyl-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	22-32mm 23-40mm 16-21mm 14-20mm
3-(4-Fluorophenyl)-4-methyl-7-((1-(p-tolyl)-1*H*-1,2,3-triazol-4- yl) methoxy)-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	15-24mm 16-32mm 13-16mm 8-14mm
7-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-3-(4-fluorophenyl)-4-methyl-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL)	18-36mm 16-34mm 14-18mm 9-16mm

Continued

	K.pneumoniae,(zone of inhibition at 10-20 µg/mL)	
3-(4-Chlorophenyl)-7-((1-(4-methoxyphenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-4-methyl-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	23-32mm 22-42mm 18-23mm 13-20mm
4-(((3-(4-Chlorophenyl)-4-methyl-2*H*-chromen-7-yl)oxy)methyl)-1-(*p*-tolyl)-1*H*-1,2,3-triazole [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	16-23mm 15-32mm 12-16mm 8-13mm
3-(4-Chlorophenyl)-7-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-4-methyl-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	18-25mm 19-38mm 15-19mm 11-17mm
3-(4-Bromophenyl)-7-((1-(4-methoxyphenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-4-methyl-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	24-34mm 22-42mm 18-25mm 12-22mm
3-(4-Bromophenyl)-4-methyl-7-((1-(*p*-tolyl)-1*H*-1,2,3-triazol-4- yl) methoxy)-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	15-24mm 16-28mm 14-17mm 6-13mm
3-(4-Bromophenyl)-7-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-4-methyl-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	16-27mm 19-39mm 12-20mm 9-17mm

Continued

3-(4-Methoxyphenyl)-7-((1-(4-methoxyphenyl)-1*H*-1,2,3-triazol-4-yl) methoxy)-4-methyl-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	26-34mm 27-39mm 21-29mm 14-22mm
3-(4-Methoxyphenyl)-4-methyl-7-((1-(*p*-tolyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	19-26mm 16-32mm 12-14mm 6-12mm
7-((1-(4-Chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-3-(4-methoxyphenyl)-4-methyl-2*H*-chromen-2-one [57]	*S. aureus*,(zone of inhibition at 10-20 µg/mL) *B.subtilis*,(zone of inhibition at 10-20 µg/mL) *E.coli*,(zone of inhibition at 10-20 µg/mL) *K.pneumoniae*,(zone of inhibition at 10-20 µg/mL)	19-27mm 18-37mm 14-25mm 8-15mm
Diethyl ((3-hydroxyphenyl) ((4-methyl-2-oxo-2*H*-chromen-7-yl) amino) methyl) phosphonate[16]	*S.aureus* ATCC 29213	IC_{50}= 0.5 mM
Diethyl ((2-bromophenyl) ((5-(2-oxo-2*H*-chromen-3-yl) thiazol-2-yl) amino) methyl) phosphonate [16]	*K.pneumoniae* ($Kpc+^{+}$)	IC_{50}= 0.125 mM
4-Methyl-7-((5-methyl-4-(*p*-tolyl) -4*H*-1,2, 4-triazol-3-yl)methoxy)-2*H*-chromen-2-one [58]	*Sclerotinia sclerotiorum* *Macropomina phaseolina* *Fusarium oxysporum,* *Fusarium culmorum,*	I %= 76.06 ± 4.37 I %= 35.38 ± 2.62 I %= 74.09 ± 3.24 I %= 28.57 ± 2.98
Ethyl(*E*)-4-(2-((*E*)-1-(6-bromo-2-oxo-2*H*-chromen-3-yl)ethylidene)hydrazineyl)-4-imino-2-(2-phenylhydrazineylid-ene) butanoate[59]	*Bacillus pumilis* (MTCC-2296) *Streptococcus faecalis* (MTCC-0459) *Escherichia coli* (ATCC-25955) *Enterobacter cloacae* (ATCC-23355) *Saccharomyces cerevisiae* (ATCC-9763) *Candida albicans* (ATCC-10231)	MIC=59.01 µmol/mL MIC=3.67 µmol/mL MIC=29.41 µmol/mL MIC=117.83 µmol/mL MIC=117.83 µmol/mL MIC=29.41 µmol/mL
6-Bromo-3-((*E*)-1-(2-(4-phenyl-5-((*Z*)-phenyldiazenyl)thiazol-2-yl)hydrazineylidene) ethyl)-2*H*-chromen-2-one [59]	*Bacillus pumilis* (MTCC-2296) *Streptococcus faecalis* (MTCC-0459) *Escherichia coli* (ATCC-25955) *Enterobacter cloacae* (ATCC-23355) *Saccharomyces cerevisiae* (ATCC-9763) *Candida albicans* (ATCC-10231)	MIC=28.65 µmol/mL MIC=14.34 µmol/mL MIC=14.34 µmol/mL MIC=28.65 µmol/mL MIC=28.65 µmol/mL MIC=114.80 µmol/mL

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2-Oxo-*N*-(4-(2-oxo-2*H*-chromen-3-yl) thiazol-2-yl)-2*H*-chromene-6-sulfonamide [60]	*S. aureus* (ATCC 6538) *E. coli* (ATCC 25922) methicillin-resistant *S. aureus* (MRSA) *Candida albicans* (ATCC 10231)	MIC=19.53 µg/mL MIC=312.5 µg/mL MIC=316.7 µg/mL MIC=156.25 µg/mL
N-(4-(6-Bromo-2-oxo-2*H*-chromen-3-yl)thiazol-2-yl)-2-oxo-2*H*-chromene-6-sulfonamide [60]	*S. aureus* (ATCC 6538) *E. coli* (ATCC 25922) methicillin-resistant *S. aureus* (MRSA) *Candida albicans* (ATCC 10231)	MIC=39.06 µg/mL MIC=625 µg/mL MIC=626.9 µg/mL MIC=78.13 µg/mL
2-Oxo-*N*-(4-(*N*-(quinoxalin-2-yl) sulfamoyl) phenyl)-2*H*-chromene-6-sulfonamide [60]	*S. aureus* (ATCC 6538) *E. coli* (ATCC 25922) methicillin-resistant *S. aureus* (MRSA) *Candida albicans* (ATCC 10231)	MIC=9.77 µg/mL MIC=312.5 µg/mL MIC=345.5 µg/mL MIC=39.06 µg/mL
2-Oxo-2*H*-chromen-7-yl- 2-oxo-2*H*-chromene-6-sulfonate [60]	*S. aureus* (ATCC 6538) *E. coli* (ATCC 25922) methicillin-resistant *S. aureus* (MRSA) *Candida albicans* (ATCC 10231)	MIC=9.77 µg/mL MIC=312.5 µg/mL MIC=312 µg/mL MIC=156.25 µg/mL
2-Oxo-2*H*-chromen-7-yl-(*E*)-*N*-(2-oxo-2*H*-chromen-6-yl) formimidate [60]	*S. aureus* (ATCC 6538) *E. coli* (ATCC 25922) methicillin-resistant *S. aureus* (MRSA) *Candida albicans* (ATCC 10231)	MIC=4.88 µg/mL MIC=78.13 µg/mL MIC=39.06 µg/mL MIC=9.77 µg/mL
Ethyl-6-(6-bromo-2-oxo-2*H*-chromen-3-yl)-2-ethylnicotinate [59]	*Bacillus pumilis* (MTCC-2296) *Streptococcus faecalis* (MTCC-0459) *Escherichia coli* (ATCC-25955) *Enterobacter cloacae* (ATCC-23355) *Saccharomyces cerevisiae* (ATCC-9763) *Candida albicans* (ATCC-10231)	MIC=80.62 µmol/mL MIC=80.62 µmol/mL MIC=20.11 µmol/mL MIC=40.18 µmol/mL MIC=80.62 µmol/mL MIC=80.62 µmol/mL
3-(5-Acetyl-6-(trifluoromethyl) pyridin-2-yl)-6-bromo-2*H*-chromen-2-one [59]	*Bacillus pumilis* (MTCC-2296) *Streptococcus faecalis* (MTCC-0459) *Escherichia coli* (ATCC-25955) *Enterobacter cloacae* (ATCC-23355) *Saccharomyces cerevisiae* (ATCC-9763) *Candida albicans* (ATCC-10231)	MIC=37.84 µmol/mL MIC=151.64 µmol/mL MIC=4.73 µmol/mL MIC=37.84 µmol/mL MIC=151.64 µmol/mL MIC=75.94 µmol/mL
6-(6-Bromo-2-oxo-2*H*-chromen-3-yl)-2-oxo-1,2-dihydropyridine-3-carbonitrile [59]	*Bacillus pumilis* (MTCC-2296) *Streptococcus faecalis* (MTCC-0459) *Escherichia coli* (ATCC-25955) *Enterobacter cloacae* (ATCC-23355) *Saccharomyces cerevisiae* (ATCC-9763) *Candida albicans* (ATCC-10231)	MIC=91.21 µmol/mL MIC=91.21 µmol/mL MIC=45.46 µmol/mL MIC=22.76 µmol/mL MIC=182.14 µmol/mL MIC=45.46 µmol/mL
Ethyl-(*E*)-5-((3-(6-bromo-2-oxo-2*H*-chromen-3-yl)-3-oxoprop-1-en-1-yl) amino)-1-phenyl-1*H*-pyrazole-4-carboxylate [59]	*Bacillus pumilis* (MTCC-2296) *Streptococcus faecalis* (MTCC-0459) *Escherichia coli* (ATCC-25955) *Enterobacter cloacae* (ATCC-23355) *Saccharomyces cerevisiae* (ATCC-9763) *Candida albicans* (ATCC-10231)	MIC=7.69 µmol/mL MIC=15.36 µmol/mL MIC=15.36 µmol/mL MIC=30.68 µmol/mL MIC=15.36 µmol/mL MIC=61.57 µmol/mL
5-(6-Bromo-2-oxo-2*H*-chromen-3-yl)-2-thioxo-2,3-dihydropyrido [2,3-*d*] pyrimidin-4(1*H*)-one [59]	*Bacillus pumilis* (MTCC-2296) *Streptococcus faecalis* (MTCC-0459) *Escherichia coli* (ATCC-25955) *Enterobacter cloacae* (ATCC-23355)	MIC=38.78 µmol/mL MIC=38.78 µmol/mL MIC=4.84 µmol/mL MIC=155.38 µmol/mL

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	Saccharomyces cerevisiae (ATCC-9763) *Candida albicans* (ATCC-10231)	MIC=155.38 µmol/mL MIC=155.38 µmol/mL
Dimethyl ((4-fluorophenyl) ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate [61]	*Acinetobacter baumannii* (ATCC 17978), *Pseudomonas aeruginosa* (ATCC 15442), *Enterobacter cloacae* (ATCC 49141), *Porphyromonas gingivalis* (ATCC 33277), *Treponema denticola* (ATCC 35405)	MIC (1.3-2 µM)
Dimethyl ((4-bromophenyl) ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate [61]	*Acinetobacter baumannii* (ATCC 17978), *Pseudomonas aeruginosa* (ATCC 15442), *Enterobacter cloacae* (ATCC 49141), *Porphyromonas gingivalis* (ATCC 33277), *Treponema denticola* (ATCC 35405)	MIC (1.3-1.9 µM)
Dimethyl ((4-iodophenyl) ((2-oxo-4-trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate [61]	*Acinetobacter baumannii* (ATCC 17978), *Pseudomonas aeruginosa* (ATCC 15442), *Enterobacter cloacae* (ATCC 49141), *Porphyromonas gingivalis* (ATCC 33277), *Treponema denticola* (ATCC 35405)	MIC (1.3-3.2 µM)
Dimethyl ((4-chlorophenyl) ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate [61]	*Acinetobacter baumannii* (ATCC 17978), *Pseudomonas aeruginosa* (ATCC 15442), *Enterobacter cloacae* (ATCC 49141), *Porphyromonas gingivalis* (ATCC 33277), *Treponema denticola* (ATCC 35405)	MIC (1.3-4.05 µM)
Dimethyl ((3-nitrophenyl) ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate [61]	*Acinetobacter baumannii* (ATCC 17978), *Pseudomonas aeruginosa* (ATCC 15442), *Enterobacter cloacae* (ATCC 49141), *Porphyromonas gingivalis* (ATCC 33277), *Treponema denticola* (ATCC 35405)	MIC (1.3-3.7 µM)
Dimethyl (furan-2-yl- ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate [61]	*Acinetobacter baumannii* (ATCC 17978), *Pseudomonas aeruginosa* (ATCC 15442), *Enterobacter cloacae* (ATCC 49141), *Porphyromonas gingivalis* (ATCC 33277), *Treponema denticola* (ATCC 35405)	MIC (1.3-3.5 µM)

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Dimethyl-((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)thiophen-2-yl) methyl) phosphonate [61]	*Acinetobacter baumannii* (ATCC 17978), *Pseudomonas aeruginosa* (ATCC 15442), *Enterobacter cloacae* (ATCC 49141), *Porphyromonas gingivalis* (ATCC 33277), *Treponema denticola* (ATCC 35405)	MIC (1.2-4.2 µM)
Dimethyl (naphthalen-1-yl- ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate [61]	*Acinetobacter baumannii* (ATCC 17978), *Pseudomonas aeruginosa* (ATCC 15442), *Enterobacter cloacae* (ATCC 49141), *Porphyromonas gingivalis* (ATCC 33277), *Treponema denticola* (ATCC 35405)	MIC (1.2-3.9 µM)
2-(7-Methoxy-2-oxo-2*H*-chromen-4-yl) acetic acid [62]	*Helicobacter pylori* (ATCC 43504)	IC_{50}= 49 µM
Ethyl-4-((6-bromo-2-oxo-2*H*-chromen-3-yl) amino) benzoate [62]	*Helicobacter pylori* (NCTC 11637)	IC_{50}= 0.5 µM
2-Oxo-2*H*-chromene-3-carboxylic acid [62]	*Salmonella typhi* 57	IC_{50}= 25 µM
Diethyl- ((2-bromophenyl) ((5-(2-oxo-2*H*-chromen-3-yl) thiazol-2-yl) amino) methyl) phosphonate [62]	*Klebsiella pneumoniae* (Kpc+)	IC_{50}= 0.125 µM
2-(4-Bromophenyl)-*N*-(4-methoxybenzyl)-2-(*N*-(4-methyl-2-oxo-2*H*-chromen-7-yl)-2-phenylacetamido) acetamide [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.1-1.3 µg/mL)
4-Nitrophenyl-((1-(4-bromophenyl)-2-((4-methoxybenzyl) amino)-2-oxoethyl) (4-methyl-2-oxo-2*H*-chromen-7-yl) amino)-5-oxopentanoate [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.1-1.28 µg/mL)
5-((1-(4-Bromophenyl)-2-((4-methoxybenzyl) amino)-2-oxoethyl) (4-methyl-2-oxo-2*H*-chromen-7-yl) amino)-5-oxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.25-0.75 µg/mL)
5-((1-(4-Bromophenyl)-2-((4-methoxybenzyl) amino)-2-oxoethyl) (2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl)amino)-3,3-dimethyl-5-oxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.25-0.8 µg/mL)
4-Nitrophenyl-5-((2-((4-methoxybenzyl) amino)-2-oxo-1-phenylethyl) (2-oxo-4-	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3	MIC (0.125-1.3 µg/mL)

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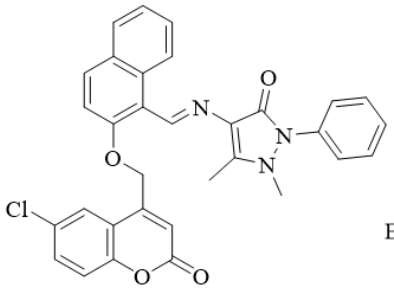
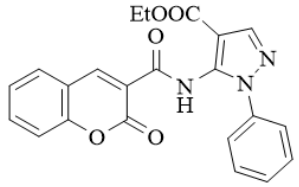
(trifluoromethyl)-2*H*-chromen-7-yl) amino)-5-oxopentanoate [63]	*Escherichia coli* R4	
5-((2-((4-Methoxybenzyl) amino)-2-oxo-1-phenylethyl) (2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-5-oxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.25-0.65 µg/mL)
5-((2-((4-Methoxybenzyl) amino)-2-oxo-1-phenylethyl)(2-oxo-4 (trifluoromethyl)-2*H*-chromen-7-yl) amino)-4,5-dioxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.20-1 µg/mL)
5-((2-((4-Methoxybenzyl)amino)-1-(4-methoxyphenyl)-2-oxoethyl) (2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl)amino)-3,3-dimethyl-5-oxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.1-1.35 µg/mL)
5-((2-((4-Methoxybenzyl) amino)-1-(4-nitrophenyl)-2-oxoethyl) (2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl)amino)-3,3-dimethyl-5-oxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.20-0.95 µg/mL)
5-((1-((4-Methoxybenzyl) amino)-4-methyl-1-oxopentan-2-yl) (2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl)amino)-3,3-dimethyl-5-oxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.23-0.85 µg/mL)
5-((2-((4-Methoxybenzyl) amino)-2-oxo-1-(*p*-tolyl) ethyl) (2-oxo-4-trifluoromethyl)-2*H*-chromen-7-yl)amino)-3,3-dimethyl-5-oxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.25-0.90 µg/mL)
(*E*)-5-((1-((4-Methoxybenzyl) amino)-1-oxo-4-phenylbut-3-en-2-yl) (2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl)amino)-3,3-dimethyl-5-oxopentanoic acid [63]	*Escherichia coli* K12 *Escherichia coli* R2 *Escherichia coli* R3 *Escherichia coli* R4	MIC (0.23-0.85 µg/mL)
6-Chloro-9-phenyl-4-(trifluoromethyl)-9,10-dihydro-2*H*,8*H*-chromeno [8,7-e] [1,3] oxazin-2-one [63]	*Botrytis cinerea*. *Colletotrichum capsici* *Alternaria solani* *Gibberella zeae* *Rhizoctonia solani* *Alternaria mali*	I%=98.7% I%=79.6% I%=37.5% I%=69.8% I%=88.2% I%=44.6%
6-Chloro-9-(4-chlorophenyl)-4-(trifluoromethyl)-9,10-dihydro-2*H*,8*H*-chromeno [8,7-*e*] [1,3] oxazin-2-one [63]	*Botrytis cinerea*. *Colletotrichum capsici* *Alternaria solani* *Gibberella zeae* *Rhizoctonia solani* *Alternaria mali*	I%=69.7% I%=45.3% I%=18.1% I%=34.1% I%=81.5% I%=20.3%
9-Benzyl-6-chloro-4-(trifluoromethyl)-9,10-dihydro-	*Botrytis cinerea*. *Colletotrichum capsici*	I%=57.8% I%=25.5%

Continued

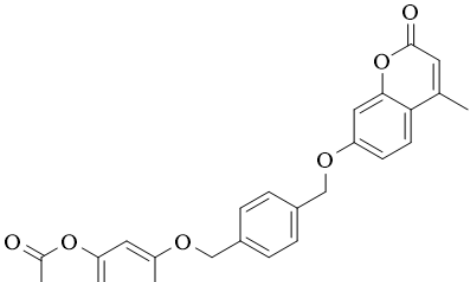
2*H*,8*H*-chromeno [8,7-*e*] [1,3] oxazin-2-one [63]	*Alternaria solani* *Gibberella zeae* *Rhizoctonia solani* *Alternaria mali*	I%=10.6% I%=40.6% I%=31 % I%=78.6%
4-Ethyl-3-methyl-2*H*,5*H*-pyrano [3,2-*c*] chromene-2,5-dione [63]	*Botrytis cinerea*. *Colletotrichum capsici* *Alternaria solani* *Gibberella zeae* *Rhizoctonia solani*	I%=64 % I%=57 % I%=22 % I%=30 % I%=30 %
3-(Trifluoromethyl)-2*H*,5*H*-pyrano [3,2-*c*] chromene-2,5-dione [63]	*Botrytis cinerea*. *Colletotrichum capsici* *Alternaria solani* *Gibberella zeae* *Rhizoctonia solani*	I%=60 % I%=10 % I%=16 % I%=6 % I%=14 %
4-Ethyl-8-methoxy-3-methyl-2*H*,5*H*-pyrano [3,2-*c*] chromene-2,5-dione [63]	*Botrytis cinerea*. *Colletotrichum capsici* *Alternaria solani* *Gibberella zeae* *Rhizoctonia solani*	I%=55 % I%=13 % I%=44 % I%=64 %I%=67 %
3,4-Dimethyl-8-(vinyloxy)-2*H*,5*H*-pyrano [3,2-*c*] chromene-2,5-dione [63]	*Botrytis cinerea*. *Colletotrichum capsici* *Alternaria solani* *Rhizoctonia solani* *Gibberella zeae*	I%=64 % I%=40 % I%=4 % I%=57 % I%=28 %
8-Butoxy-3-methyl-2*H*,5*H*-pyrano [3,2-*c*] chromene-2,5-dione [63]	*Botrytis cinerea*. *Colletotrichum capsici* *Alternaria solani* *Rhizoctonia solani* *Gibberella zeae*	I%=23 % I%=36 % I%=7 % I%=23 % I%=26 %
7,8,9,10-Tetrahydro-6*H*,11*H*-isochromeno [4,3-*c*] chromene-6,11-dione [63]	*Botrytis cinerea*. *Colletotrichum capsici* *Alternaria solani* *Rhizoctonia solani* *Gibberella zeae*	I%=35 % I%=14 % I%=19 % I%=13 % I%=41 %

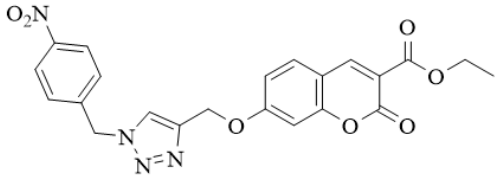


(*E*)-4-(((2-(((6-Chloro-2-oxo-2*H*-chromen-4-yl)methoxy)naphthalen-1-yl)methylene)amino)-1,5-dimethyl-2-phenyl-1,2-dihydro-3*H*-pyrazol-3-one

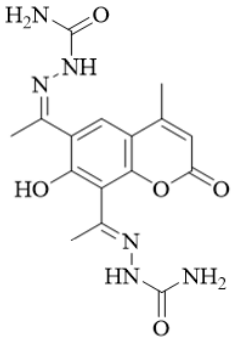


Ethyl-5-(2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate

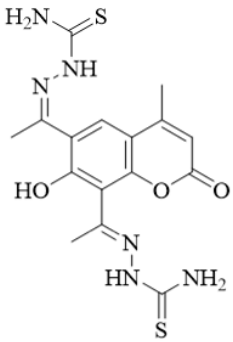




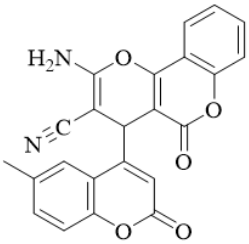
Ethyl-7-((1-(4-aminobenzyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate



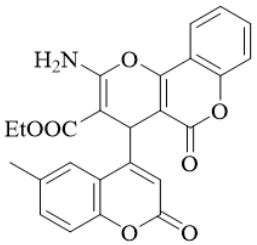
(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)-bis(ethan-1-yl-1-ylidene))bis(hydrazine-1-carboxamide)



(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis(ethan-1-yl-1-ylidene))bis(hydrazine-1-carbothioamide)



2-Amino-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-5-oxo-4a,10b-dihydro-4*H*,5*H*-pyrano[3,2-*c*]chromene-3-carbonitrile



Ethyl-2-amino-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-5-oxo-4a,10b-dihydro-4*H*,5*H*-pyrano[3,2-*c*]chromene-3-carboxylate

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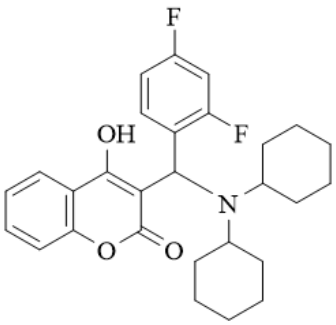
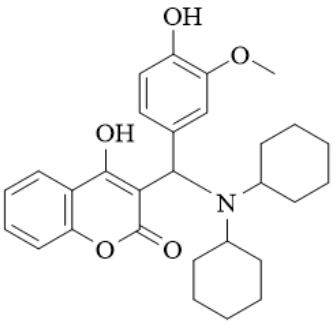
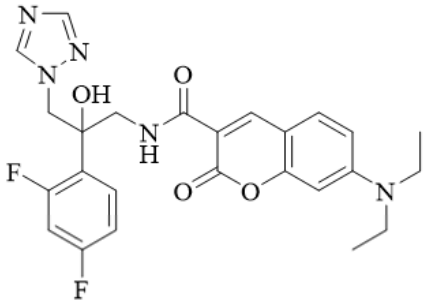


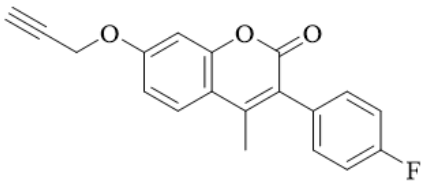
3-((Dicyclohexylamino)(2,4-difluorophenyl)methyl)-4-hydroxy-2*H*-chromen-2-one



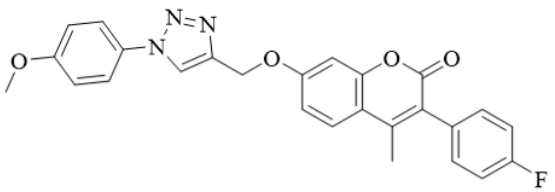
3-((Dicyclohexylamino)(4-hydroxy-3-methoxyphenyl)methyl)-4-hydroxy-2*H*-chromen-2-one



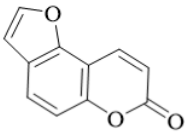
7-(Diethylamino)-*N*-(2-(2,4-difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-2*H*-chromene-3-carboxamide



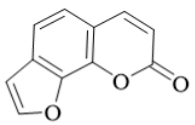
3-(4-Fluorophenyl)-4-methyl-7-(prop-2-yn-1-yloxy)-2*H*-chromen-2-one



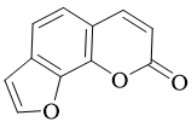
3-(4-Fluorophenyl)-7-((1-(4-methoxyphenyl)-1*H*-1,2,3-triazol-4-yl) methoxy)-4-methyl-2*H*-chromen-2-one



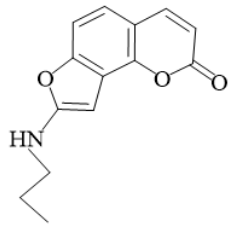
Allopsoralen



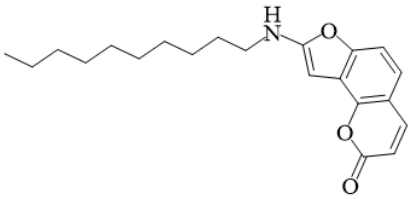
Isopseudopsoralen



Pseudoisopsoralen



8-(Propylamino)-2*H*-furo[2,3-*h*] chromen-2-one



8-(Decylamino)-2*H*-furo[2,3-*h*]chromen-2-one

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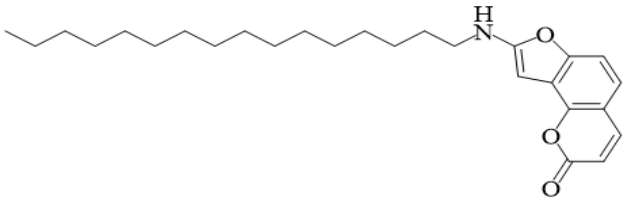
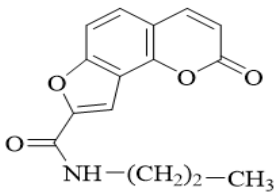
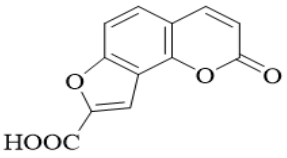


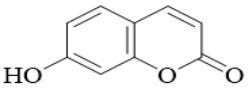
8-(Hexadecylamino)-2*H*-furo[2,3-*h*]chromen-2-one



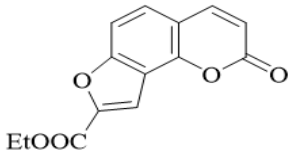
2-Oxo-*N*-propyl-2*H*-furo [2,3-*h*] chromene-8-carboxamide



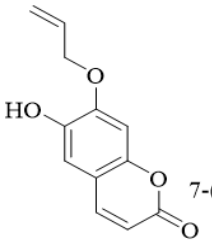
2-Oxo-2*H*-furo [2,3-*h*] chromene-8-carboxylic acid



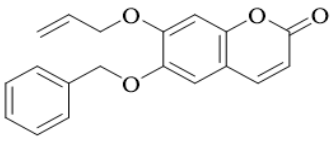
7-Hydroxy-2*H*-chromen-2-one



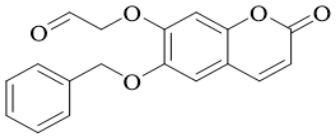
Ethyl-2-oxo-2*H*-furo [2,3-*h*] chromene-8-carboxylate



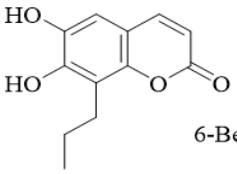
7-(Allyloxy)-6-hydroxy-2*H*-chromen-2-one



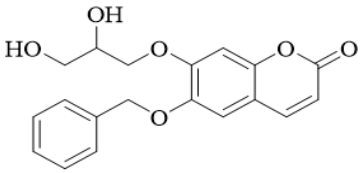
7-(Allyloxy)-6-(benzyloxy)-2*H*-chromen-2-one



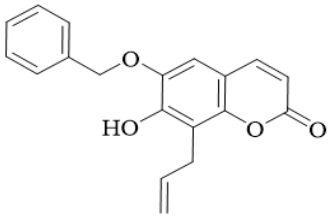
6-Benzyloxy-7-[2-(oxo)ethoxy]-2*H*-1-benzopyran-2-one



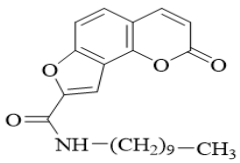
6,7-Dihydroxy-8-propyl-2*H*-chromen-2-one



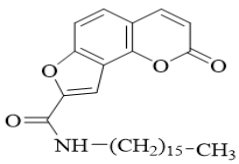
6-Benzyloxy-7-[2,3-(dihydroxy)propoxy]-2*H*-1-benzopyran-2-one



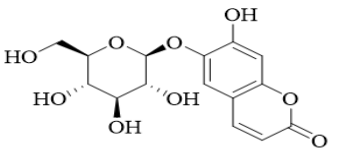
8-Allyl-6-(benzyloxy)-7-hydroxy-2*H*-chromen-2-one



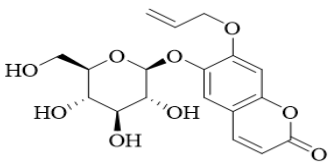
N-Decyl-2-oxo-2*H*-furo[2,3-*h*] chromene-8-carboxamide



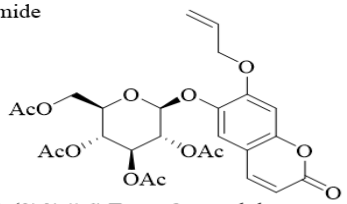
N-Hexadecyl-2-oxo-2*H*-furo [2,3-*h*] chromene-8-carboxamide



7-Hydroxy-6-[1-(*β*-*D*-(glucopyranosyloxy))]-2*H*-chromen-2-one



6-[1-(*β*-*D*-(glucopyranosyloxy))]-7-(3-allyloxy)-2*H*-chromen-2-one



6-[1-(*B*-*D*-(2',3',4',6'-Tetra-*O*-acetylglucopyranosyloxy))]-7-(3-allyloxy)-2*H*-1-benzopyran-2-one

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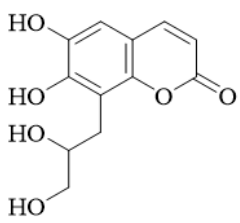
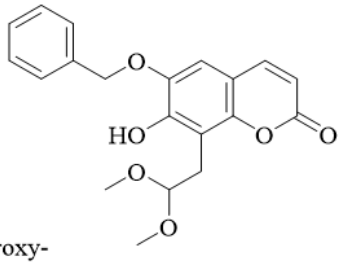
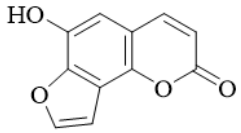


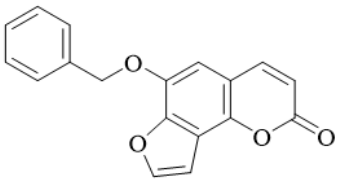
8-(2,3-Dihydroxypropyl)-6,7-dihydroxy-2*H*-chromen-2-one



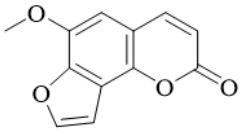
6-(Benzyloxy)-8-(2,2-dimethoxyethyl)-7-hydroxy-2*H*-chromen-2-one



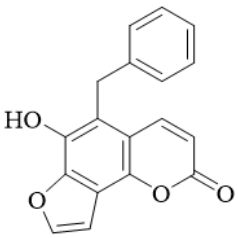
6-Hydroxy-2*H*-furo [2,3-*h*] chromen-2-one



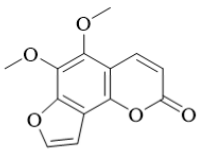
6-(Benzyloxy)-2*H*-furo [2,3-*h*] chromen-2-one



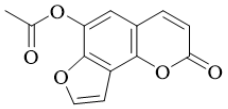
6-Methoxy-2*H*-furo [2,3-*h*] chromen-2-one



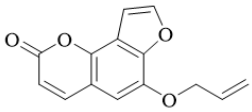
5-Benzyl-6-hydroxy-2*H*-furo [2,3-*h*] chromen-2-one



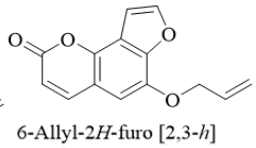
5,6-Dimethoxy-2*H*-furo [2,3-*h*] chromen-2-one



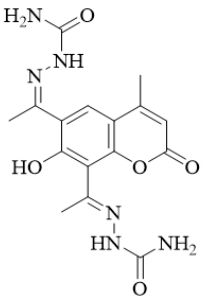
2-Oxo-2*H*-furo [2,3-*h*] chromen-6-yl-acetate



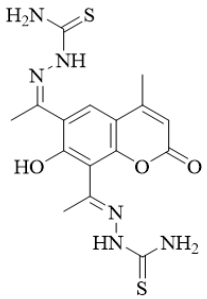
6-Allyl-2*H*-furo [2,3-*h*] chromen-2-one



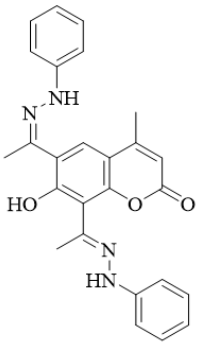
6-Allyl-2*H*-furo [2,3-*h*] chromen-2-one



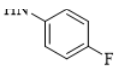
(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(ethan-1-yl-1-ylidene))bis(hydrazine-1-carboxamide)



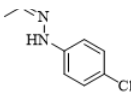
(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(ethan-1-yl-1-ylidene)) bis(hydrazine-1-carbothioamide)



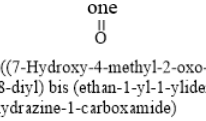
7-Hydroxy-4-methyl-8-((*E*)-1-(2-phenylhydrazineylidene) ethyl)-6-((*Z*)-1-(2-phenylhydrazineylidene) ethyl)-2*H*-chromen-2-one



8-((*E*)-1-(2-(4-Fluorophenyl) hydrazineylidene) ethyl)-6-((*Z*)-1-(2-(4-fluorophenyl) hydrazineylidene) ethyl)-7-hydroxy-4-methyl-2*H*-chromen-2-one

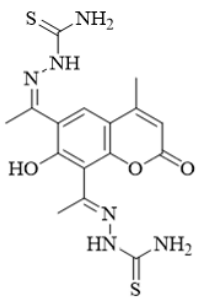


8-((*E*)-1-(2-(4-Chlorophenyl) hydrazineylidene) ethyl)-6-((*Z*)-1-(2-(4-chlorophenyl) hydrazineylidene) ethyl)-7-hydroxy-4-methyl-2*H*-chromen-2-one

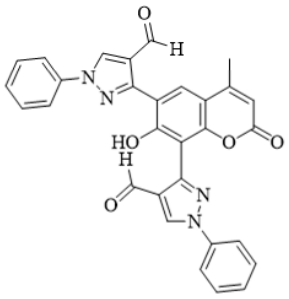


(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis (ethan-1-yl-1-ylidene)) bis(hydrazine-1-carboxamide)

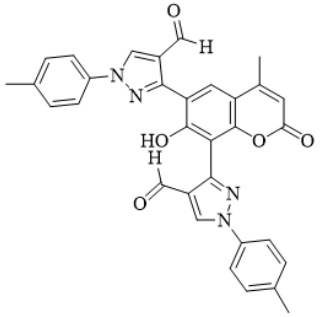
Continued



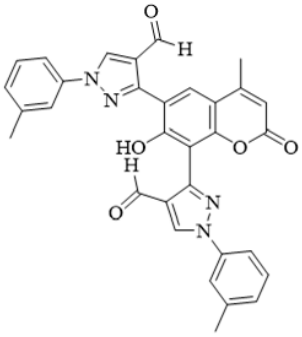
(2*Z*,2'*E*)-2,2'-((7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl) bis (ethan-1-yl-1-ylidene)) bis (hydrazine-1-carbothioamide)



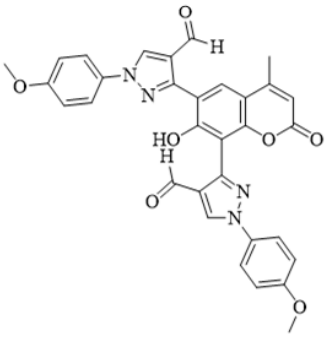
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-phenyl-1*H*-pyrazole-4-carbaldehyde)



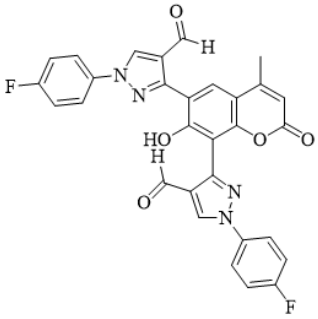
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-(*p*-tolyl)-1*H*-pyrazole-4-carbaldehyde)



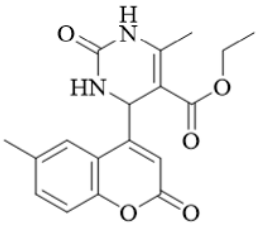
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-(*m*-tolyl)-1*H*-pyrazole-4-carbaldehyde)



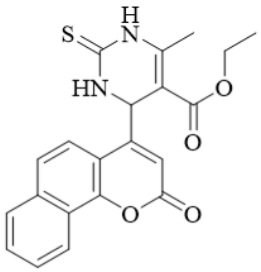
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-(4-methoxyphenyl)-1*H*-pyrazole-4-carbaldehyde)



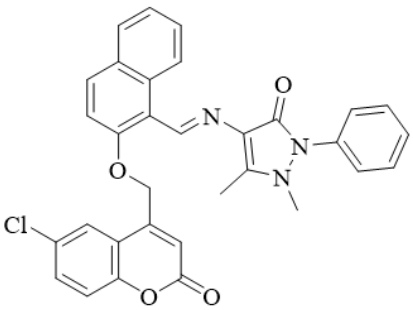
3,3'-(7-Hydroxy-4-methyl-2-oxo-2*H*-chromene-6,8-diyl)bis(1-(4-fluorophenyl)-1*H*-pyrazole-4-carbaldehyde)



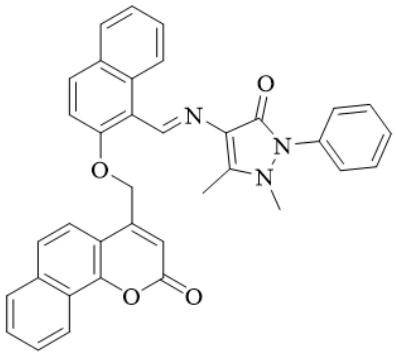
Ethyl-6-methyl-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate



Ethyl-6-methyl-4-(2-oxo-2*H*-benzo[*h*]chromen-4-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate



(*E*)-4-(((2-(((6-Chloro-2-oxo-2*H*-chromen-4-yl)methoxy)-naphthalen-1-yl)methylene)amino)-1,5-dimethyl-2-phenyl-1,2-dihydro-3*H*-pyrazol-3-one



(*E*)-1,5-Dimethyl-4-(((2-((2-oxo-2*H*-benzo[*h*]chromen-4-yl)methoxy)naphthalen-1-yl)methylene)amino)-2-phenyl-1,2-dihydro-3*H*-pyrazol-3-one

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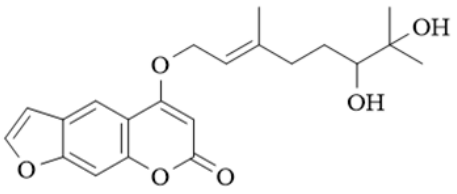
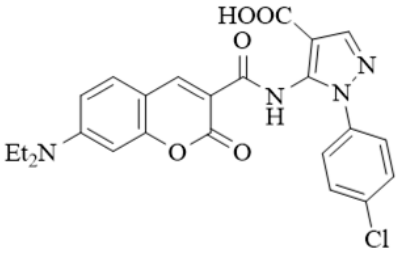
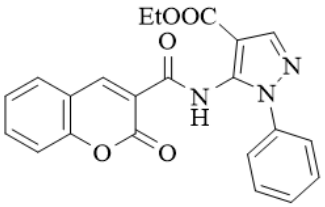


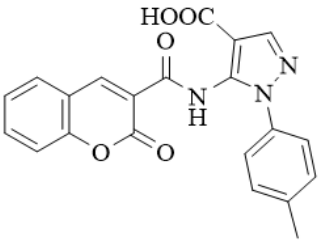
6',7'-Dihydroxybergamottin



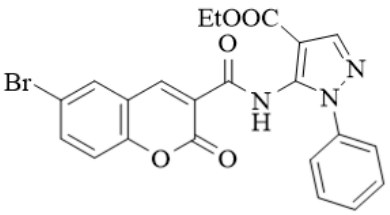
1-(4-Chlorophenyl)-5-(7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1*H*-pyrazole-4-carboxylic acid



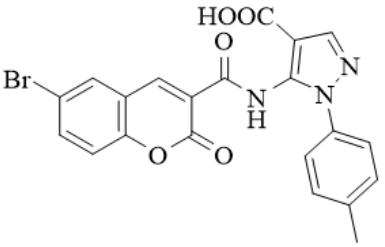
Ethyl-5-(2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate



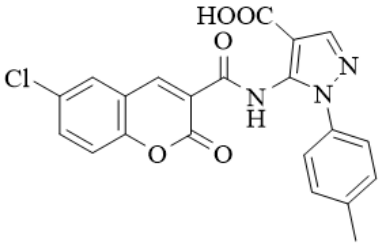
5-(2-Oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid



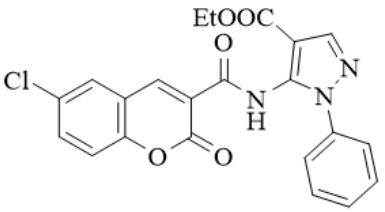
Ethyl-5-(6-bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate



5-(6-Bromo-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid

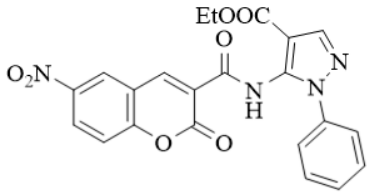


5-(6-Chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid

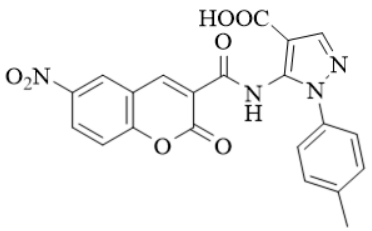


Ethyl-5-(6-chloro-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate

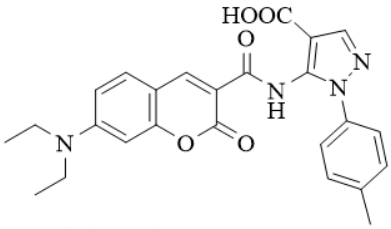
Continued



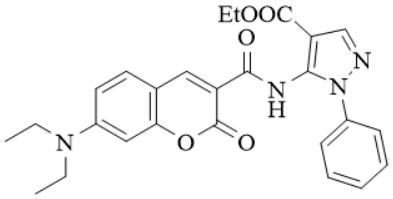
Ethyl-5-(6-nitro-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate



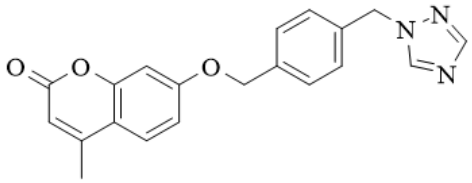
5-(6-Nitro-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid



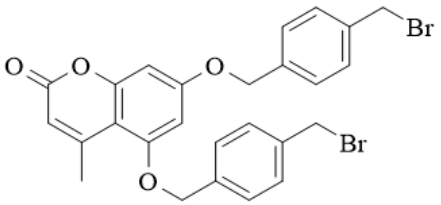
5-(7-(Diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-(*p*-tolyl)-1*H*-pyrazole-4-carboxylic acid



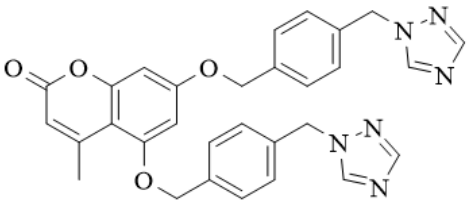
Ethyl-5-(7-(diethylamino)-2-oxo-2*H*-chromene-3-carboxamido)-1-phenyl-1*H*-pyrazole-4-carboxylate



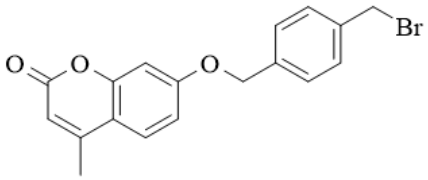
7-((4-((1*H*-1,2,4-Triazol-1-yl)methyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one



5,7-Bis((4-(bromomethyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one

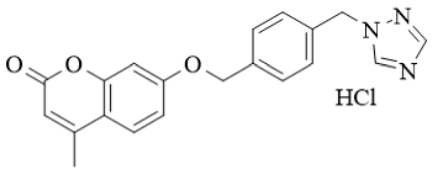


5,7-Bis((4-((1*H*-1,2,4-triazol-1-yl)methyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one

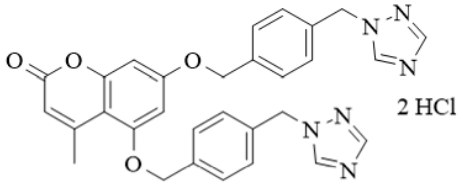


7-((4-(Bromomethyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one

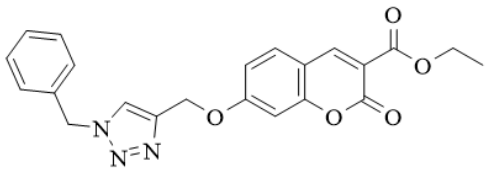
Continued



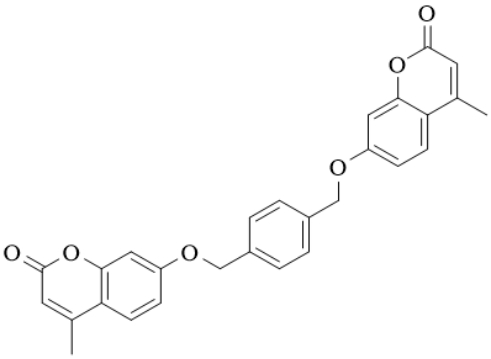
7-((4-((1*H*-1,2,4-Triazol-1-yl)methyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one hydrochloride



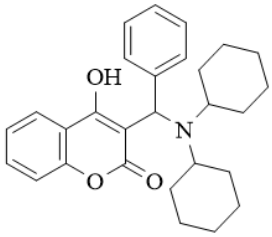
5,7-Bis((4-((1*H*-1,2,4-triazol-1-yl)methyl)benzyl)oxy)-4-methyl-2*H*-chromen-2-one bihydrochloride



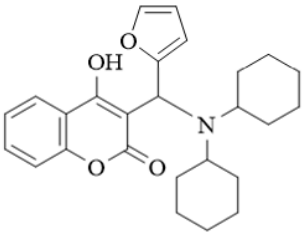
Ethyl-7-((1-benzyl-1*H*-1,2,3-triazol-4-yl)methoxy)-2-oxo-2*H*-chromene-3-carboxylate



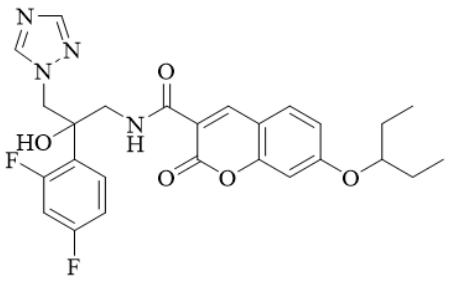
7,7'-((1,4-Phenylenebis(methylene))bis(oxy))bis-(4-methyl-2*H*-chromen-2-one)



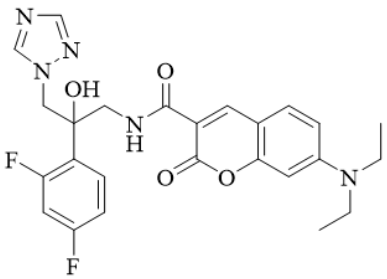
3-((Dicyclohexylamino)(phenyl)methyl)-4-hydroxy-2*H*-chromen-2-one



3-((Dicyclohexylamino)(furan-2-yl)methyl)-4-hydroxy-2*H*-chromen-2-one

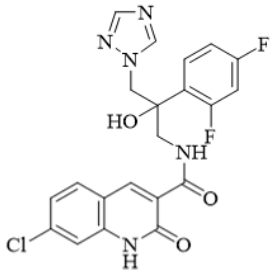


N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-7-(pentan-3-yloxy)-2*H*-chromene-3-carboxamide

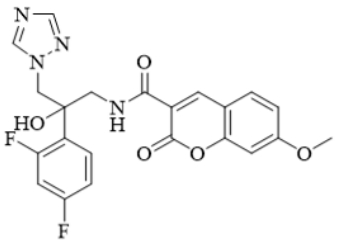


7-(Diethylamino)-*N*-(2-(2,4-difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-2*H*-chromene-3-carboxamide

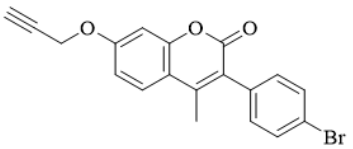
Continued



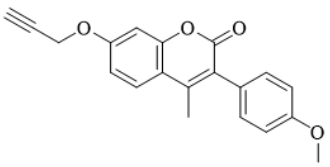
7-Chloro-*N*-(2-(2,4-difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-2-oxo-1,2-dihydroquinoline-3-carboxamide



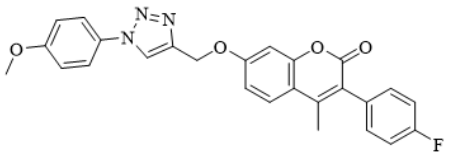
N-(2-(2,4-Difluorophenyl)-2-hydroxy-3-(1*H*-1,2,4-triazol-1-yl)propyl)-7-methoxy-2-oxo-2*H*-chromene-3-carboxamide



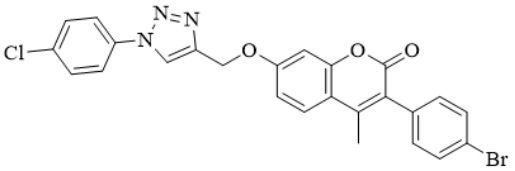
3-(4-Bromophenyl)-4-methyl-7-(prop-2-yn-1-yloxy)-2*H*-chromen-2-one



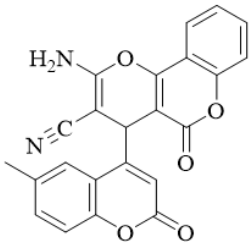
3-(4-Methoxyphenyl)-4-methyl-7-(prop-2-yn-1-yloxy)-2*H*-chromen-2-one



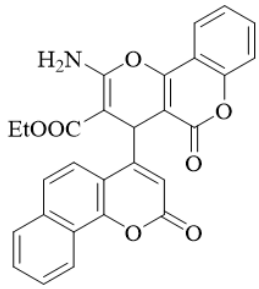
3-(4-Fluorophenyl)-7-((1-(4-methoxyphenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-4-methyl-2*H*-chromen-2-one



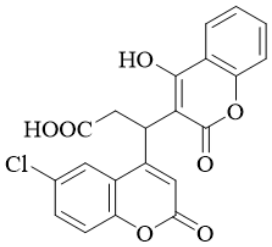
3-(4-Bromophenyl)-7-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methoxy)-4-methyl-2*H*-chromen-2-one



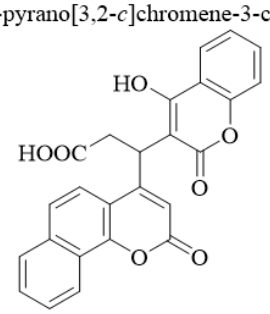
2-Amino-4-(6-methyl-2-oxo-2*H*-chromen-4-yl)-5-oxo-4a,10b-dihydro-4*H*,5*H*-pyrano[3,2-*c*]chromene-3-carbonitrile



Ethyl-2-amino-5-oxo-4-(2-oxo-2*H*-benzo[*h*]chromen-4-yl)-4*H*,5*H*-pyrano[3,2-*c*]chromene-3-carboxylate



3-(6-Chloro-2-oxo-2*H*-chromen-4-yl)-3-(4-hydroxy-2-oxo-2*H*-chromen-3-yl)propanoic acid



3-(4-Hydroxy-2-oxo-2*H*-chromen-3-yl)-3-(2-oxo-2*H*-benzo[*h*]chromen-4-yl)propanoic acid

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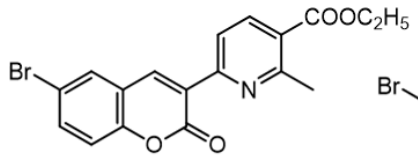
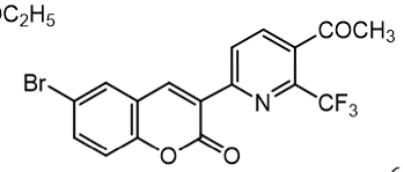
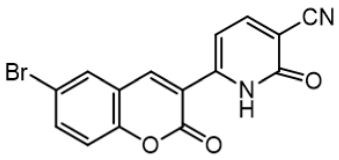


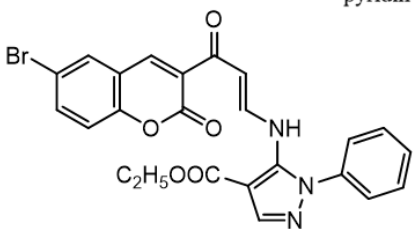
Ethyl-6-(6-bromo-2-oxo-2*H*-chromen-3-yl)-2-methylnicotinate



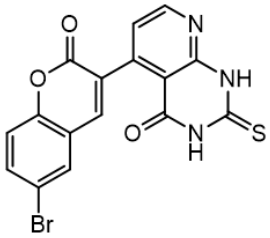
3-(5-Acetyl-6-(trifluoromethyl) pyridin-2-yl)-6-bromo-2*H*-chromen-2-one



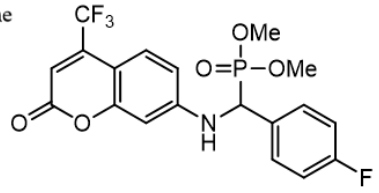
6-(6-Bromo-2-oxo-2*H*-chromen-3-yl)-2-oxo-1,2-dihydropyridine-3-carbonitrile



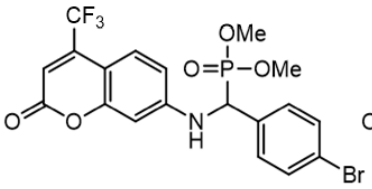
Ethyl (*E*)-5-((3-(6-bromo-2-oxo-2*H*-chromen-3-yl)-3-oxoprop-1-en-1-yl) amino)-1-phenyl-1*H*-pyrazole-4-carboxylate



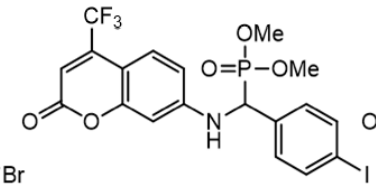
5-(6-Bromo-2-oxo-2*H*-chromen-3-yl)-2-thioxo-2,3-dihydropyrido [2,3-*d*] pyrimidin-4 (1*H*)-one



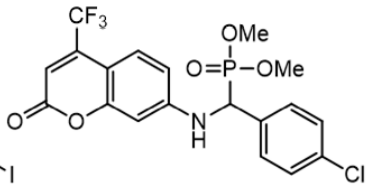
Dimethyl ((4-fluorophenyl) ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate



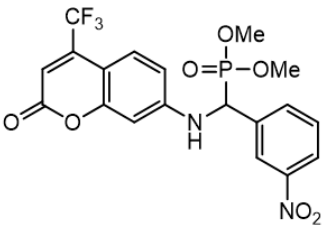
Dimethyl ((4-bromophenyl) ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate



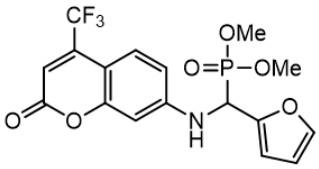
Dimethyl ((4-iodophenyl)((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)methyl) phosphonate



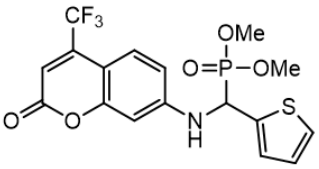
Dimethyl ((4-chlorophenyl) ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate



Dimethyl ((3-nitrophenyl)((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)methyl) phosphonate

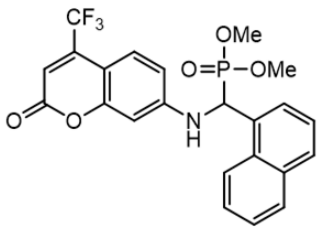


Dimethyl (furan-2-yl ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)methyl) phosphonate

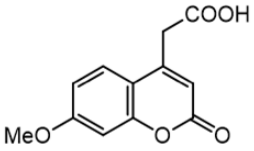


Dimethyl (((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) (thiophen-2-yl) methyl) phosphonate

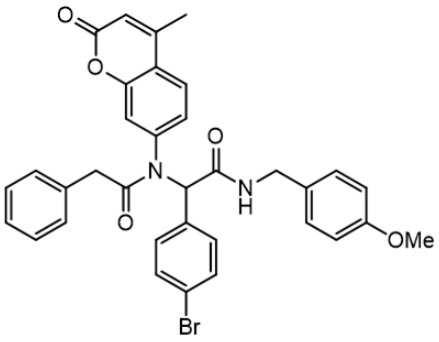
Continued



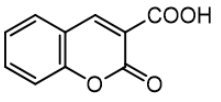
Dimethyl (naphthalen-1-yl ((2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino) methyl) phosphonate



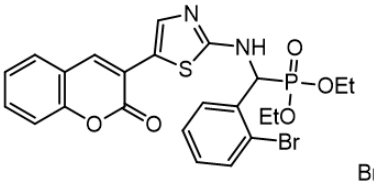
2-(7-Methoxy-2-oxo-2*H*-chromen-4-yl) acetic acid



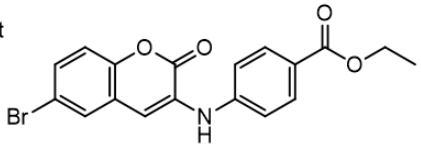
2-(4-Bromophenyl)-*N*-(4-methoxybenzyl)-2-(*N*-(4-methyl-2-oxo-2*H*-chromen-7-yl)-2-phenylacetamido) acetamide



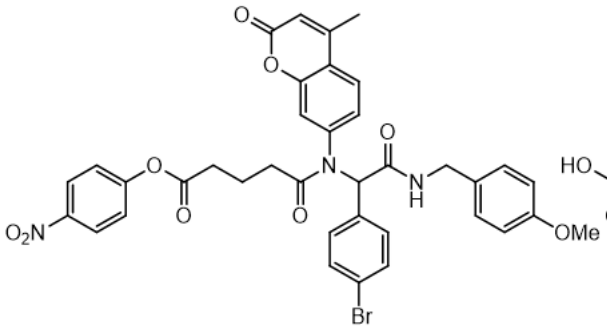
2-Oxo-2*H*-chromene-3-carboxylic acid



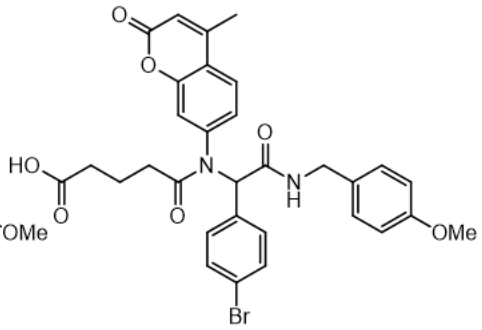
Diethyl ((2-bromophenyl)((5-(2-oxo-2*H*-chromen-3-yl) thiazol-2-yl) amino) methyl) phosphonate



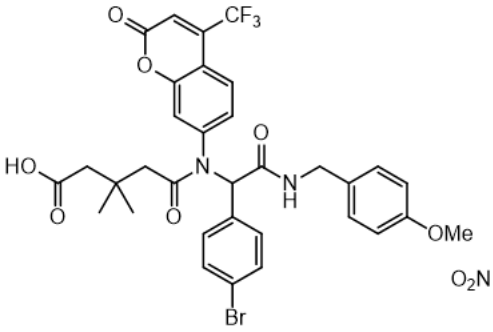
Ethyl-4-((6-bromo-2-oxo-2*H*-chromen-3-yl) amino) benzoate



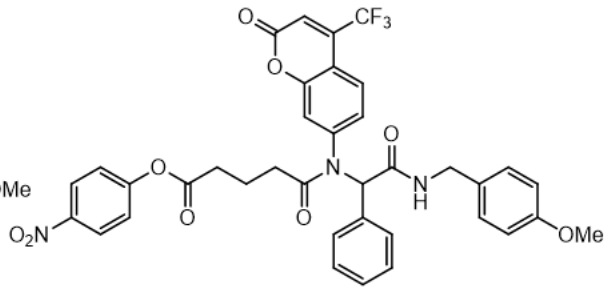
4-Nitrophenyl 5-((1-(4-bromophenyl)-2-((4-methoxybenzyl) amino)-2-oxoethyl)(4-methyl-2-oxo-2*H*-chromen-7-yl) amino)-5-oxopentanoate



5-((1-(4-Bromophenyl)-2-((4-methoxybenzyl) amino)-2-oxoethyl)(4-methyl-2-oxo-2*H*-chromen-7-yl) amino)-5-oxopentanoic acid

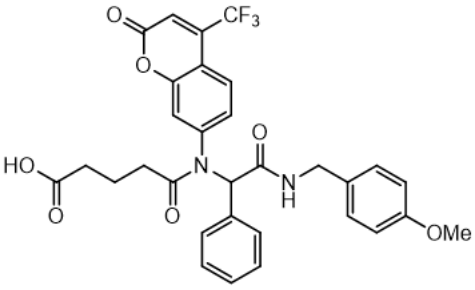


5-((1-(4-Bromophenyl)-2-((4-methoxybenzyl) amino)-2-oxoethyl)(2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-3,3-dimethyl-5-oxopentanoic acid

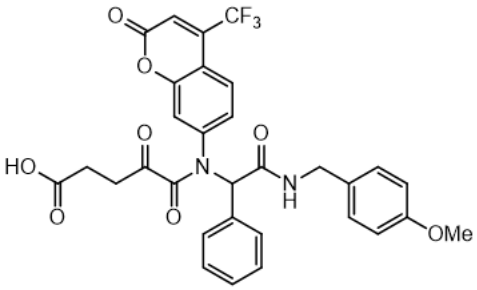


4-Nitrophenyl-5-((2-((4-methoxybenzyl) amino)-2-oxo-1-phenylethyl)(2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-5-oxopentanoate

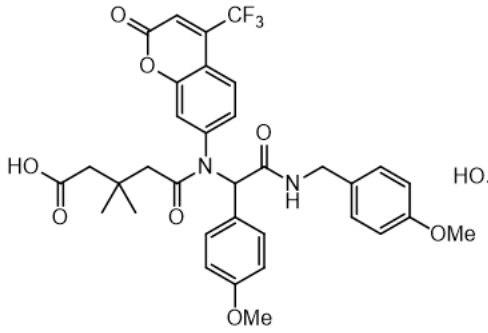
Continued



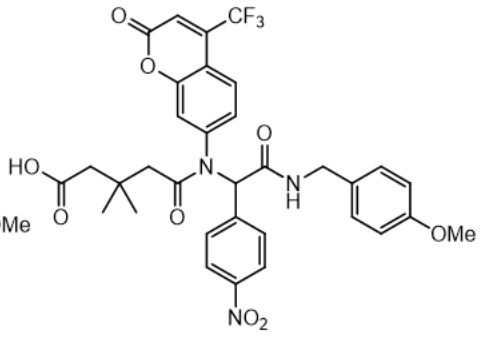
5-((2-((4-Methoxybenzyl)amino)-2-oxo-1-phenylethyl) (2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-5-oxopentanoic acid



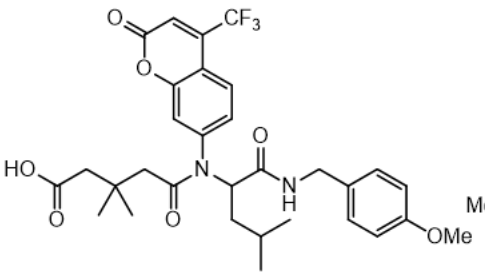
5-((2-((4-Methoxybenzyl) amino)-2-oxo-1-phenylethyl)(2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-4,5-dioxopentanoic acid



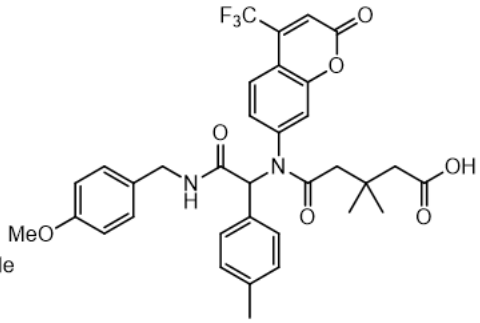
5-((2-((4-Methoxybenzyl) amino)-1-(4-methoxyphenyl)-2-oxoethyl)(2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-3,3-dimethyl-5-oxopentanoic acid



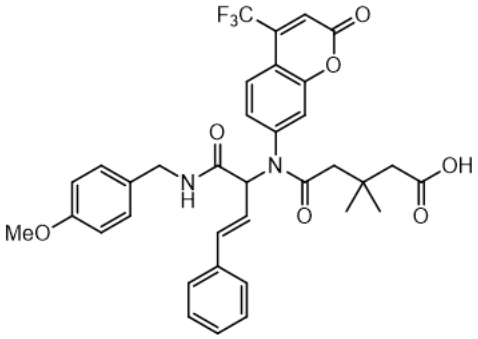
5-((2-((4-Methoxybenzyl) amino)-1-(4-nitrophenyl)-2-oxoethyl)(2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-3,3-dimethyl-5-oxopentanoic acid



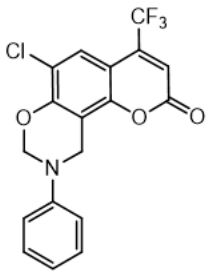
5-((1-((4-Methoxybenzyl) amino)-4-methyl-1-oxopentan-2-yl)(2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-3,3-dimethyl-5-oxopentanoic acid



5-((2-((4-Methoxybenzyl) amino)-2-oxo-1-(*p*-tolyl) ethyl)(2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-3,3-dimethyl-5-oxopentanoic acid



(*E*)-5-((1-((4-Methoxybenzyl) amino)-1-oxo-4-phenylbut-3-en-2-yl)(2-oxo-4-(trifluoromethyl)-2*H*-chromen-7-yl) amino)-3,3-dimethyl-5-oxopentanoic acid



6-Chloro-9-phenyl-4-(trifluoromethyl) -9,10-dihydro-2*H*,8*H*-chromeno [8,7-*e*][1,3] oxazin-2-one

Continued

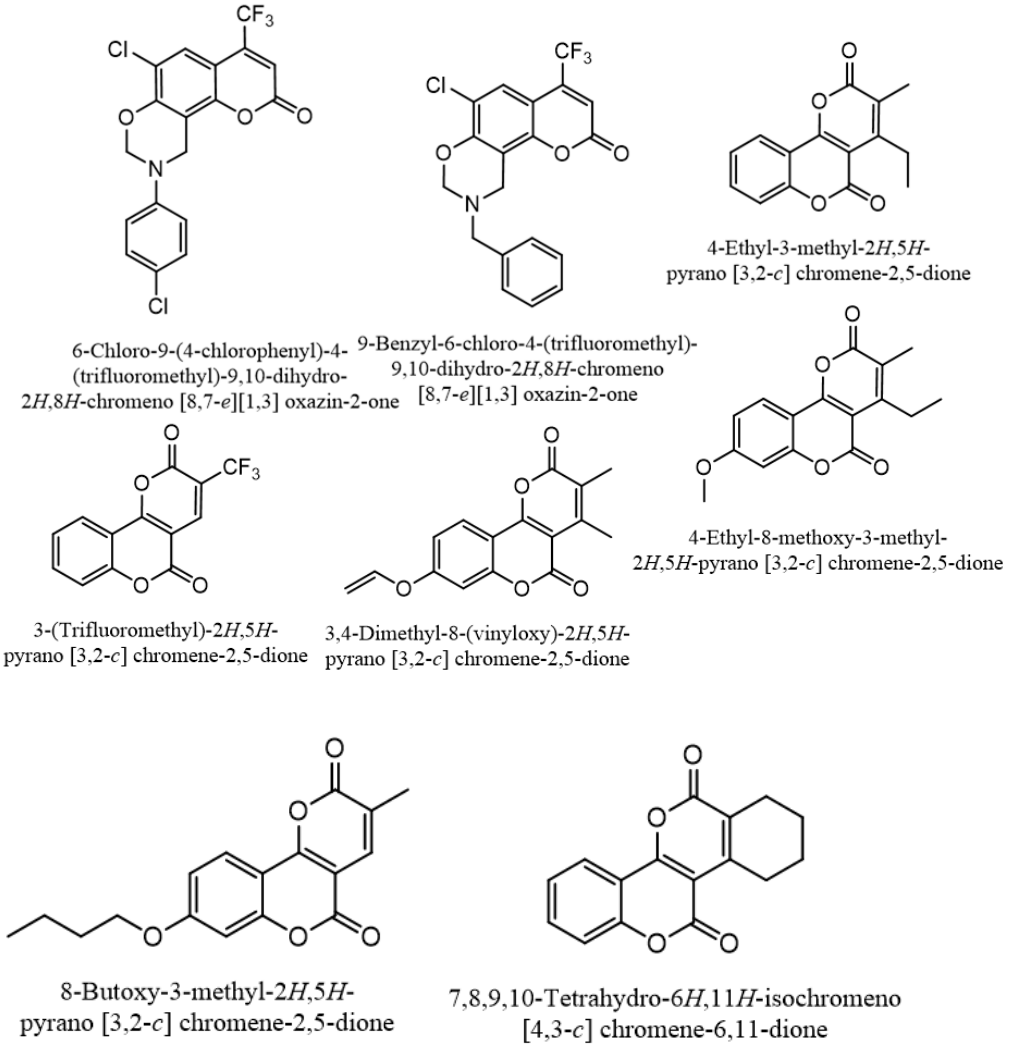


Figure 2. Chemical structures of some synthesized bioactive coumarins and their derivatives.

2.3. Synthesized alkaloid derivatives

Several semisynthetic and synthetic alkaloids were shown to enhance the effects of antibiotics in addition to natural alkaloids (**Table 4**), as in the case of combination of *N*-(2-(4-(5-(2-amino-1-isobutyl-1*H*-imidazol-4-yl) pentyl)-1*H*-1,2,3-triazol-1-yl) ethyl)-4-pentylbenzamide (4e: Alk-1), amlodipine, (*S*)-5-amino-2-((*S*)-2-amino-4-phenylbutanamido)-*N*-(quinolin-3-yl) pentanamide (compound 13:Alk-2), 5-benzhydryl-2-(benzylthio)-1-methyl-6-oxo-3,6-dihydropyrimidin-1-ium-4-olate (INF392) and *N*-(4-(2-(6,7-dimethoxy-3,4-dihydroisoquinolin-2(1*H*)-yl) ethyl) phenyl)-5-methoxy-9-oxo-4*a*,9,9*a*,10-tetrahydroacridine-4-carboxamide (GG918) [9] at relatively low alkaloid concentrations ((*S*)-5-amino-2-((*S*)-2-amino-4-phenylbutanamido)-*N*-(quinolin-3-yl) pentanamide at 2.5 mg/mL and INF392 at 0.4 mg/mL).

This synergy was observed with amlodipine *in vivo*, as mice are protected against *Salmonella enterica* serotype *Typhimurium* infection by intraperitoneal injections of amlodipine and streptomycin [10]. The capacity of some of these substances to prevent the advancement of antibiotic resistance is a second advantageous consequence (the compound INF392 100-fold declines the onset of ciprofloxacin resistance) (**Fig.3**) [11].

Table 4. The most potently synergistic synthetic alkaloid/antibiotic combinations as reported by PubMed and ScienceDirect searches.

Alkaloid	Class	Antibiotic	Bacteria	Reduction in antibiotic MIC	Ref
Amlodipine	piperidine	streptomycin	*Salmonella enterica* serotype *Typhimurium*	6.5 to 8 fold	[113]
INF392	pyrimidine	ciprofloxacin	*Bacillus subtilis*	8 fold	[112]
GG918	acridine-isoquinoline	norfloxacin	*S.aureus*	4 to 8 fold	[119]
Alk-1: 4e	pyrrole-imidazole	oxacillin	Methicillin-resistant *S. aureus*	4 fold	[114]
Alk-2: 13	quinoline	levofloxacin	*P.aeruginosa*	4 to 8 fold	[117]

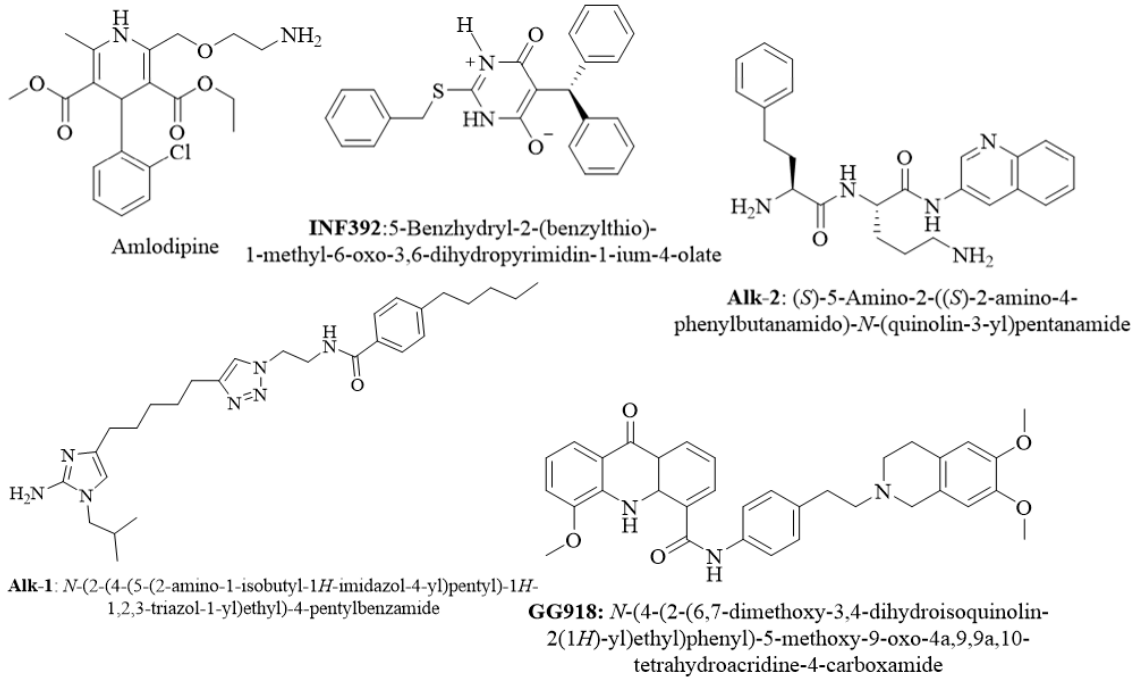


Figure 3. The most potently synergistic synthetic alkaloid/antibiotic combinations.

Tim Cushnie et *al*. (2014) have highlighted other alkaloids with development potential and have studied natural and synthetic alkaloids of all classes, focusing first on those with direct antibacterial activity and those that enhance antibiotic activity. Further studies have identified several potent antibacterial alkaloids (MIC ≤10 µg/mL) belonging to different classes, including: indole [64–69], quinoline[70, 71]isoquinoline[72–77], quinolone [78], piperazine [79], indolizidine [80], aaptamine[81, 82], and polyamine[83] as monomer classes. In addition, bispyrrole[84, 85], bisindole[86, 87], pyrrole-imidazole[88], aaptamine-indole[89], indole-quinoline [90, 91], and pyridoacridine [92, 93] were all found to contain alkaloid dimers with comparable levels of activity.

The major structural difference among the evocarpine E compounds was the substitution at C-2. The side chain carbon number reaching a certain number (>9) antibacterial activity appeared positive. When the side chain,

composed of 13 carbons, makes the antibacterial activity more optimal. It is worthy of note that the double bond and α,β-unsaturated carbonyl group on the aliphatic side chain reduce the antibacterial activity. Additionally, the keto-enol at position-3 of the quinolone skeleton in product evocarpine E exhibited low antibacterial activity compared to 1-methyl-2-nonyl-4(1*H*)-quinolone. Other indole derivatives, a *β*-carboline dimer (NCD9) and a simple indole dimer (5,6,6′-tribromo-1*H*,1′*H*-2,2′-biindole) have been synthesized, with respective MICs of 0.1-4.0 mg/mL [94] and 0.5 mg/mL [95] against Gram-positive pathogens. A list of some synthesized alkaloids as antimicrobial agents are summarized in **Table 5**.

Table 5: Some synthesized alkaloids as antimicrobial agents.

Compound	**Bioactivity**	**Bacterial strain**	**Ref**
Eudistomin Y1 Eudistomin Y8 Eudistomin Y9 Eudistomin Y10 Eudistomin Y11 Eudistomin Y12 Eudistomin Y13	Antibacterial	*Staphylococcus aureus* (ATCC 6538p), *Bacillus subtilis* (ATCC 6633), *Micrococcus luteus* (IFO 12708), *Salmonella typhimurium* (ATCC 14028), *Proteus vulgaris* (ATCC 3851), *Escherichia coli* (ATCC 35270),	[96]
	Antifungal	*Aspergillus fumigatus* (HIC 6094), *Trichophyton rubrum* (IFO 9185), *Trichophyton mentagrophytes* (IFO 40996), *Candida albicans* (ATCC 10231).	[96]
1-Methyl-2-tridecyl-4(1*H*)-quinolone [81], 1-Methyl-2-pentadecenyl-4(1*H*)-quinolone [81], 1-Methyl-2-[(*Z*)-5′-pentadecenyl]-4(1*H*)-quinolone [81].	Antibacterial	*Staphylococcus aureus* (ATCC 25923), *Staphylococcus epidermidis* (ATCC 12228), *Bacillus subtilis* (ATCC 6633),	[97]
O,*N*-tribenzyl dihydroisoquinolinium salt , 6,7-Bis(benzyloxy)-1,2-dimethylisoquinolin-2-ium , 6,7-Bis(benzyloxy)-1-ethyl-2-methylisoquinolin-2-ium , 3-(1-(3,4-dimethoxyphenyl) ethyl)-6,7-dimethoxy-2-methylisoquinolin-2-ium ,	Antibacterial	*Staphylococcus aureus,* *Bacillus subtilis,* *Salmonella enteritidis,* *Escherichia coli* (IFO 026), *Plasmodium falciparum,*	[98]
	Antifungal	*Candida albicans* (IFO 1061)	[98]

Continued

3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxy-2-methylisoquinolin-2-ium iodide , 3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxy-1,2-dimethylisoquinolin-2-ium iodide , 3-([1,1'-Biphenyl]-3-yl)-6,7,8-trimethoxy-1,2-dimethylisoquinolin-2-ium iodide, 3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxy-1,2-dimethylisoquinolin-2-ium iodide , 3-([1,1':4',1''-Terphenyl]-3-yl)-6,7-dimethoxy-1,2-dimethylisoquinolin-2-ium iodide , 3-(5,6-Dimethoxy-[1,1':4',1''-terphenyl]-3 -yl)-6,7,8-trimethoxy-1,2-dimethylisoquinolin-2-ium iodide , 3-(4'-(*t*-Butyl)-[1,1'-biphenyl]-3-yl)-6,7-dimethoxy-1,2-dimethylisoquinolin-2-ium iodide , 3-([1,1'-Biphenyl]-3-yl)-1-(dimethylamino)-6,7-dimethoxy-2-methylisoquinolin-2-ium iodide , 2-(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl) guanidine , (3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxy isoquinolin-1-yl) methanamine , 2-((3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxy isoquinolin-1-yl) methyl)guanidine , 2-(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxy isoquinolin-1-yl) ethanamine , 2-(2-(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxy isoquinolin-1-yl) ethyl)guanidine , (3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxy isoquinolin-1-yl) methanamine , 2-(3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxy isoquinolin-1-yl) ethanamine , N'-((3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxy isoquinolin-1-yl)methyl) acetimidamide, 2-((3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxyisoquinolin-1-yl)methyl) guanidine , 2-(2-(3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxyisoquinolin-1-yl)ethyl) guanidine, 2-((3-(4'-(*t*-Butyl)-[1,1'-biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl)methyl) guanidine.	Antibacterial	Methicillin-resistant *staphylococcus aureus* (MRSA), Methicillin-sensitive *Staphylococcus aureus* (MSSA), Vancomycin-resistant *enterococci faecalis* (VRE), Vancomycin-sensitive *enterococci faecalis* (VSE),	[99]
2-(2,8-Bis(trifluoromethyl)quinolin-4-yl)-5-methyl-2,4-dihydro-3*H*-pyrazol-3-one	Antibacterial	*M. tuberculosis* (MIC=6.25 µg/mL)	[100]

Continued

2-(5-(2-Chloro-6-fluoroquinolin-3-yl)-3-(4-fluorophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4(5*H*)-one	Antibacterial	*Escherichia coli* MTCC 443 (MIC=50 µg/mL), *Staphylococcus aureus* MTCC 96 (MIC=100 µg/mL), *Streptococcus pyogenes* MTCC 442 (MIC=25 µg/mL), *Pseudomonas aeruginosa* MTCC 1688 (MIC=50 µg/mL),	[101]
	Antifungal	*Aspergillus niger* MTCC 282 (MIC=250 µg/mL), *Aspergillus clavatus* MTCC 1323 (MIC=100 µg/mL),	[102]
2-(5-(2-Chloro-6-fluoroquinolin-3-yl)-3-(2-nitrophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4 (5*H*)-one	Antibacterial	*Escherichia coli* MTCC 443 (MIC=25 µg/mL), *Staphylococcus aureus* MTCC 96 (MIC=100 µg/mL), *Streptococcus pyogenes* MTCC 442 (MIC=25 µg/mL), *Pseudomonas aeruginosa* MTCC 1688 (MIC=12.5 µg/mL),	[103]
	Antifungal	*Aspergillus niger* MTCC 282 (MIC=25 µg/mL), *Aspergillus clavatus* MTCC 1323 (MIC=12.5 µg/mL), *Candida albicans* MTCC 227 (MIC=100 µg/mL),	[104]
(*E*)-4-((1*H*-Benzo [g] pyrazolo [3,4-*b*] quinolin-3-yl) diazenyl)-2- (3,4-dichlorophenyl)-5-methyl-2,4-dihydro-3*H*-pyrazol-3-one	Antibacterial	*E. coli* MTCC 739 (MIC=20 (50) µg/mL), *Staphylococcus aureus* MTCC 96 (MIC=20 (20) µg/mL), *Bacillus subtilis* MTCC 619 (MIC=24 (20) µg/mL), *Pseudomonas aeruginosa* MTCC 741 (MIC=21 (50) µg/mL),	[105]
	Antifungal	*Candida albicans* MTCC 183 (MIC=23 (50) µg/mL), *Aspergillus niger* MTCC 282 (MIC=22 (50) µg/mL),	[106]
7-Methoxy-1*H*-pyrazolo [3,4-*b*] quinolin-3-amine	Antibacterial	*Mycobacterium smegmatis* (MIC=50 nM),	[107]

Continued

(3-Amino-1*H*-[1,3]dioxolo [4,5-g] pyrazolo [3,4-*b*] quinolin-1-yl)(5-nitrofuran-2-yl) methanone	Antibacterial	*Mycobacterium smegmatis* (MIC= 4 µg/mL),	[108]
2-Amino-4-(5-chloro-3-methyl-1-(*p*-tolyl)-1*H*-pyrazol-4-yl)-1-(4-(4-fluorophenyl) thiazol-2-yl)-5-oxo-1,4,5,6,7,8-hexahydro quinoline-3-carbonitrile	Antibacterial	*Streptococcus pneumoniae* MTCC 1936 (MIC= 200 µg/mL), *Bacillus subtilis* MTCC 441 (MIC= 100 µg/mL), *Salmonella typhi* MTCC 98 (MIC= 100 µg/mL), *Escherichia coli* MTCC 443 (MIC= 50 µg/mL),	[109]
	Antifungal	*Candida albicans* MTCC 227 (MIC= 500 µg/mL),	[110]
2-(5-(2-Chloro-6-methyl quinolin-3-yl)-3-(2-nitrophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4(5*H*)-one	Antibacterial	*E. coli* MTCC 443 (MIC=25 ± 1.78 µg/mL), *Pseudomonas aeruginosa* MTCC 1688 (MIC=12.5 ± 3.78 µg/mL), *Staphylococcus aureus* MTCC 96 (MIC= 250 ± 1.78 µg/mL), *Streptococcus pyogenes* MTCC 442 (MIC= 25 ± 1.16 µg/mL),	[111]
	Antifungal	*Candida albicans* MTCC 227 (MIC=250 ± 4.72 µg/mL), *Aspergillus niger* MTCC 282 (MIC=50 ± 1.60 µg/mL), *Aspergillus clavatus* MTCC 1323 (MIC=12.5 ± 2.52 µg/mL),	[112]
2-Methyl-3-(1*H*-pyrazol-3-yl) quinoline	Antibacterial	*Mycobacterium smegmatis* ATCC 14468 (MIC = 14.66 ± 1.25 µg/mL)	[113]
1-Allyl-3-(1,7-bis(2,5-dichlorophenyl)-3,5-dimethyl-4,7-dihydro-1*H*-pyrano [2,3-c:6,5-c'] dipyrazol-4-yl) quinolin-2 (1*H*)-one	Antibacterial	*Streptococcus pneumoniae* MTCC 1936 (MIC = 50 µg/mL), *Clostridium tetani* MTCC 449 (MIC = 250 µg/mL), *Bacillus subtilis* MTCC 441 (MIC = 200 µg/mL), *Salmonella typhi* MTCC 98 (MIC = 100 µg/mL), *Vibrio cholerae* MTCC 3906 (MIC = 500 µg/mL), *Escherichia coli* MTCC 443 (MIC = 250 µg/mL),	[114]

Continued

2-Amino-4-(5-chloro-3-methyl-1-(*p*-tolyl)-1*H*-pyrazol-4-yl)-5-oxo-1-(pyridin-3-yl)-1,4,5,6,7,8-hexahydroquinoline-3-carbonitrile	Antibacterial	*Bacillus subtilis* ATCC6633 (MIC = 3.13 µg/mL), *Staphylococcus aureus* ATCC6538 (MIC = 6.25 µg/mL), *Escherichia coli* ATCC35218 (MIC = 1.56 µg/mL), *Pseudomonas aeruginosa* ATCC13525 (MIC = 50 µg/mL),	[115]
3-(1-(7-Chloroquinolin-4-yl)-1*H*-pyrazole-4-carbonyl)-1-methylquinolin-2(1*H*)-one	Antibacterial	*Staphylococcus aureus* ATCC 25923 d=10 mm (10 mg/mL), *Bacillus subtilis* ATCC 6635 d=13 mm (10 mg/mL), *Salmonella typhimurium* ATCC 14028 d=14 mm (10 mg/mL), *Escherichia coli* ATCC 25922 d=15 mm (10 mg/mL),	[116]
	Antifungal	*Aspergillus fumigatus* d=18 mm (10 mg/mL),	[116]
(*E*)-4-(2-((3-(4-Chlorophenyl)-1*H*-pyrazol-4-yl) methylene)hydrazinyl)-8-(trifluoromethyl) quinoline	Antibacterial	*Mycobacterium tuberculosis* (MIC = 12.5 µg/mL)	[117]
4-(3-(3-(4-Bromophenyl)-1-(4-fluorophenyl)-1*H*-pyrazol-5-yl) quinolin-2-yl) morpholine	Antibacterial	*Mycobacterium tuberculosis* (MIC = 47 µM)	[117]
1-(5-(3-((7-Chloroquinolin-4-yl) amino)phenyl)-3-(3,4,5-trimethoxyphenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) ethan-1-one	Antibacterial	*Neisseria gonorrhoeae* ATCC 31426 (MIC = 31.25 µg/mL).	[118]
2-(4-Phenyl-3-(trifluoromethyl)-1*H*-pyrazolo [3,4-*b*] quinolin-1-yl) -*N*-(2-(piperazin-1-yl)ethyl) acetamide	Antibacterial	*Staphylococcus aureus* MTCC 96 (MIC = 4.1± 0.22 µg/mL). *Bacillus subtilis* MTCC 121 (MIC = 2.2 ± 0.18 µg/mL). *Staphylococcus aureus* MLS16 MTCC 2940 (MIC = 2.1 ± 0.22 µg/mL). *Micrococcus luteus* MTCC 2470 (MIC = 2.5 ± 0.17 µg/mL). *Escherichia coli* MTCC 739 (MIC =	[119]

Continued

		4.2 ± 0.28 µg/mL). *Klebsiella planticola* MTCC 530 (MIC = 2.3 ± 0.11 µg/mL).	
	Antifungal	*Candida albicans* MTCC 4748 (MIC = 2.6 ± 0.11 µg/mL).	[120]
3-(2-(5-(2-Chloroquinolin-3-yl)-3-(2-fluorophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4-yl)-6-fluoro-2*H*-chromen-2-one	Antibacterial	*Staphylococcus aureus* ATCC 25923 (MIC = 25.89 ± 0.32 (50) µg/mL), *Enterococcus faecalis* ATCC 29212 (MIC = 23.25 ± 0.41 (50) µg/mL), *Staphylococcus epidermidis* ATCC 12228 (MIC = 26.25 ± 0.28 (50) µg/mL), *Bacillus subtilis* ATCC 6633 (MIC = 23.60 ± 0.34 (50) µg/mL), *Bacillus cereus* ATCC 9946 (MIC = 27.50 ± 0.35 (50) µg/mL), *Escherichia coli* ATCC 25922 (MIC = 27.50 ± 0.33 (50) µg/mL), *Pseudomonas aeruginosa* ATCC 27853 (MIC = 30.19 ± 0.32 (50) µg/mL), *Klebsiella pneumoniae* ATCC 700603 (MIC = 23.62 ± 0.36 (75) µg/mL), *Bordetella bronchiseptica* ATCC 4617 (MIC = 25.08 ± 0.29 (50) µg/mL), *Proteus vulgaris* ATCC 9920 (MIC = 24.93 ± 0.44 (75) µg/mL),	[121]
	Antifungal	*Candida albicans* ATCC 2091 (MIC = 27.90 ± 0.38 (50) µg/mL), *Aspergillus niger* MTCC 281 (MIC = 29.19 ± 0.27 (50) µg/mL), *Aspergillus flavus* MTCC 277 (MIC = 28.75 ± 0.46 (50) µg/mL), *Penicillium citrinum* NCIM 768 (MIC = 30.94 ± 0.32 (50) µg/mL), *Monascus purpureous* MTCC 369 (MIC = 30.19 ± 0.17 (50) µg/mL).	[121]
3-(2-(5-(2-Chloroquinolin-3-yl)-3-(4-fluorophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4-yl)-6-fluoro-2*H*-chromen-2-one	Antibacterial	*Staphylococcus aureus* ATCC 25923 (MIC = 27.52 ± 0.38 (50)µg/mL), *Enterococcus faecalis* ATCC 29212 (MIC = 25.94 ± 0.42 (50) µg/mL), *Staphylococcus epidermidis* ATCC 12228 (MIC = 29.43 ± 0.28 (50) µg/mL),	[121]

Continued

		Bacillus subtilis ATCC 6633 (MIC = 27.69 ± 0.49 (50) µg/mL), *Bacillus cereus* ATCC 9946 (MIC = 29.33 ± 0.39 (50) µg/mL), *Escherichia coli* ATCC 25922 (MIC = 27.50 ± 0.33 (50) µg/mL), *Pseudomonas aeruginosa* ATCC 27853 (MIC = 30.19 ± 0.32 (50) µg/mL), *Klebsiella pneumoniae* ATCC 700603(MIC = 23.62 ± 0.36 (75) µg/mL), *Bordetella bronchiseptica* ATCC 4617(MIC = 25.08 ± 0.29 (50) µg/mL), *Proteus vulgaris* ATCC 9920 (MIC = 24.93 ± 0.44 (75) µg/mL),	
	Antifungal	*Candida albicans* ATCC 2091 (MIC = 29.45 ± 0.47 (50) µg/mL), *Aspergillus niger* MTCC 281 (MIC = 29.42 ± 0.21 (50) µg/mL), *Aspergillus flavus* MTCC 277 (MIC = 29.05 ± 0.37 (50) µg/mL), *Penicillium citrinum* NCIM 768 (MIC = 30.99 ± 0.30 (50) µg/mL), *Monascus purpureous* MTCC 369 (MIC = 30.33 ± 0.35 (50) µg/mL).	[121]
3-((*E*)-(3-Methyl-4-((*Z*)-(4-nitrophenyl) diazenyl)-1*H*-pyrazol-5-yl) diazenyl) quinoline-2,4-diol	Antibacterial	*Klebsiella pneumonia* (d=15 mm with 0.1mg/mL), *S.aureus* ATCC25923 (d=16 mm with 0.1mg/mL), *S.aureus* (d=17.5 mm with 0.1mg/mL), *Proteus vulgaris* (d=12 mm with 0.1mg/mL), *Staphylococcus epidermis* (d=12 mm with 0.1mg/mL), *Staphylococcus haemolyticus* (d=15 mm with 0.1mg/mL), *Staphylococcus hominis* (d=12 mm with 0.1mg/mL),	[122]
161a: 2-(3,5-Dimethyl-1*H*-pyrazol-1-yl) quinoline-3-carbonitrile	Antibacterial	*Streptococcus pneumonia* (MIC = 200 µg/mL), *Bacillus subtilis* (MIC = 100 µg/mL), *Escherichia coli* (MIC = 400 µg/mL),	[123]
	Antifungal	*Aspergillus fumigates*	

Continued

		(MIC = 200 µg/mL), *Syncephalastrum racemosum* (MIC = 200 µg/mL), *Candida albicans* (MIC = 100 µg/mL),	
2-(3,5-Dimethyl-1*H*-pyrazol-1-yl)-6-methoxyquinoline-3-carbonitrile	Antibacterial	*Streptococcus pneumonia* (MIC = 200 µg/mL), *Bacillus subtilis* (MIC = 100 µg/mL), *Escherichia coli* (MIC = 400 µg/mL),	[124]
	Antifungal	*Aspergillus fumigates* (MIC = 200 µg/mL), *Syncephalastrum racemosum* (MIC = 200 µg/mL), *Candida albicans* (MIC = 100 µg/mL),	[124]
5-Amino-3-(2,4-dichlorophenyl)-1-(quinolin-2-yl)-1*H*-pyrazole-4-carbonitrile	Antibacterial	*Staphylococcus aureus* RCMB 010027 (MIC = 0.49 µg/mL), *Staphylococcus epidermidis* RCMB 010024 (MIC = 0.49 µg/mL), *Bacillis subtilis* RCMB 010063 (MIC = 0.12 µg/mL), *Proteous vulgaris* RCMB 010085 (MIC = 0.98 µg/mL), *Klebsiella pneumonia* RCMB 010093 (MIC = 0.49 µg/mL), *Shigella flexneri* RCMB 0100542 (MIC = 0.12 µg/mL),	[125]
	Antifungal	*Aspergillus fumigatus* RCMB 02564 (MIC = 0.98 µg/mL), *Aspergillus clavatus* RCMB 02593 (MIC = 0.49 µg/mL), *Candida albicans* RCMB 05035 (MIC = 0.12 µg/mL),	
3-(4-Hydroxy-2-oxo-1,2-dihydroquinolin-3-yl)-5-(4-methoxyphenyl)-4,5-dihydro-1*H*-pyrazole-1-carbothioamide	Antibacterial	*Staphylococcus aureus* (MIC = 0.5 µg/mL), *Bacillus subtilis* (MIC = 0.25 µg/mL), *Escherichia coli* (MIC = 0.125 µg/mL), *Pseudomonas aeruginosa* (MIC = 0.25 µg/mL),	[126]
	Antifungal	*Aspergillus flavus* (MIC = 32 µg/mL), *Trichoderma harzianum* (MIC = 16 µg/mL),	

Continued

		Penicillium chrysogenum (MIC = 16 µg/mL), *Candida albicans* (MIC = 32 µg/mL),	
3-(4-Hydroxy-2-oxo-1,2-dihydroquinolin-3-yl)-5-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazole-1-carbothioamide	Antibacterial	*Staphylococcus aureus* (MIC = 4 µg/mL), *Bacillus subtilis* (MIC = 4 µg/mL), *Escherichia coli* (MIC = 2 µg/mL), *Pseudomonas aeruginosa* (MIC = 2 µg/mL),	[126]
	Antifungal	*Aspergillus flavus* (MIC = 16 µg/mL), *Trichoderma harzianum* (MIC = 16 µg/mL), *Penicillium chrysogenum* (MIC = 16 µg/mL), *Candida albicans* (MIC = 16 µg/mL),	
5-(Furan-2-yl)-3-(4-hydroxy-2-oxo-1,2-dihydroquinolin-3-yl)-4,5-dihydro-1*H*-pyrazole-1-carbothioamide	Antibacterial	*Staphylococcus aureus* (MIC = 2 µg/mL), *Bacillus subtilis* (MIC = 1 µg/mL), *Escherichia coli* (MIC = 1 µg/mL), *Pseudomonas aeruginosa* (MIC = 1 µg/mL),	[126]
	Antifungal	*Aspergillus flavus* (MIC = 16 µg/mL), *Trichoderma harzianum* (MIC = 16 µg/mL), *Penicillium chrysogenum* (MIC = 16 µg/mL), *Candida albicans* (MIC = 32 µg/mL,	
5-(4-(Dimethylamino) phenyl)-3-(4-hydroxy-2-oxo-1,2-dihydroquinolin-3-yl)-4,5-dihydro-1*H*-pyrazole-1-carbothioamide	Antibacterial	*Staphylococcus aureus* (MIC = 0.5 µg/mL), *Bacillus subtilis* (MIC = 0.5 µg/mL), *Escherichia coli* (MIC = 0.125 µg/mL), *Pseudomonas aeruginosa* (MIC = 0.25 µg/mL),	[126]
	Antifungal	*Aspergillus flavus* (MIC = 32 µg/mL), *Trichoderma harzianum*	

Continued

		(MIC = 32 µg/mL), *Penicillium chrysogenum* (MIC = 64 µg/mL), *Candida albicans* (MIC = 64 µg/mL,	
2-(1-(4-Fluorophenyl)-3-phenyl-1*H*-pyrazol-4-yl) quinoline-4-carboxylic acid	Antibacterial	*Streptococcus pneumoniae* MTCC 1936(MIC = 125 µg/mL), *Clostridium tetani* MTCC 449 (MIC = 250 µg/mL), *Bacillus subtilis* MTCC 441 (MIC = 250 µg/mL), *Salmonella typhi* MTCC 98 (MIC = 200 µg/mL), *Vibrio cholerae* MTCC 3906 (MIC = 100 µg/mL), *Escherichia coli* MTCC 443 (MIC = 62.5 µg/mL),	[127]
	Antifungal	*Candida albicans* (MIC = 250 µg/mL), *Aspergillus fumigatus* (MIC = 500 µg/mL),	
8-Methyl-7,10-diphenyl-5*H*-benzo [*h*] pyrazolo [3,4-*b*] quinoline-5,6 (10*H*)-dione	Antibacterial	*Mycobacterium tuberculosis* H37Rv 27294 (MIC ≤2 µg/mL), *Mycobacterium tuberculosis* H37Rv 35837 (MIC ≤2 µg/mL), *Mycobacterium tuberculosis* H37Rv 35838 (MIC ≤2 µg/mL), *Mycobacterium tuberculosis* H37Rv 35822 (MIC ≤2 µg/mL), *Mycobacterium tuberculosis* H37Rv 35820 (MIC ≤2 µg/mL), *Mycobacterium tuberculosis* MTB2556 (MIC ≤2 µg/mL), *Mycobacterium tuberculosis* MTB4000 (MIC ≤2 µg/mL), *Mycobacterium tuberculosis* UT544 (MIC ≤2 µg/mL), *Mycobacterium tuberculosis* MTB411 (MIC = 4 µg/mL), *Mycobacterium tuberculosis* MTB985 (MIC ≤2 µg/mL),	[128]
N-((1*H*-Tetrazol-5-yl) methyl)-*N*-(2-chlorobenzyl) aniline	Antibacterial	*Staphylococcus aureus* ATCC25923 (MIC = 32 µg/mL), Methicillinresistant *Staphylococcus aureus* N315 (MIC = 32 µg/mL), *Bacillus subtilis* ATCC6633 (MIC = 16 µg/mL),	[129]

Continued

		Micrococcus luteus ATCC 4698 (MIC = 32 µg/mL), *Bacillus proteus* ATCC13315 (MIC = 16 µg/mL), *Escherichia coli* DH52 (MIC = 16 µg/mL), *Shigella dysenteriae* ATCC51252 (MIC = 32 µg/mL), *Pseudomonas aeruginosa* ATCC27853 (MIC = 16 µg/mL), *Bacillus proteus* ATCC13315 (MIC = 16 µg/mL),	
	Antifungal	*Candida albicans* ATCC90029 (MIC = 8 µg/mL), *Candida mycoderma* (MIC = 4 µg/mL), *Candida utilis* ATCC9950 (MIC = 4 µg/mL), *Aspergillus flavus* (MIC = 8 µg/mL).	[129]
N-((1*H*-Tetrazol-5-yl) ethyl)-*N*-decylaniline	Antibacterial	*Staphylococcus aureus* ATCC25923 (MIC = 64 µg/mL), Methicillinresistant *Staphylococcus aureus* N315(MIC = 32 µg/mL), *Bacillus subtilis* ATCC6633 (MIC = 32 µg/mL), *Micrococcus luteus* ATCC 4698 (MIC = 32 µg/mL), *Bacillus proteus* ATCC13315 (MIC = 64 µg/mL), *Escherichia coli* DH52 (MIC = 32 µg/mL), *Shigella dysenteriae* ATCC51252 (MIC = 64 µg/mL), *Pseudomonas aeruginosa* ATCC27853(MIC = 128 µg/mL), *Bacillus proteus* ATCC13315 (MIC = 64 µg/mL),	
	Antifungal	*Candida albicans* ATCC90029 (MIC = 32 µg/mL), *Candida mycoderma* (MIC = 16 µg/mL), *Candida utilis* ATCC9950 (MIC = 32 µg/mL), *Aspergillus flavus* (MIC = 32 µg/mL),	
1,1'-(2,5-Dibromo-1,3-phenylene)	Antibacterial	*Staphylococcus aureus* ATCC	

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dipyrrolidine		25923 (MIC = 32 µg/mL), *Bacillus subtilis* ATCC 6633 (MIC = 128 µg/mL), *Yersinia enterocolitica* ATCC 1501 (MIC = 256 µg/mL), *Escherichia coli* ATCC 11230 (MIC = 256 µg/mL), *Klebsiella pneumoniae* (MIC = 256 µg/mL),	[130]
	Antifungal	*Candida albicans* (MIC = 32 µg/mL),	[130]
1,1'-(2,5-Dibromo-4-chloro-1,3-phenylene) dipyrrolidine	Antibacterial	*Staphylococcus aureus* ATCC 25923 (MIC = 32 µg/mL), *Bacillus subtilis* ATCC 6633 (MIC = 32 µg/mL), *Yersinia enterocolitica* ATCC 1501 (MIC = 128 µg/mL), *Escherichia coli* ATCC 11230 (MIC = 64 µg/mL), *Klebsiella pneumoniae* (MIC = 256 µg/mL),	[130]
	Antifungal	*Candida albicans* (MIC = 32 µg/mL),	[130]
(*E*)-1-(2-Hydroxynaphthalen-1-yl)-3-(2-(pyrrolidin-1-yl) quinolin-3-yl) prop-2-en-1-one	Antibacterial	*Staphylococcus aureus* (d=11.6 mm at 100 µg/mL), *Escherichia coli* (d=11.6 mm at 100 µg/mL),	[131]
	Antifungal	*Aspergillus niger* (d=18.4 mm at 100 µg/mL), *Candida metapsilosis* (d=19.1 mm at 100 µg/mL),	[131]
(*E*)-1-(1-Hydroxynaphthalen-2-yl)-3-(2-(pyrrolidin-1-yl) quinolin-3-yl) prop-2-en-1-one	Antibacterial	*Staphylococcus aureus* (d=12.1 mm at 100 µg/mL), *Escherichia coli* (d=12.6 mm at 100 µg/mL),	[131]
	Antifungal	*Aspergillus niger* (d=18.9 mm at 100 µg/mL), *Candida metapsilosis* (d=17.9 mm at 100 µg/mL),	[131]
5-Phenyl-2-(3-(2-(*m*-tolyl) pyrrolidin-1-yl) propyl)-2*H*-tetrazole	Antibacterial	*Candida albicans* (MIC=46.05µM),	[132]

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5-Phenyl-2-(3-(2-(*m*-tolyl) pyrrolidin-1-yl) propyl)-2*H*-tetrazole	Antibacterial	*Candida albicans* (MIC=41.47µM),	[132]
1-(2-(2-(4-Fluorophenyl)-4,5-dimethyl-1*H*-imidazol-1-yl) ethyl) piperazine	Antibacterial	*Staphylococcus aureus* (d=14 mm at 1000 µg/mL), *Escherichia coli* (d=15 mm at 1000 µg/mL), *Pseudomonas aeruginosa* (d=16 mm at 1000 µg/mL), *Salmonella typhi* (d=15 mm at 1000 µg/mL),	[133]
	Antifungal	*Aspergillus niger* (d=22 mm at 1000 µg/mL), *Aspergillus flavus* (d=16 mm at 1000 µg/mL), *Candida albicans* (d=20 mm at 1000 µg/mL), *Rhizopus. Sp* (d=17 mm at 1000 µg/mL),	[133]
1-(2-(2-(4-Chlorophenyl)-4,5-dimethyl-1*H*-imidazol-1-yl) ethyl) piperazine	Antibacterial	*Staphylococcus aureus* (d=15 mm at 1000 µg/mL), *Escherichia coli* (d=15 mm at 1000 µg/mL), *Pseudomonas aeruginosa* (d=18 mm at 1000 µg/mL), *Salmonella typhi* (d=16 mm at 1000 µg/mL),	[133]
	Antifungal	*Aspergillus niger* (d=20 mm at 1000 µg/mL), *Aspergillus flavus* (d=18 mm at 1000 µg/mL), *Candida albicans* (d=18 mm at 1000 µg/mL), *Rhizopus. Sp* (d=16 mm at 1000 µg/mL),	[133]
1-(2-(2-(3-Bromo-4-fluorophenyl)-4,5-dimethyl-1*H*-imidazol-1-yl) ethyl) piperazine	Antibacterial	*Staphylococcus aureus* (d=16 mm at 1000 µg/mL), *Escherichia coli* (d=16 mm at 1000 µg/mL), *Pseudomonas aeruginosa* (d=15 mm at 1000 µg/mL), *Salmonella typhi* (d=18 mm at 1000 µg/mL),	[133]
	Antifungal	*Aspergillus niger* (d=21 mm at 1000 µg/mL), *Aspergillus flavus* (d=19 mm at 1000 µg/mL), *Candida albicans*	[133]

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		(d=19 mm at 1000 µg/mL), *Rhizopus. Sp* (d=18 mm at 1000 µg/mL),	
1-(2-(4,5-Dimethyl-2-(thiophen-2-yl)-1*H*-imidazol-1-yl) ethyl) piperazine	Antibacterial	*Staphylococcus aureus* (d=15 mm at 1000 µg/mL), *Escherichia coli* (d=16 mm at 1000 µg/mL), *Pseudomonas aeruginosa* (d=17 mm at 1000 µg/mL), *Salmonella typhi* (d=14 mm at 1000 µg/mL),	[133]
	Antifungal	*Aspergillus niger* (d=16 mm at 1000 µg/mL), *Aspergillus flavus* (d=20 mm at 1000 µg/mL), *Candida albicans* (d=20 mm at 1000 µg/mL), *Rhizopus. Sp* (d=17 mm at 1000 µg/mL),	[133]
2-((4-(1*H*-Imidazol-1-yl) phenyl) amino)-2-oxoethyl 4-(4-methoxybenzyl) piperazine-1-carbodithioate	Antifungal	*Candida albicans* ATCC 24433 (MIC = 1.56 µg/mL), *Candida krusei* ATCC 6258 (MIC = 0.78 µg/mL), *Candida parapsilosis* ATCC 22019 (MIC = 1.56 µg/mL), *Candida glabrata* ATCC 90030 (MIC = 3.125 µg/mL),	[134]
2-(1*H*-Imidazol-1-yl)-1-(4-methoxyphenyl) ethan-1-one	Antifungal	*Candida albicans* (I% = 79 %), *Aspergillus fumigatus* (I% = 72 %),	[135]
2-(1*H*-Imidazol-1-yl)-1-(4-methoxyphenyl) ethan-1-ol	Antifungal	*Candida albicans* (I% = 74 %), *Aspergillus fumigatus* (I% = 73 %),	[135]
1-(2,4-Difluorophenyl)-2-(1*H*-1,2,4-triazol-1-yl) ethan-1-one	Antifungal	*Candida albicans* (I% = 81 %), *Aspergillus fumigatus* (I% = 78 %),	[135]
(*E*)-2-(4-(2,5-Dichlorothiophen-3-yl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 63 %), *Botryotinia fuckeliana* (I% = 36 %), *Erysiphe necator* (I% = 96 %), *Zymoseptoria tritici* (I% = 10 %),	[136]
(*E*)-2-(4-(4-Chloro-1-methyl-5-(trifluoromethyl)-1*H*-pyrazol-3-yl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 97 %), *Botryotinia fuckeliana* (I% = 96 %), *Erysiphe necator* (I% = 100 %), *Zymoseptoria tritici* (I% = 75 %),	[136]
(*E*)-2-(4-(5-Chloropyrimidin-2-yl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl)	Antifungal	*Alternaria solani* (I% = 42 %), *Botryotinia fuckeliana* (I% = 38 %),	[136]

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acetonitrile		*Erysiphe necator* (I% = 96 %), *Zymoseptoria tritici* (I% = 35 %),	
(*E*)-2-(4-(2-chlorophenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 93 %), *Botryotinia fuckeliana* (I% = 91 %), *Erysiphe necator* (I% = 99 %), *Zymoseptoria tritici* (I% = 40 %),	[136]
(E)-2-(4-(4-((1l5-Cyclopropylidyne) methyl)-2-chlorophenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 69 %), *Botryotinia fuckeliana* (I% = 4 %), *Erysiphe necator* (I% = 25 %), *Zymoseptoria tritici* (I% = 40 %),	[136]
(*E*)-2-(4-(2-Chloro-4-(prop-2-yn-1-yloxy) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 97 %), *Botryotinia fuckeliana* (I% = 91 %), *Erysiphe necator* (I% = 100 %), *Zymoseptoria tritici* (I% = 70 %)	[136]
(*E*)-2-(4-(2-Chloro-4-(1*H*-pyrazol-1-yl) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 68 %), *Botryotinia fuckeliana* (I% = 94 %), *Erysiphe necator* (I% = 94 %), *Zymoseptoria tritici* (I% = 55 %)	[136]
(*E*)-2-(4-(2-Chloro-4-(pyrimidin-2-yl) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 93 %), *Botryotinia fuckeliana* (I% = 97 %), *Erysiphe necator* (I% = 99 %), *Zymoseptoria tritici* (I% = 90 %)	[136]
(*E*)-2-(4-(2-Chloro-4-((5-(trifluoromethyl) pyrazin-2-yl)oxy)phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 62 %), *Botryotinia fuckeliana* (I% = 31 %), *Erysiphe necator* (I% = 98 %), *Zymoseptoria tritici* (I% = 80 %)	[136]
(*E*)-2-(4-(2-Chloro-4-((5-chloropyrimidin-2-yl) oxy) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 96 %), *Botryotinia fuckeliana* (I% = 94 %), *Erysiphe necator* (I% = 88 %), *Zymoseptoria tritici* (I% = 55 %)	[136]
(*E*)-2-(4-(2-Chloro-4-((6-methoxypyridazin-3-yl)oxy)phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 29 %), *Botryotinia fuckeliana* (I% = 38 %), *Zymoseptoria tritici* (I% = 10 %)	[136]
(*E*)-6-(3-Chloro-4-(2-(cyano(1*H*-imidazol-1-yl)methylene)-1,3-dithiolan-4-yl) phenoxy) nicotinonitrile	Antifungal	*Alternaria solani* (I% = 79 %), *Botryotinia fuckeliana* (I% = 44 %), *Erysiphe necator* (I% = 67 %), *Zymoseptoria tritici* (I% = 70 %)	[136]
(*E*)-2-(4-(4-(But-2-yn-1-yloxy)-2-chlorophenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 81 %), *Botryotinia fuckeliana* (I% = 50 %), *Erysiphe necator* (I% = 63 %), *Zymoseptoria tritici* (I% = 45 %)	[136]

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(*E*)-2-(4-(2-Chloro-4-(prop-2-yn-1-yloxy) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 97 %), *Botryotinia fuckeliana* (I% = 91 %), *Erysiphe necator* (I% = 100 %), *Zymoseptoria tritici* (I% = 70 %)	[136]
(*E*)-2-(4-(4-(But-3-yn-2-yloxy)-2-chlorophenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 94 %), *Erysiphe necator* (I% = 63 %), *Zymoseptoria tritici* (I% = 38 %)	[136]
(*E*)-2-(4-(2-Chloro-3-fluoro-4-(prop-2-yn-1-yloxy)phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antibacterial	*Alternaria solani* (I% = 97 %), *Botryotinia fuckeliana* (I% = 93 %), *Erysiphe necator* (I% = 99 %), *Zymoseptoria tritici* (I% = 98 %),	[136]
(*E*)-2-(4-(2,3-Dichloro-4-(prop-2-yn-1-yloxy)phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 91 %), *Botryotinia fuckeliana* (I% = 75 %), *Erysiphe necator* (I% = 19 %), *Zymoseptoria tritici* (I% = 75 %),	[136]
(*E*)-2-(4-(2-Chloro-3-methyl-4-(prop-2-yn-1-yloxy) phenyl)-1,3-dithiolan-2-ylidene) -2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 86 %), *Botryotinia fuckeliana* (I% = 99 %), *Erysiphe necator* (I% = 38 %), *Zymoseptoria tritici* (I% = 85 %),	[136]
(*E*)-2-(4-(2-chloro-3,4-bis(prop-2-yn-1-yloxy)phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 91 %), *Botryotinia fuckeliana* (I% = 6 %), *Erysiphe necator* (I% = 75 %), *Zymoseptoria tritici* (I% = 31 %),	[136]
(*E*)-2-(4-(2-chlorophenyl)-1,3-dithiolan-2-ylidene) -2-(4-methyl-1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 97 %), *Botryotinia fuckeliana* (I% = 69 %), *Erysiphe necator* (I% = 99 %), *Zymoseptoria tritici* (I% = 74 %),	[136]
(*E*)-2-(4-(2-Chlorophenyl)-1,3-dithiolan-2-ylidene) -2-(1*H*-imidazol-1-yl) acetonitrile	Antifungal	*Alternaria solani* (I% = 93 %), *Botryotinia fuckeliana* (I% = 91 %), *Erysiphe necator* (I% = 99 %), *Zymoseptoria tritici* (I% = 40 %),	[136]
(*E*)-2-(2,4-Dichlorophenyl)-*N'*-(2-fluorobenzylidene)-1-propyl-1*H*-indene-6-carbohydrazide	Antibacterial	*Staphylococcus aureus* MIC=12.5 µg/mL (17-20 mm), *Bacillus subtilis* MIC= 6.25 µg/mL (19-22 mm), *Escherichia coli* MIC= 6.25 µg/mL (20-25 mm), *Klebsiella pneumonia* MIC= 12.5 µg/mL (18-21 mm),	[137]
	Antifungal	*Aspergillus niger* MIC= 3.12 µg/mL (22-26 mm), *Candida tropicalis* MIC= 6.25 µg/mL (18-22 mm),	[137]

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		Candida albicans MIC= 6.25 µg/mL (19-22 mm), *Pencillium notatum* MIC= 12.5 µg/mL (16-20 mm),	
(*E*)-2-(2,4-Dichlorophenyl)-*N'*-(4-fluorobenzylidene)-1-propyl-1*H*-indene-6-carbohydrazide	Antibacterial	*Staphylococcus aureus* MIC=6.25 µg/mL (20-24 mm), *Bacillus subtilis* MIC= 6.25 µg/mL (19-22 mm), *Escherichia coli* MIC= 6.25 µg/mL (20-24 mm), *Klebsiella pneumonia* MIC= 2.25 µg/mL (19-22 mm),	[137]
	Antifungal	*Aspergillus niger* MIC= 6.25 µg/mL (20-24 mm), *Candida tropicalis* MIC= 6.25 µg/mL (18-22 mm), *Candida albicans* MIC= 6.25 µg/mL (18-21 mm), *Pencillium notatum* MIC= 25 µg/mL (15-19 mm),	[137]
(*E*)-2-(2,4-Dichlorophenyl)-*N'*-(4-methylbenzylidene)-1-propyl-1*H*-indene-6-carbohydrazide	Antibacterial	*Staphylococcus aureus* MIC=6.25 µg/mL (20-24 mm), *Bacillus subtilis* MIC= 12.5 µg/mL (17-20 mm), *Escherichia coli* MIC= 12.5 µg/mL (18-22 mm), *Klebsiella pneumonia* MIC= 6.25 µg/mL (18-22 mm),	[137]
	Antifungal	*Aspergillus niger* MIC= 3.12 µg/mL (22-26 mm), *Candida tropicalis* MIC= 6.25 µg/mL (18-22 mm), *Candida albicans* MIC= 12.5 µg/mL (16-20mm), *Pencillium notatum* MIC= 6.25 µg/mL (17-21 mm),	[137]
(*E*)-*N'*-(5-Bromo-2-hydroxybenzylidene)-2-(2,4-dichlorophenyl) -1-propyl-1*H*-indene-6-carbohydrazide	Antibacterial	*Staphylococcus aureus* MIC=3.12 µg/mL (22-26mm), *Bacillus subtilis* MIC=3.12 µg/mL (22-25 mm), *Escherichia coli* MIC=3.12 µg/mL (22-26 mm), *Klebsiella pneumonia* MIC= 6.25 µg/mL (20-23 mm),	[137]
	Antifungal	*Aspergillus niger* MIC= 3.12 µg/mL (22-26 mm),	[137]

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		Candida tropicalis MIC= 6.25 µg/mL (18-22 mm), *Candida albicans* MIC= 3.12 µg/mL (21-25mm), *Pencillium notatum* MIC= 6.25 µg/mL (18-22 mm),	
(*Z*)-5-Amino-6-(benzo [*d*] thiazol-2-yl)-2-(2-(4-chlorobenzylidene) hydrazineyl)-7-(4-chlorophenyl)-4a,8a-dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one	Antibacterial	*Staphylococcus aureus* (MIC = 25 µg/mL), *Escherichia coli* (MIC = 25 µg/mL), *Klebsiella pneumoniae* (MIC = 50 µg/mL), *Pseudomonas aeruginosa* (MIC = 50 µg/mL), *Streptococcus pyogenes* (MIC = 25 µg/mL),	[137]
	Antifungal	*Aspergillus flavus* (MIC = 25 µg/mL), *Aspergillus fumigatus* (MIC = 50 µg/mL), *Candida albicans* (MIC = 50 µg/mL), *Penicillium marneffei* (MIC = 25 µg/mL), *Mucor* (MIC = 50 µg/mL),	[138]
(*Z*)-5-Amino-6-(benzo[*d*]thiazol-2-yl)-2-(2-(2-chlorobenzylidene)hydrazineyl)-7-(4-chlorophenyl)-4a,8a-dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one	Antibacterial	*Staphylococcus aureus* (MIC = 25 µg/mL), *Escherichia coli* (MIC = 25 µg/mL), *Klebsiella pneumoniae* (MIC = 50 µg/mL), *Pseudomonas aeruginosa* (MIC = 50 µg/mL), *Streptococcus pyogenes* (MIC = 25 µg/mL),	[138]
	Antifungal	*Aspergillus flavus* (MIC = 25 µg/mL), *Aspergillus fumigatus* (MIC = 100 µg/mL), *Candida albicans* (MIC = 50 µg/mL), *Penicillium marneffei* (MIC = 50 µg/mL), *Mucor* (MIC = 50 µg/mL),	[138]
(*Z*)-5-Amino-7-(4-chlorophenyl)-2-(2-(4-	Antibacterial	*Staphylococcus aureus*	

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fluorobenzylidene)hydrazineyl)-6-(4,5,6,7-tetrahydrobenzo [*d*] thiazol-2-yl)-4a,8a-dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one		(MIC = 12.5 µg/mL), *Escherichia coli* (MIC = 25 µg/mL), *Klebsiella pneumoniae* (MIC = 25 µg/mL), *Pseudomonas aeruginosa* (MIC = 25 µg/mL), *Streptococcus pyogenes* (MIC = 12.5 µg/mL),	[138]
	Antifungal	*Aspergillus flavus* (MIC = 12.5 µg/mL), *Aspergillus fumigatus* (MIC = 12.5 µg/mL), *Candida albicans* (MIC = 25 µg/mL), *Penicillium marneffei* (MIC = 25 µg/mL), *Mucor* (MIC = 12.5 µg/mL),	[138]
(*Z*)-5-Amino-6-(benzo[*d*] thiazol-2-yl)-7-(4-chlorophenyl)-2-(2-(4-nitrobenzylidene)hydrazineyl)-4a,8a-dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one	Antibacterial	*Staphylococcus aureus* (MIC = 12.5 µg/mL), *Escherichia coli* (MIC = 12.5 µg/mL), *Klebsiella pneumoniae* (MIC = 12.5 µg/mL), *Pseudomonas aeruginosa* (MIC = 12.5 µg/mL), *Streptococcus pyogenes* (MIC = 12.5 µg/mL),	[138]
	Antifungal	*Aspergillus flavus* (MIC = 12.5 µg/mL), *Aspergillus fumigatus* (MIC = 12.5 µg/mL), *Candida albicans* (MIC =12.5 µg/mL), *Penicillium marneffei* (MIC = 12.5 µg/mL), *Mucor* (MIC = 12.5 µg/mL),	[138]
(*Z*)-5-Amino-2-(2-(4-aminobenzylidene) hydrazineyl)-6-(benzo [*d*] thiazol-2-yl)-7-(4-chlorophenyl)-4a,8a -dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one	Antibacterial	*Staphylococcus aureus* (MIC = 25 µg/mL), *Escherichia coli* (MIC = 12.5 µg/mL), *Klebsiella pneumoniae* (MIC = 12.5 µg/mL), *Pseudomonas aeruginosa* (MIC =25 µg/mL), *Streptococcus pyogenes*	[138]

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		(MIC = 12.5 µg/mL),	
	Antifungal	*Aspergillus flavus* (MIC = 25 µg/mL), *Aspergillus fumigatus* (MIC = 12.5 µg/mL), *Candida albicans* (MIC =25 µg/mL), *Penicillium marneffei* (MIC = 12.5 µg/mL), *Mucor* (MIC = 25 µg/mL),	[138]
2-((4-(Trifluoromethyl) benzyl) thio) benzo [*d*] thiazole	Antifungal	*Botrytis cinerea* (IC_{50}=10.3 ± 1.7µM), *Fusarium oxysporum* (IC_{50}=57 ± 5µM), *Aspergillus niger* (IC_{50}=34 ± 7µM), *Aspergillus terreus* (IC_{50}=40 ± 6µM), *Aspergillus ustus* (IC_{50}=0.0119 ± 0.0015µM)	[139]
4-((Benzo [*d*] thiazol-2-ylthio) methyl) benzonitrile	Antifungal	*Botrytis cinerea* (IC_{50}=4 ± 7µM), *Fusarium oxysporum* (IC_{50}=7.2 ± 1.2µM), *Aspergillus fumigatus* (IC_{50}=165 ± 12µM), *Aspergillus terreus* (IC_{50}=22 ± 4µM), *Aspergillus ustus* (IC_{50}=92 ±12µM),	[139]
2-((4-Methylbenzyl) thio) benzo [*d*] thiazole	Antifungal	*Botrytis cinerea* (IC_{50}=20 ± 6µM), *Fusarium oxysporum* (IC_{50}=79 ± 7µM), *Aspergillus fumigatus* (IC_{50}=29 ± 9µM), *Aspergillus niger* (IC_{50}=35 ± 11µM), *Aspergillus ustus* (IC_{50}=62 ±18µM),	[139]
2-(Benzylthio) benzo [*d*] oxazole	Antifungal	*Fusarium oxysporum* (IC_{50}=3 ± 2µM), *Aspergillus fumigatus* (IC_{50}=205 ± 16µM), *Aspergillus niger* (IC_{50}=60 ± 21µM),	[139]

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		Aspergillus terreus (IC_{50}=93 ± 7µM), *Aspergillus ustus* (IC_{50}=173 ±13µM),	
6-Benzyl-3-(2-chlorophenyl)-[1,2,4] triazolo [3,4-*b*][1,3,4] thiadiazole	Antibacterial	*Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*	[140]
	Antifungal	*Candida albicans*, *Aspergillus niger*	[140]
6-Benzyl-3-(3-chlorophenyl)-[1,2,4] triazolo [3,4-*b*][1,3,4] thiadiazole	Antibacterial	*Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*	[140]
	Antifungal	*Candida albicans*, *Aspergillus niger*	[140]
3-(2-Bromophenyl)-6-phenyl-[1,2,4] triazolo[3,4-*b*][1,3,4] thiadiazole	Antibacterial	*Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*	[140]
	Antifungal	*Candida albicans*, *Aspergillus niger*	[140]
6-Benzyl-3-(2,4-dichlorophenyl)-[1,2,4] triazolo [3,4-*b*][1,3,4] thiadiazole	Antibacterial	. *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*	[140]
	Antifungal	*Candida albicans*, *Aspergillus niger*	[140]
(*E*)-1-(9-((2-Chlorobenzyl) oxy)-10-methoxy-5,8,13,13a-tetrahydro-6*H*-[1,3] dioxolo [4,5-*g*] isoquinolino [3,2-*a*] isoquinolin-12-yl)-*N*-(4*H*-1,2,4-triazol-4-yl) methanimine	Antibacterial	*Staphylococcus aureus* ATCC25923 (MIC=16 µg/mL), methicillin-resistant *Staphylococcus aureus* N315 (MIC=16 µg/mL), *Bacillus subtilis* ATCC6633 (MIC=32 µg/mL), *Micrococcus luteus* ATCC4698 (MIC=256 µg/mL), *Escherichia coli* JM109 (MIC=4 µg/mL), *Escherichia coli* DH52 (MIC=64 µg/mL), *Shigella dysenteriae* (MIC=16 µg/mL), *Pseudomonas aeruginosa* ATCC27853 (MIC=2 µg/mL),	[141]

Continued

		Bacillus proteus ATCC13315 (MIC=512 µg/mL), *Bacillus typhi* (MIC=1 µg/mL),	
(*E*)-1-(9-((3-Chlorobenzyl)oxy)-10-methoxy-5,8,13,13a-tetrahydro-6*H*-[1,3] dioxolo [4,5-g] isoquinolino[3,2-a] isoquinolin-12-yl)-*N*-(4*H*-1,2,4-triazol-4-yl) methanimine	Antibacterial	*Staphylococcus aureus* ATCC25923 (MIC=256 µg/mL), methicillin-resistant *Staphylococcus aureus* N315 (MIC=256 µg/mL), *Bacillus subtilis* ATCC6633 (MIC=512 µg/mL), *Micrococcus luteus* ATCC4698 (MIC=512 µg/mL), *Escherichia coli* JM109 (MIC=0.5 µg/mL), *Escherichia coli* DH52 (MIC=512 µg/mL), *Shigella dysenteriae* (MIC=64 µg/mL), *Pseudomonas aeruginosa* ATCC27853 (MIC=512 µg/mL), *Bacillus proteus* ATCC13315 (MIC=512 µg/mL), *Bacillus typhi* (MIC=256 µg/mL),	[141]
(*E*)-1-(9-((2-Bromobenzyl)oxy)-10-methoxy-5,8,13,13a-tetrahydro-6*H*-[1,3] dioxolo [4,5-*g*] isoquinolino [3,2-*a*] isoquinolin-12-yl)-*N*-(4*H*-1,2,4-triazol-4-yl) methanimine	Antibacterial	*Staphylococcus aureus* ATCC25923 (MIC=8 µg/mL), methicillin-resistant *Staphylococcus aureus* N315 (MIC=32 µg/mL), *Bacillus subtilis* ATCC6633 (MIC=16 µg/mL), *Micrococcus luteus* ATCC4698 (MIC=16 µg/mL), *Escherichia coli* JM109 (MIC=8 µg/mL), *Escherichia coli* DH52 (MIC=32 µg/mL), *Shigella dysenteriae* (MIC=4 µg/mL), *Pseudomonas aeruginosa* ATCC27853 (MIC=512 µg/mL), *Bacillus proteus* ATCC13315 (MIC=8 µg/mL), *Bacillus typhi* (MIC=8 µg/mL),	[142]
(*E*)-1-(9-((2,4-Dichlorobenzyl)oxy)-10-methoxy-5,8,13,13*a*-tetrahydro-6*H*-[1,3] dioxolo[4,5-*g*] isoquinolino[3,2-*a*] isoquinolin-12-yl)-*N*-(4*H*-1,2,4-triazol-4-yl) methanimine	Antibacterial	*Staphylococcus aureus* ATCC25923 (MIC=16 µg/mL), methicillin-resistant *Staphylococcus aureus* N315 (MIC=8 µg/mL), *Bacillus subtilis* ATCC6633 (MIC=32 µg/mL), *Micrococcus luteus* ATCC4698	[141]

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		(MIC=128 µg/mL), *Escherichia coli* JM109 (MIC=16 µg/mL), *Escherichia coli* DH52 (MIC=256 µg/mL), *Shigella dysenteriae* (MIC=512 µg/mL), *Pseudomonas aeruginosa* ATCC27853 (MIC=32 µg/mL), *Bacillus proteus* ATCC13315 (MIC=32 µg/mL), *Bacillus typhi* (MIC=32 µg/mL),	
(*E*)-2-((1*H*-Benzo [*d*] [1,2,3] triazol-5-yl) diazenyl)-5-(*tert*-butyl) phenol	Antibacterial	*Botrytis cinerea* (I%= 29.7 ± 1.8%)	[143]
5,5'-bis((*E*)-(1*H*-Benzo[*d*] [1,2,3] triazol-5-yl) diazenyl)-[1,1'-biphenyl]-2,2'-diol	Antibacterial	*Botrytis cinerea* (I%= 48.8 ± 2.4 %)	[143]
(*E*)-2-((1*H*-Benzo [*d*][1,2,3] triazol-5-yl) diazenyl)-6-chloroaniline	Antibacterial	*Botrytis cinerea* (I%= 40.7 ± 2.4 %)	[143]
(*E*)-4-((1*H*-Benzo[*d*][1,2,3] triazol-5-yl) diazenyl)-2-chloroaniline	Antibacterial	*Botrytis cinerea* (I%= 56.1 ± 3.2 %)	[143]
(*E*)-4-((1*H*-Benzo[*d*][1,2,3] triazol-5-yl) diazenyl)-2-methylphenol	Antibacterial	*Botrytis cinerea* (I%= 70.7 ± 2.5 %).	[143]
1-((1*H*-Imidazol-1-yl)(phenyl) methyl)-2-(2,4-dinitrophenyl) pyrazolidine-3,5-dione	Antibacterial	*S. aureus* (MIC=64 µg/mL), *E. coli* (MIC >100 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC=32 µg/mL).	[145]
1-((4-Chlorophenyl)(1*H*-imidazol-1-yl) methyl)-2-(2,4-dinitrophenyl) pyrazolidine-3,5-dione	Antibacterial	*S. aureus* (MIC=16 µg/mL), *E. coli* (MIC >100 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC=16 µg/mL).	[145]
1-(2,4-Dinitrophenyl)-2-((4-hydroxyphenyl) (1*H*-imidazol-1-yl) methyl) pyrazolidine-3,5-dione	Antibacterial	*S. aureus* (MIC=64 µg/mL), *E. coli* (MIC=4 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC=32 µg/mL).	[145]
1-((1*H*-imidazol-1-yl) (4-nitrophenyl) methyl)-2-(2,4-dinitrophenyl)pyrazolidine -3,5-dione	Antibacterial	*S. aureus* (MIC=32 µg/mL), *E. coli* (MIC=8 µg/mL), *E. faecalis* (MIC=16 µg/mL), *P. aeruginosa* (MIC=2 µg/mL), *K. pneumoniae* (MIC >100 µg/mL).	[145]

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1-((1*H*-Imidazol-1-yl)(4-methoxyphenyl) methyl) -2-(2,4-dinitrophenyl) pyrazolidine-3,5-dione	Antibacterial	*S. aureus* (MIC=16 µg/mL), *E. coli* (MIC=32 µg/mL), *E. faecalis* (MIC=32 µg/mL), *P. aeruginosa* (MIC=32 µg/mL), *K. pneumoniae* (MIC =32 µg/mL).	[145]
1-((1*H*-Imidazol-1-yl)(*p*-tolyl)methyl)-2-(2,4-dinitrophenyl) pyrazolidine-3,5-dione	Antibacterial	*S. aureus* (MIC=32 µg/mL), *E. coli* (MIC=32 µg/mL), *E. faecalis* (MIC=62 µg/mL), *P. aeruginosa* (MIC=16 µg/mL), *K. pneumoniae* (MIC =16 µg/mL).	[145]
1-((4-(Dimethylamino)phenyl)(1*H*-imidazol-1-yl) methyl)-2-(2,4-dinitrophenyl) pyrazolidine-3,5-dione	Antibacterial	*S. aureus* (MIC=32 µg/mL), *E. coli* (MIC=64 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC=64 µg/mL), *K. pneumoniae* (MIC >100 µg/mL).	[145]
4-((2-(2,4-Dinitrophenyl) hydrazineyl) (phenyl) methyl)-4*H*-1,2,4-triazole	Antibacterial	*S. aureus* (MIC=8 µg/mL), *E. coli* (MIC=32 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC=62 µg/mL), *K. pneumoniae* (MIC >100 µg/mL).	[145]
4-((4-Chlorophenyl)(2-(2,4-dinitrophenyl) hydrazineyl) methyl)-4*H*-1,2,4-triazole	Antibacterial	*S. aureus* (MIC=32 µg/mL), *E. coli* (MIC=2 µg/mL), *E. faecalis* (MIC=4 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC=32 µg/mL).	[145]
4-((2-(2,4-Dinitrophenyl) hydrazineyl) (4*H*-1,2,4-triazol-4-yl) methyl) phenol	Antibacterial	*S. aureus* (MIC=64 µg/mL), *E. coli* (MIC >100 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC=8 µg/mL).	[145]
4-((2-(2,4-Dinitrophenyl) hydrazineyl) (4-nitrophenyl) methyl)-4*H*-1,2,4-triazole	Antibacterial	*S. aureus* (MIC=16 µg/mL), *E. coli* (MIC >100 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC >100 µg/mL).	[145]
4-((2-(2,4-Dinitrophenyl)hydrazineyl)(4-methoxyphenyl) methyl)-4*H*-1,2,4-triazole	Antibacterial	*S. aureus* (MIC >100 µg/mL), *E. coli* (MIC=16 µg/mL), *E. faecalis* (MIC=32 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC >100 µg/mL).	[145]
4-((2-(2,4-Dinitrophenyl) hydrazineyl) (*p*-tolyl) methyl)-4*H*-1,2,4-triazole	Antibacterial	*S. aureus* (MIC=32 µg/mL), *E. coli* (MIC=32 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC=64 µg/mL).	[145]

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4-((2-(2,4-Dinitrophenyl) hydrazineyl) (4*H*-1,2,4-triazol-4-yl)methyl)-*N*,*N*-dimethylaniline	Antibacteria	*S. aureus* (MIC=64 µg/mL), *E. coli* (MIC=16 µg/mL), *E. faecalis* (MIC >100 µg/mL), *P. aeruginosa* (MIC >100 µg/mL), *K. pneumoniae* (MIC=32 µg/mL).	[145]
3-(5-(*p*-Tolyl)-1,3,4-oxadiazol-2-yl)-2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=13mm) *Proteus vulgaris* (d=12mm) *Escherichia coli* (d=14mm) *Staphylococcus aureus* (d=15mm)	[146]
	Antifungal	*Candida albicans* (d=19mm)	[146]
3-(5-(4-Methoxyphenyl)-1,3,4-oxadiazol-2-yl)-2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=19mm) *Proteus vulgaris* (d=21mm) *Escherichia coli* (d=20mm) *Staphylococcus aureus* (d=19mm)	[146]
	Antifungal	*Candida albicans* (d=16mm)	[146]
3-(5-Phenyl-1,3,4-oxadiazol-2-yl)-2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=15mm) *Proteus vulgaris* (d=16mm) *Escherichia coli* (d=19mm) *Staphylococcus aureus* (d=20mm)	[146]
	Antifungal	*Candida albicans* (d=20mm)	[146]
3-(5-(*o*-Tolyl)-1,3,4-oxadiazol-2-yl)-2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Proteus vulgaris* (d=17mm) *Escherichia coli* (d=16mm)	[146]
	Antifungal	*Candida albicans* (d=18mm)	[146]
3-(5-(4-Chlorophenyl)-1,3,4-oxadiazol-2-yl)-2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=20mm) *Proteus vulgaris* (d=14mm) *Staphylococcus aureus* (d=15mm)	[146]
	Antifungal	*Candida albicans* (d=20mm)	[146]
3-(5-(4-Bromophenyl)-1,3,4-oxadiazol-2-yl) -2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=13mm) *Proteus vulgaris* (d=13mm) *Staphylococcus aureus* (d=14mm)	[146]

Continued

	Antifungal	*Candida albicans* (d=15mm)	[146]
3-(5-(4-Fluorophenyl)-1,3,4-oxadiazol-2-yl) -2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=11mm) *Proteus vulgaris* (d=18mm) *Escherichia coli* (d=20mm) *Staphylococcus aureus* (d=13mm)	[146]
	Antifungal	*Candida albicans* (d=17mm)	[146]
3-(5-(4-Hydroxyphenyl)-1,3,4-oxadiazol-2-yl) -2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Proteus vulgaris* (d=15mm) *Escherichia coli* (d=17mm) *Staphylococcus aureus* (d=13mm)	[146]
	Antifungal	*Candida albicans* (d=18mm)	[146]
3-(5-(3-Chlorophenyl)-1,3,4-oxadiazol-2-yl) -2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=15mm) *Proteus vulgaris* (d=17mm) *Escherichia coli* (d=20mm) *Staphylococcus aureus* (d=15mm)	[146]
	Antifungal	*Candida albicans* (d=17mm)	[146]
3-(5-(3-Bromophenyl)-1,3,4-oxadiazol-2-yl) -2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=18mm) *Proteus vulgaris* (d=13mm) *Escherichia coli* (d=10mm) *Staphylococcus aureus* (d=17mm)	[146]
	Antifungal	*Candida albicans* (d=18mm)	[146]
3-(5-(2-Chlorophenyl)-1,3,4-oxadiazol-2-yl) -2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=17mm) *Proteus vulgaris* (d=12mm) *Escherichia coli* (d=16mm) *Staphylococcus aureus* (d=15mm)	[146]
	Antifungal	*Candida albicans* (d=15mm)	[146]
3-(5-(2-Nitrophenyl)-1,3,4-oxadiazol-2-yl)-2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=16mm) *Proteus vulgaris* (d=18mm) *Escherichia coli* (d=19mm) *Staphylococcus aureus* (d=17mm)	[146]
	Antifungal	*Candida albicans* (d=20mm)	[146]
3-(5-(2,6-Dimethoxyphenyl)-1,3,4-oxadiazol-2-yl)-2,5,6,7-tetrahydro-4*H*-	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=20mm)	[146]

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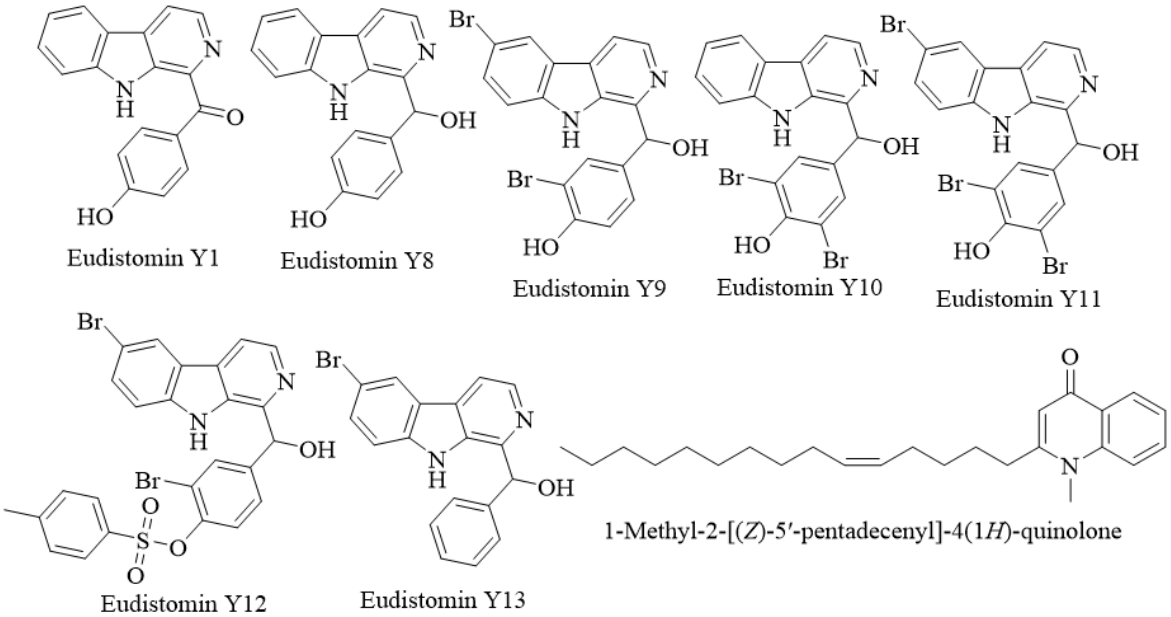
indazol-4-one		*Proteus vulgaris* (d=20mm) *Escherichia coli* (d=15mm) *Staphylococcus aureus* (d=12mm)	
	Antifungal	*Candida albicans* (d=14mm)	[146]
3-(5-(3,4-Dimethoxyphenyl)-1,3,4-oxadiazol -2-yl) 2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=13mm) *Proteus vulgaris* (d=18mm) *Escherichia coli* (d=20mm) *Staphylococcus aureus* (d=14mm)	[146]
	Antifungal	*Candida albicans* (d=17mm)	[146]
3-(5-(4-Nitrophenyl)-1,3,4-oxadiazol-2-yl)-2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Escherichia coli* (d=17mm) *Staphylococcus aureus* (d=14mm)	[146]
	Antifungal	*Candida albicans* (d=11mm)	[146]
3-(5-(2-Bromophenyl)-1,3,4-oxadiazol-2-yl) -2,5,6,7-tetrahydro-4*H*-indazol-4-one	Antibacterial	MIC=1000 µg/mL *Pseudomonas aeruginosa* (d=14mm) *Proteus vulgaris* (d=17mm) *Escherichia coli* (d=20mm) *Staphylococcus aureus* (d=12mm)	[146]



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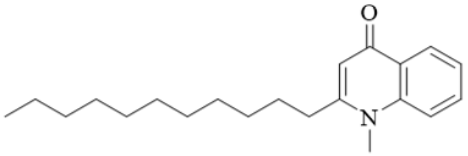
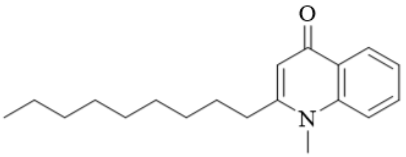
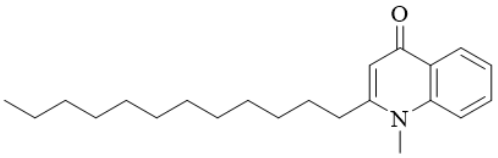


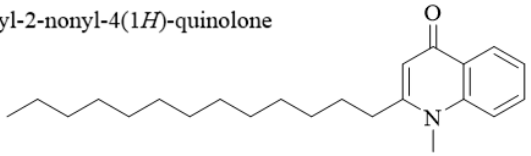
1-Methyl-2-undecyl-4(1*H*)-quinolone



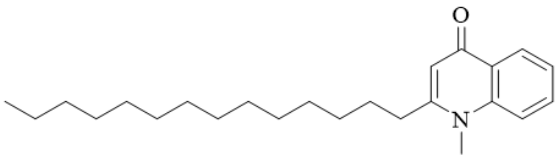
1-Methyl-2-nonyl-4(1*H*)-quinolone



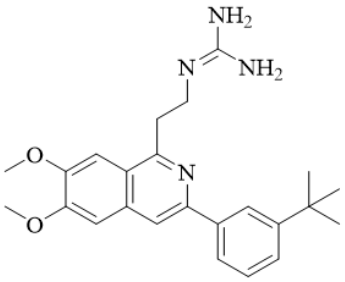
1-Methyl-2-dodecyl-4-(1*H*)-quinolone



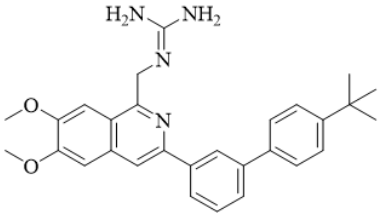
1-methyl-2-tridecyl-4(1*H*)-quinolone



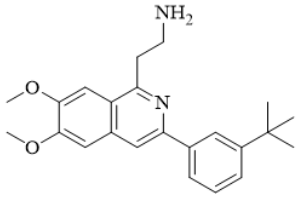
1-Methyl-2-tetradecyl-4-(1*H*)-quinolone



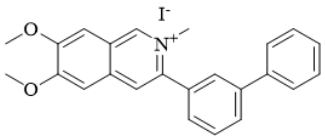
2-(2-(3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxy-isoquinolin-1-yl)ethyl) guanidine



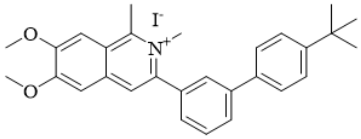
2-((3-(4'-(*t*-Butyl)-[1,1'-biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl) methyl) guanidine



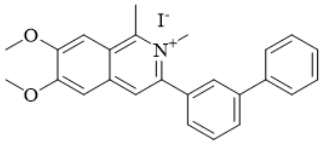
2-(3-(3-(*t*-Butyl) phenyl)-6,7-dimethoxy-isoquinolin-1-yl) ethanamine



3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxy-2-methylisoquinolin-2-ium iodide



3-(4'-(*t*-Butyl)-[1,1'-biphenyl]-3-yl)-6,7-dimethoxy-1,2-dimethylisoquinolin-2-ium iodide



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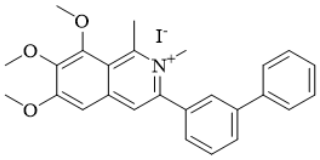

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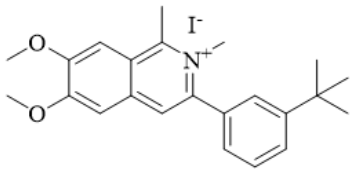
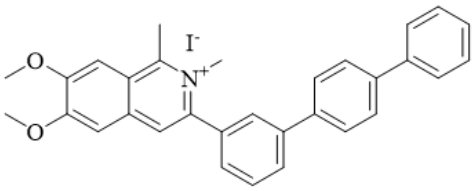
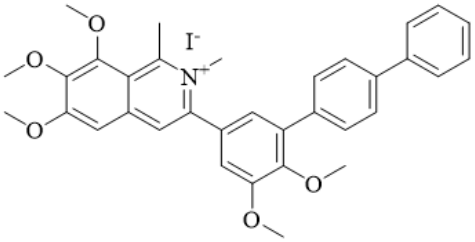


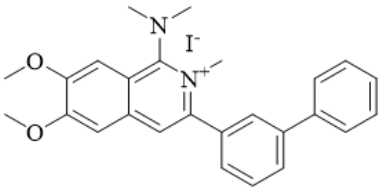
3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxy-1,2-dimethylisoquinolin-2-ium iodide



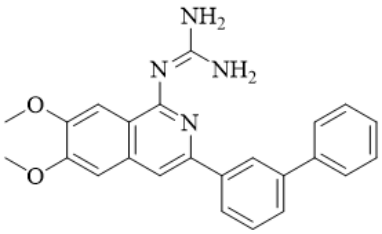
3-([1,1':4',1"-Terphenyl]-3-yl)-6,7-dimethoxy-1,2-dimethylisoquinolin-2-ium iodide



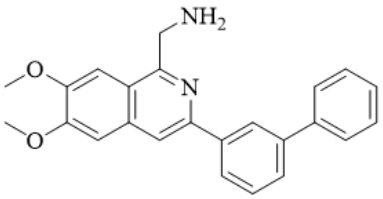
3-(5,6-Dimethoxy-[1,1':4',1"-terphenyl]-3-yl)-6,7,8-trimethoxy-1,2-dimethylisoquinolin-2-ium iodide



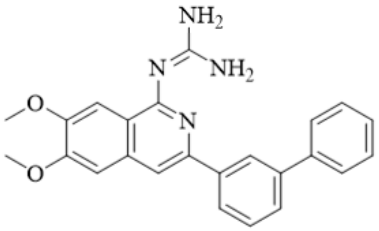
3-([1,1'-Biphenyl]-3-yl)-1-(dimethylamino)-6,7-dimethoxy-2-methylisoquinolin-2-ium iodide



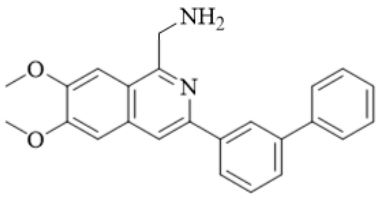
2-(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl)guanidine



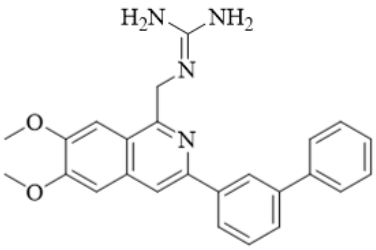
(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl)methanamine



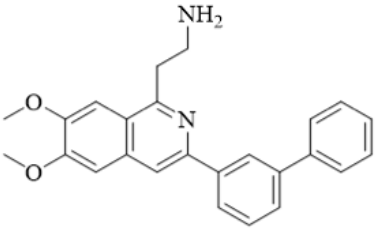
2-(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl)guanidine



(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl)methanamine

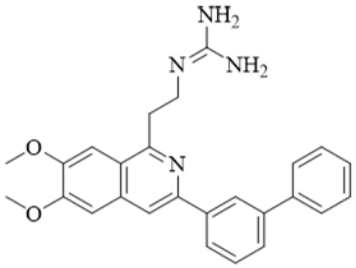


2-((3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl)methyl)guanidine

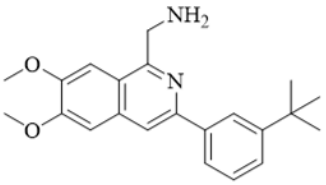


2-(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl)ethanamine

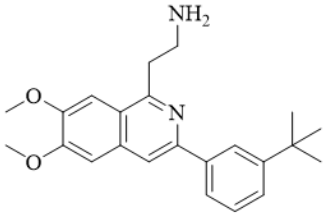
Continued



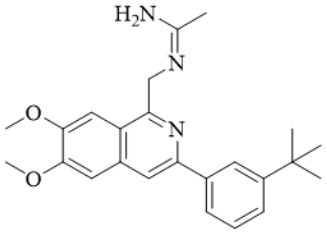
2-(2-(3-([1,1'-Biphenyl]-3-yl)-6,7-dimethoxyisoquinolin-1-yl)ethyl)guanidine



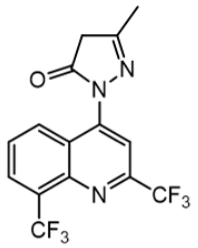
(3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxyisoquinolin-1-yl)methanamine



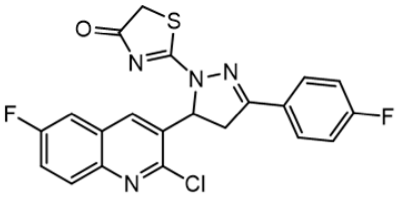
2-(3-(3-(*t*-Butyl)phenyl)-6,7-dimethoxyisoquinolin-1-yl)ethanamine



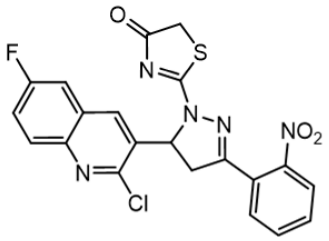
N'-((3-(3-*(t*-Butyl)phenyl)-6,7-dimethoxyisoquinolin-1-yl) methyl) acetimidamide



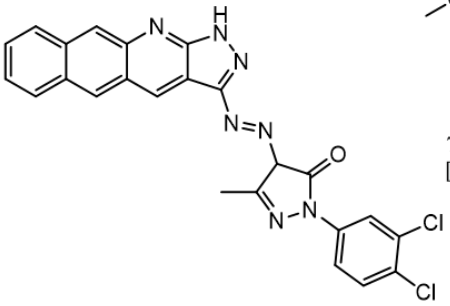
2-(2,8-Bis(trifluoromethyl) quinolin-4-yl)-5-methyl-2,4-dihydro-3*H*-pyrazol-3-one



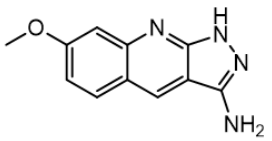
2-(5-(2-Chloro-6-fluoroquinolin-3-yl)-3-(4-fluorophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4(5*H*)-one



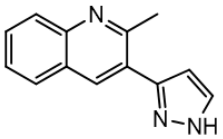
2-(5-(2-Chloro-6-fluoroquinolin-3-yl)-3-(2-nitrophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4(5*H*)-one



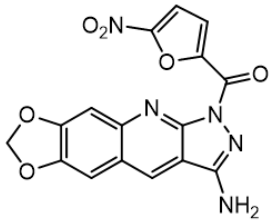
(*E*)-4-((1*H*-Benzo[*g*]pyrazolo[3,4-*b*] quinolin-3-yl)diazenyl)-2-(3,4-dichlorophenyl)-5-methyl-2,4-dihydro-3*H*-pyrazol-3-one



7-Methoxy-1*H*-pyrazolo [3,4-*b*] quinolin-3-amine

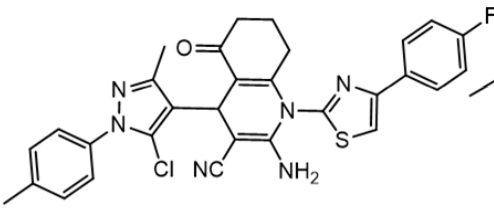


2-Methyl-3-(1*H*-pyrazol-3-yl) quinoline

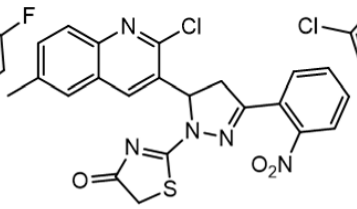


(3-Amino-1*H*-[1,3] dioxolo [4,5-*g*] pyrazolo [3,4-*b*] quinolin-1-yl) (5-nitrofuran-2-yl) methanone

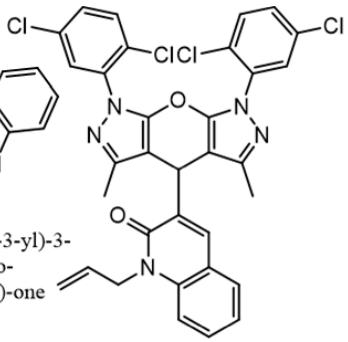
Continued



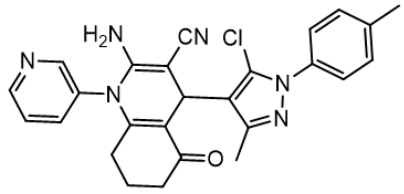
2-Amino-4-(5-chloro-3-methyl-1-(*p*-tolyl)-1*H*-pyrazol-4-yl)-1-(4-(4-fluorophenyl) thiazol-2-yl)-5-oxo-1,4,5,6,7,8-hexahydroquinoline-3-carbonitrile



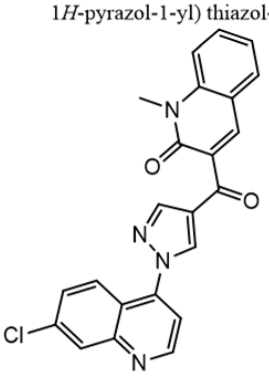
2-(5-(2-Chloro-6-methylquinolin-3-yl)-3-(2-nitrophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4(5*H*)-one



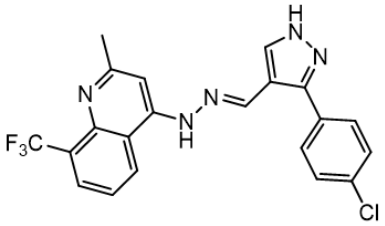
1-Allyl-3-(1,7-bis(2,5-dichlorophenyl)-3,5-dimethyl-4,7-dihydro-1*H*-pyrano [2,3-*c*:6,5-*c*′]dipyrazol-4-yl) quinolin-2(1*H*)-one



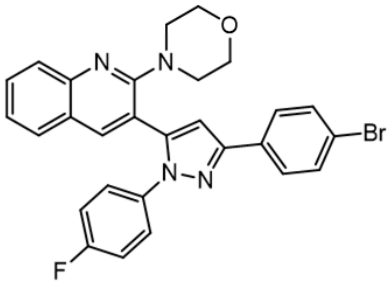
2-Amino-4-(5-chloro-3-methyl-1-(*p*-tolyl)-1*H*-pyrazol-4-yl)-5-oxo-1-(pyridin-3-yl)-1,4,5,6,7,8-hexahydroquinoline-3-carbonitrile



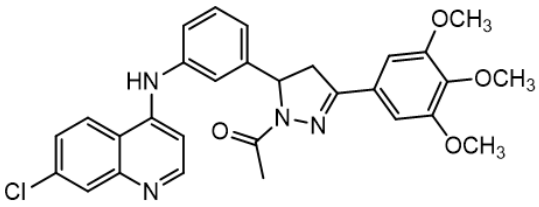
3-(1-(7-Chloroquinolin-4-yl)-1*H*-pyrazole-4-carbonyl)-1-methylquinolin-2(1*H*)-one



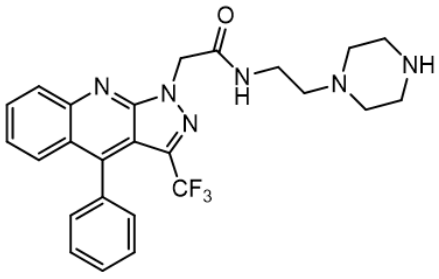
(*E*)-4-(2-((3-(4-Chlorophenyl)-1*H*-pyrazol-4-yl)methylene) hydrazineyl)-2-methyl-8-(trifluoromethyl) quinoline



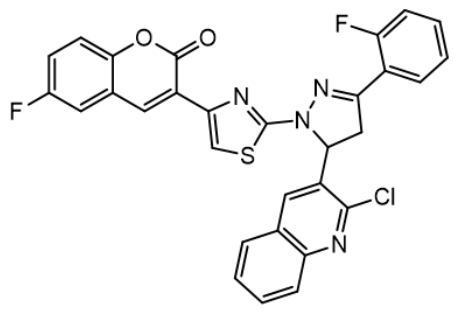
4-(3-(3-(4-Bromophenyl)-1-(4-fluorophenyl)-1*H*-pyrazol-5-yl) quinolin-2-yl) morpholine



1-(5-(3-((7-Chloroquinolin-4-yl) amino) phenyl)-3-(3,4,5-trimethoxyphenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) ethan-1-one

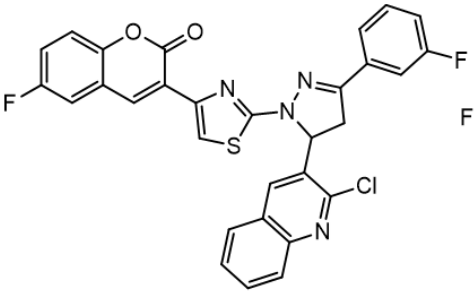


2-(4-Phenyl-3-(trifluoromethyl)-1*H*-pyrazolo [3,4-*b*] quinolin-1-yl)-*N*-(2-(piperazin-1-yl) ethyl) acetamide

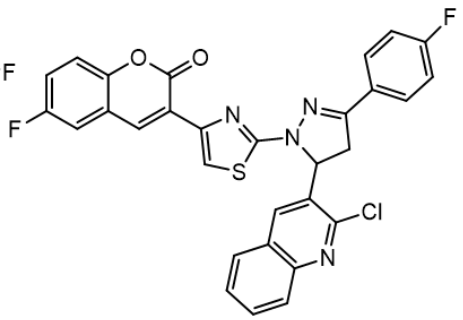


3-(2-(5-(2-Chloroquinolin-3-yl)-3-(2-fluorophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4-yl) -6-fluoro-2*H*-chromen-2-one

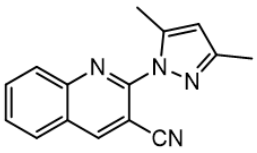
Continued



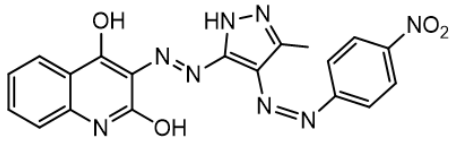
3-(2-(5-(2-Chloroquinolin-3-yl)-3-(3-fluorophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4-yl)-6-fluoro-2*H*-chromen-2-one



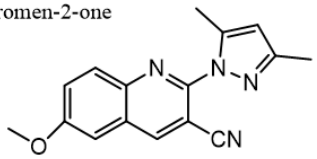
3-(2-(5-(2-Chloroquinolin-3-yl)-3-(4-fluorophenyl)-4,5-dihydro-1*H*-pyrazol-1-yl) thiazol-4-yl) -6-fluoro-2*H*-chromen-2-one



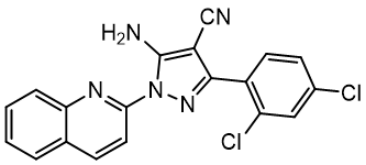
2-(3,5-Dimethyl-1*H*-pyrazol-1-yl) quinoline-3-carbonitrile



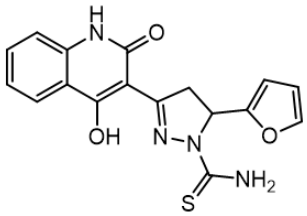
3-((*E*)-(3-Methyl-4-((*Z*)-(4-nitrophenyl) diazenyl)-1*H*-pyrazol-5-yl) diazenyl) quinoline-2,4-diol



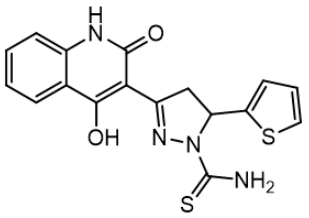
2-(3,5-Dimethyl-1*H*-pyrazol-1-yl)-6-methoxyquinoline-3-carbonitrile



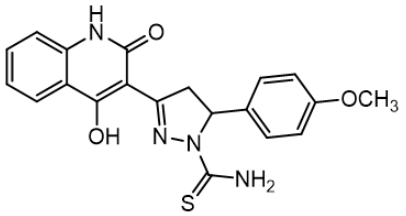
5-Amino-3-(2,4-dichlorophenyl)-1-(quinolin-2-yl)-1*H*-pyrazole-4-carbonitrile



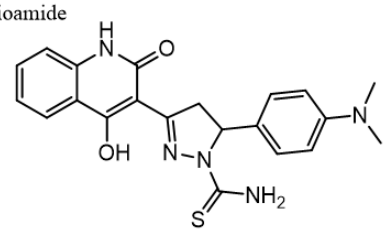
5-(Furan-2-yl)-3-(4-hydroxy-2-oxo-1,2-dihydroquinolin-3-yl)-4,5-dihydro-1*H*-pyrazole-1-carbothioamide



3-(4-Hydroxy-2-oxo-1,2-dihydroquinolin-3-yl)-5-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazole-1-carbothioamide



3-(4-Hydroxy-2-oxo-1,2-dihydroquinolin-3-yl)-5-(4-methoxyphenyl)-4,5-dihydro-1*H*-pyrazole-1-carbothioamide



5-(4-(Dimethylamino) phenyl)-3-(4-hydroxy-2-oxo-1,2-dihydroquinolin-3-yl)-4,5-dihydro-1*H*-pyrazole-1-carbothioamide

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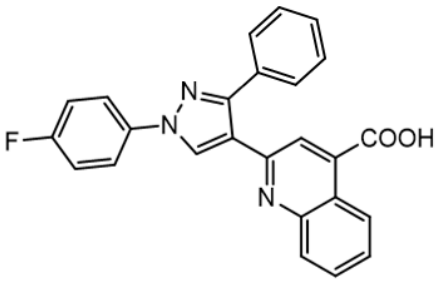
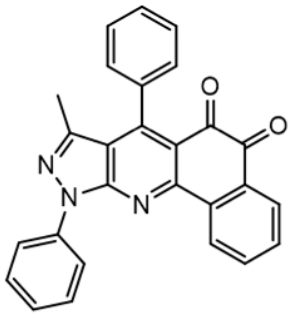
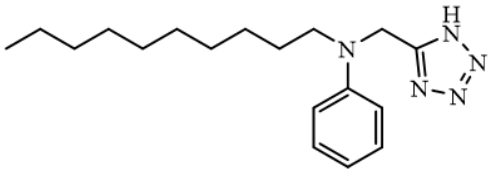


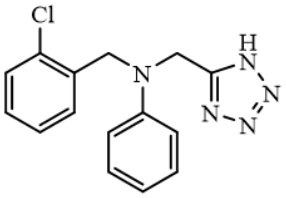
2-(1-(4-Fluorophenyl)-3-phenyl-1*H*-pyrazol-4-yl) quinoline-4-carboxylic acid



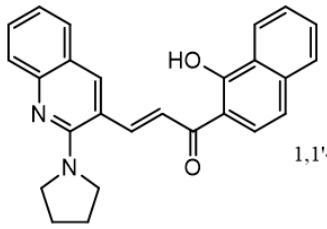
8-Methyl-7,10-diphenyl-5*H*-benzo [*h*] pyrazolo [3,4-*b*] quinoline-5,6(10*H*)-dione



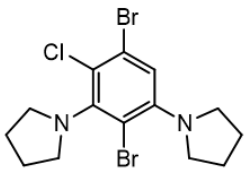
N-((1*H*-Tetrazol-5-yl) methyl)-*N*-decylaniline



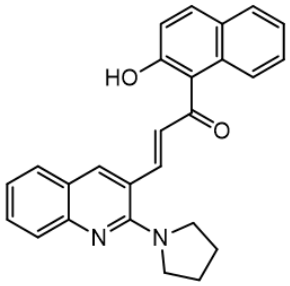
N-((1*H*-Tetrazol-5-yl) methyl)-*N*-(2-chlorobenzyl) aniline



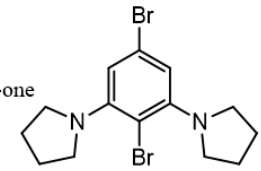
(*E*)-1-(1-Hydroxynaphthalen-2-yl)-3-(2-(pyrrolidin-1-yl) quinolin-3-yl) prop-2-en-1-one



1,1'-(2,5-Dibromo-4-chloro-1,3-phenylene) dipyrrolidine



(*E*)-1-(2-Hydroxynaphthalen-1-yl)-3-(2-(pyrrolidin-1-yl) quinolin-3-yl) prop-2-en-1-one



1,1'-(2,5-Dibromo-1,3-phenylene) dipyrrolidine

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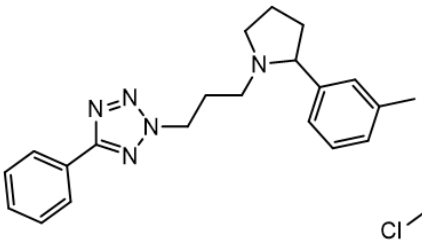
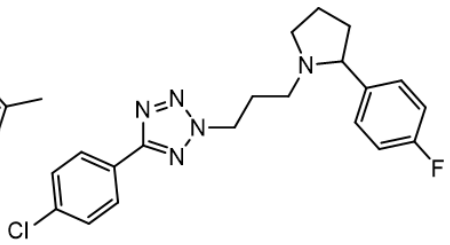
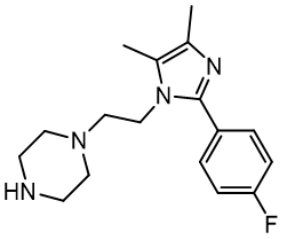


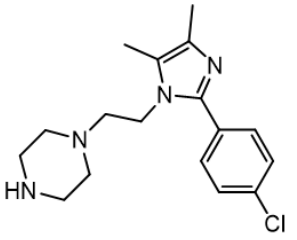
5-Phenyl-2-(3-(2-(*m*-tolyl) pyrrolidin-1-yl) propyl)-2*H*-tetrazole



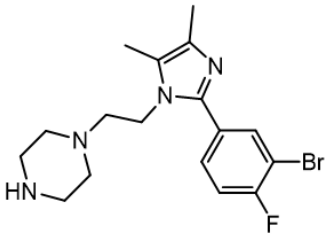
5-Phenyl-2-(3-(2-(*m*-tolyl) pyrrolidin-1-yl) propyl)-2*H*-tetrazole



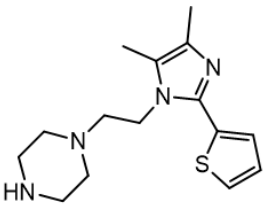
1-(2-(2-(4-Fluorophenyl)-4,5-dimethyl-1*H*-imidazol-1-yl)ethyl) piperazine



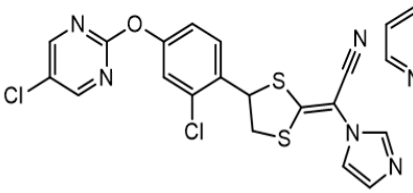
1-(2-(2-(4-Chlorophenyl)-4,5-dimethyl-1*H*-imidazol-1-yl)ethyl) piperazine



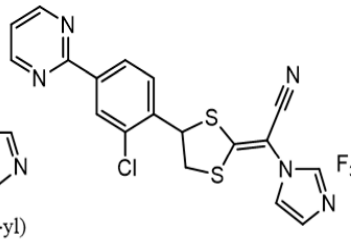
1-(2-(2-(3-Bromo-4-fluorophenyl)-4,5-dimethyl-1*H*-imidazol-1-yl)ethyl) piperazine



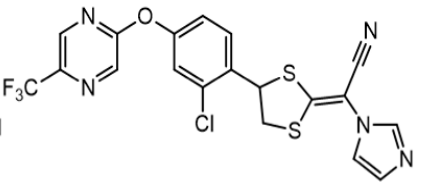
1-(2-(4,5-Dimethyl-2-(thiophen-2-yl)-1*H*-imidazol-1-yl)ethyl) piperazine



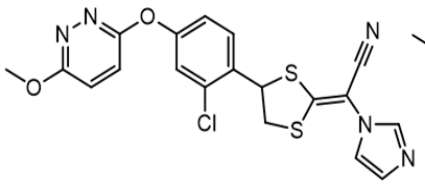
(*E*)-2-(4-(2-Chloro-4-((5-chloropyrimidin-2-yl) oxy) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile



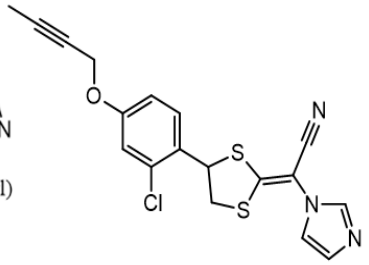
(*E*)-2-(4-(2-Chloro-4-(pyrimidin-2-yl) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile



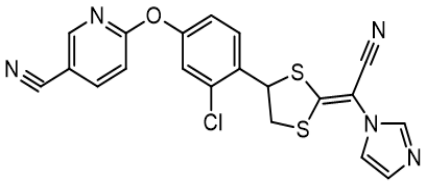
(*E*)-2-(4-(2-Chloro-4-((5-(trifluoromethyl) pyrazin-2-yl)oxy)phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile



(*E*)-2-(4-(2-Chloro-4-((6-methoxypyridazin-3-yl) oxy)phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile



(*E*)-2-(4-(4-(But-2-yn-1-yloxy)-2-chlorophenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl)acetonitrile



(*E*)-6-(3-Chloro-4-(2-(cyano(1*H*-imidazol-1-yl) methylene)-1,3-dithiolan-4-yl) phenoxy)nicotinonitrile

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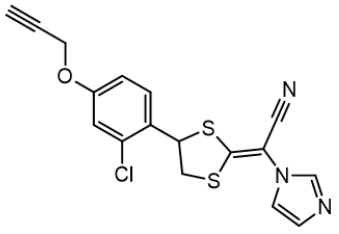
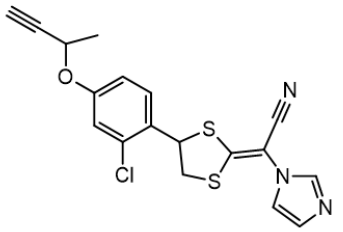
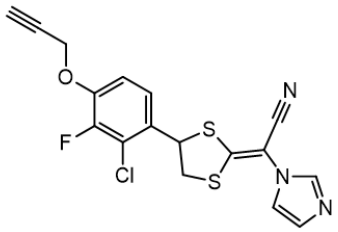


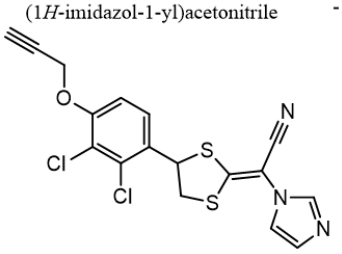
(*E*)-2-(4-(2-Chloro-4-(prop-2-yn-1-yloxy) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl)acetonitrile



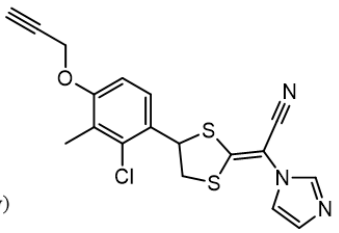
(*E*)-2-(4-(4-(But-3-yn-2-yloxy)-2-chlorophenyl) -1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile



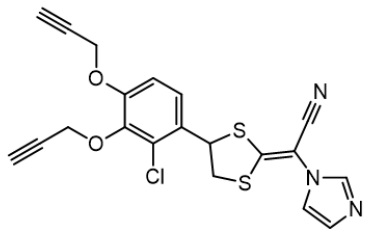
(*E*)-2-(4-(2-Chloro-3-fluoro-4-(prop-2-yn-1-yloxy) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile



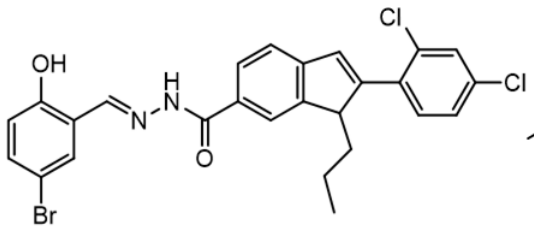
(*E*)-2-(4-(2,3-Dichloro-4-(prop-2-yn-1-yloxy) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile



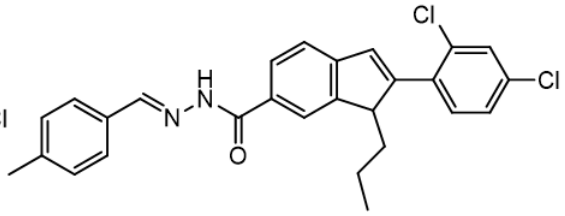
(*E*)-2-(4-(2-Chloro-3-methyl-4-(prop-2-yn-1-yloxy) phenyl)-1,3-dithiolan-2-ylidene) -2-(1*H*-imidazol-1-yl) acetonitrile



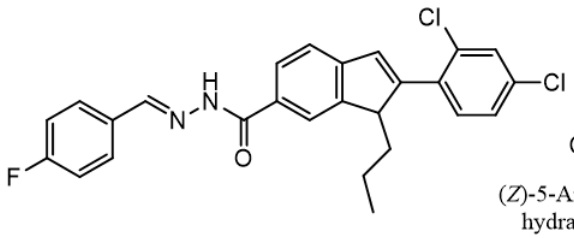
(*E*)-2-(4-(2-chloro-3,4-bis(prop-2-yn-1-yloxy) phenyl)-1,3-dithiolan-2-ylidene)-2-(1*H*-imidazol-1-yl) acetonitrile



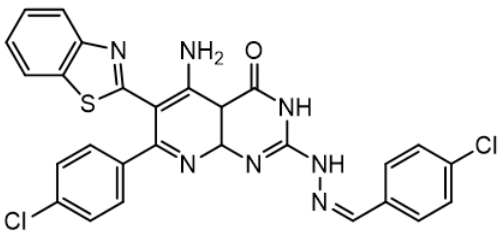
(*E*)-*N*'-(5-Bromo-2-hydroxybenzylidene) -2-(2,4-dichlorophenyl)-1-propyl-1*H*-indene-6-carbohydrazide



(*E*)-2-(2,4-Dichlorophenyl)-*N*'-(4-methylbenzylidene) -1-propyl-1*H*-indene-6-carbohydrazide



(*E*)-2-(2,4-Dichlorophenyl)-*N*'-(4-fluorobenzylidene) -1-propyl-1*H*-indene-6-carbohydrazide



(*Z*)-5-Amino-6-(benzo[*d*]thiazol-2-yl)-2-(2-(4-chlorobenzylidene) hydrazineyl)-7-(4-chlorophenyl)-4a,8a-dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one

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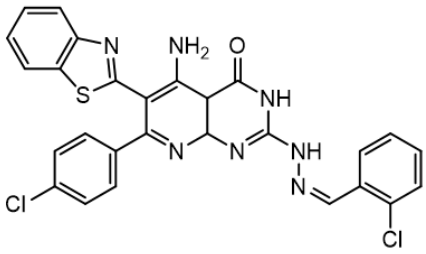
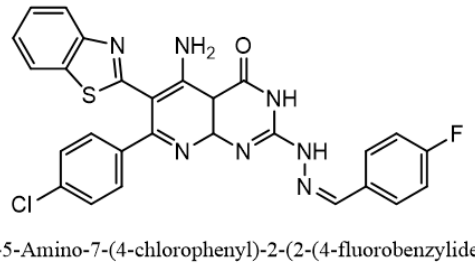
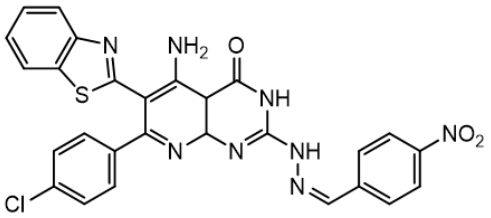


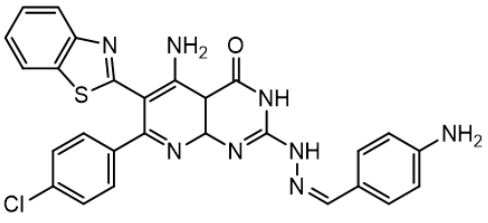
(*Z*)-5-Amino-6-(benzo[*d*] thiazol-2-yl)-2-(2-(2-chlorobenzylidene) hydrazineyl)-7-(4-chlorophenyl)-4a,8a-dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one



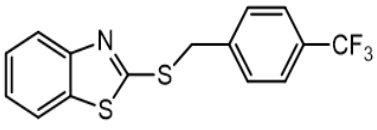
(*Z*)-5-Amino-7-(4-chlorophenyl)-2-(2-(4-fluorobenzylidene) hydrazineyl)-6-(4,5,6,7-tetrahydrobenzo [*d*] thiazol-2-yl)-4a,8a-dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one



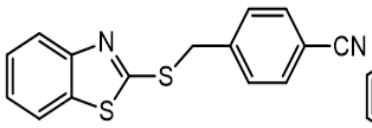
(*Z*)-5-Amino-6-(benzo[*d*] thiazol-2-yl)-7-(4-chlorophenyl)-2-(2-(4-nitrobenzylidene)hydrazineyl)-4a,8a-dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one



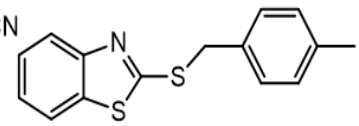
(*Z*)-5-Amino-2-(2-(4-aminobenzylidene) hydrazineyl)-6-(benzo[*d*] thiazol-2-yl)-7-(4-chlorophenyl)-4a,8a -dihydropyrido [2,3-*d*] pyrimidin-4(3*H*)-one



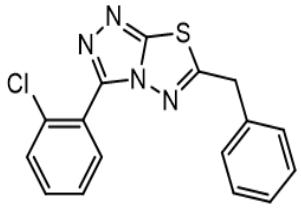
2-((4-(Trifluoromethyl) benzyl) thio) benzo [*d*] thiazole



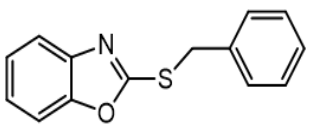
4-((Benzo [*d*] thiazol-2-ylthio) methyl) benzonitrile



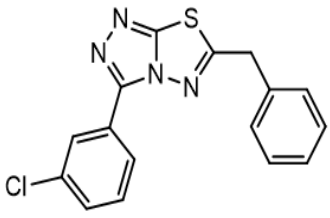
2-((4-Methylbenzyl) thio) benzo [*d*] thiazole



6-Benzyl-3-(2-chlorophenyl)-[1,2,4] triazolo [3,4-*b*][1,3,4] thiadiazole



2-(Benzylthio) benzo [*d*] oxazole



6-Benzyl-3-(3-chlorophenyl)-[1,2,4] triazolo [3,4-*b*][1,3,4] thiadiazole

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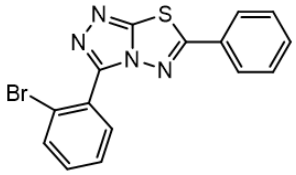
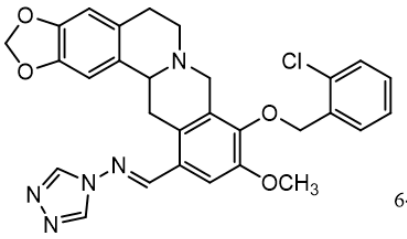
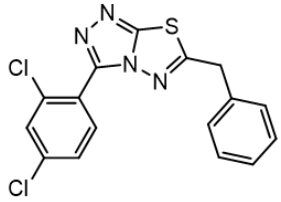


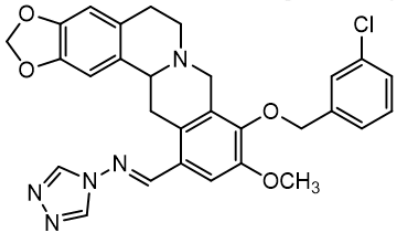
3-(2-Bromophenyl)-6-phenyl-[1,2,4] triazolo[3,4-*b*][1,3,4] thiadiazole



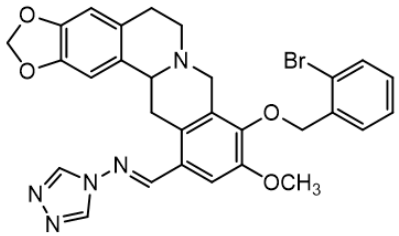
(*E*)-1-(9-((2-Chlorobenzyl) oxy)-10-methoxy-5,8,13,13a-tetrahydro-6*H*-[1,3] dioxolo [4,5-*g*] isoquinolino [3,2-*a*] isoquinolin-12-yl)-*N*-(4*H*-1,2,4-triazol-4-yl) methanimine



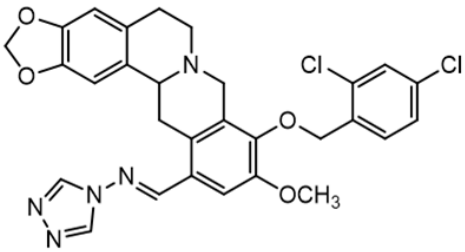
6-Benzyl-3-(2,4-dichlorophenyl)-[1,2,4] triazolo [3,4-*b*][1,3,4] thiadiazole



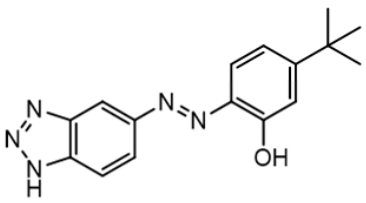
(*E*)-1-(9-((3-Chlorobenzyl)oxy)-10-methoxy-5,8,13,13a-tetrahydro-6*H*-[1,3]dioxolo [4,5-*g*] isoquinolino[3,2-*a*] isoquinolin-12-yl)-*N*-(4*H*-1,2,4-triazol-4-yl) methanimine



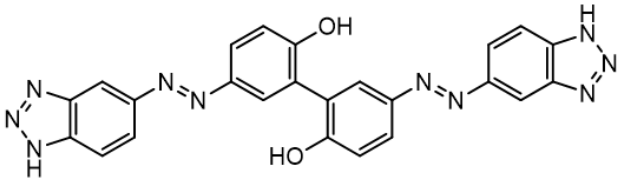
(*E*)-1-(9-((2-Bromobenzyl)oxy)-10-methoxy-5,8,13,13a -tetrahydro-6*H*-[1,3]dioxolo [4,5-*g*] isoquinolino [3,2-*a*] isoquinolin-12-yl)-*N*-(4*H*-1,2,4-triazol-4-yl) methanimine



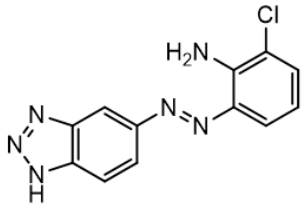
(*E*)-1-(9-((2,4-Dichlorobenzyl)oxy)-10-methoxy-5,8,13,13a -tetrahydro-6*H*-[1,3] dioxolo[4,5-*g*] isoquinolino [3,2-*a*] isoquinolin-12-yl)-*N*-(4*H*-1,2,4-triazol-4-yl) methanimine



(*E*)-2-((1*H*-Benzo[*d*] [1,2,3] triazol-5-yl) diazenyl)-5-(*tert*-butyl) phenol



5,5'-bis((*E*)-(1*H*-Benzo[*d*] [1,2,3] triazol-5-yl) diazenyl)-[1,1'-biphenyl]-2,2'-diol



(*E*)-2-((1*H*-Benzo [*d*][1,2,3] triazol-5-yl) diazenyl)-6-chloroaniline

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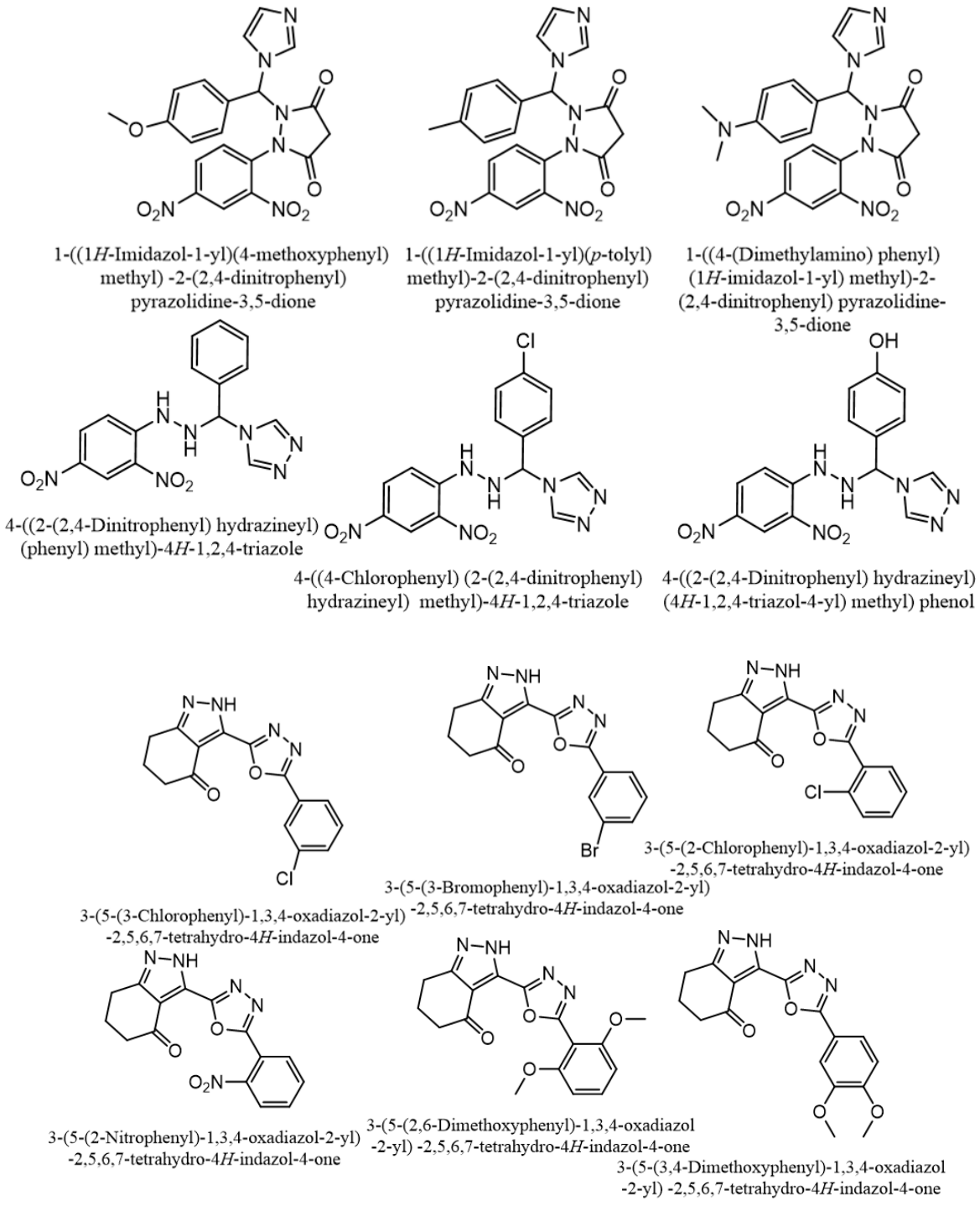

Figure 4. Chemical structures of some synthesized alkaloids used as antimicrobial agents.

3. Mechanisms of action of synthesized molecules

In most cases, an antibiotic's mode of action dictates whether it has a bacteriostatic or bactericidal effect. Since understanding the mechanisms specific to the metabolic systems of infectious organisms serves as the foundation for the future development of contemporary chemotherapeutic medicines and the biochemical processes of microbes are a current area of research, the distinction may be significant for the treatment of serious, life-threatening infections, especially if the host's natural defense mechanisms are either inadequate or overpowered by the infection. Under such conditions, it is obviously advised to use a bactericidal agent. Better structural analogues of powerful antibiotics will probably continue to be developed as mechanisms of action become more apparent, although there is still more work to be done in this field.

The most effective anti-infective drugs are typically those that disrupt the metabolic processes of microbes rather than those of mammalian cells. For example, antibiotics that interfere with the formation of bacterial cell walls are particularly prone to selective toxicity. Because of their structural similarities to some important metabolites of microbes, some antibiotics may work through competitive antagonism. Therefore, it is thought that cycloserine is an antimetabolite of *D*-alanine, which is a component of bacterial cell walls. The synthesis of microbial proteins (such as aminoglycosides, tetracyclines, macrolides, chloramphenicol, and lincomycin) or nucleic acids (such as rifampin) is selectively disrupted by a number of antibiotics. Others are thought to disrupt the integrity and functionality of microbial cell membranes, including polymyxins and polyenes.

Most studies concerning the mechanism of antibacterial activity of the aminoglycosides used streptomycin. Nonetheless, it is believed that additional aminoglycosides have qualitatively comparable particular effects. The aminoglycosides interfere with the accuracy of the genetic message's translation and prevent the start of protein synthesis by directly acting on the bacterial ribosome. They create a complex with the 30S ribosomal subunit that prevents appropriate amino acid polymerization from starting [12].

Misreading mutations of the genetic code are also brought on by streptomycin and other aminoglycosides binding to ribosomes. These mutations appear to be caused by certain aminoacyl RNAs failing to recognize the correct codons on messenger RNA (mRNA), which leads to the incorporation of incorrect amino acids into the peptide chain [13]. Since streptomycin is equally effective at inhibiting initiation and causing misreading, there is evidence that deoxystreptamine-containing aminoglycosides cause misreading at lower concentrations than those needed to prevent initiation of protein synthesis [14]. Streptomycin inhibits protein synthesis from the start, but it doesn't seem to induce misreading.

Furthermore, some antibiotics, such as tetracyclines and chloramphenicol, have been dubbed broad-spectrum antibiotics because of their ability to inhibit the growth of a wide range of infections. A spectrum of activity designations cannot be used by doctors unless they are based on the antibiotic's clinical effectiveness against specific microorganisms. Many broad-spectrum antibiotics only work against some microbe species that are frequently included in the "spectrum" at quite high concentrations. The mechanisms of action of some common antibiotics are summarized in **Table 6**.

Table 6. List of some antibiotics with their modes of action (CLSI) [14].

Site of action	Antibiotic	Action	Bioactivity
Nucleic acids	Actinomycin	DNA and mRNA synthesis	Pancidal
	Griseofulvin	Cell division and microtubule assembly	Fungistatic
50S subunit	Erythromycin	Protein synthesis	Bacteriostatic
	Lincomycins	Protein synthesis	Bacteriostatic
30S subunit	Tetracyclins	Protein synthesis	Bacteriostatic
	Aminoglycosides	Protein synthesis and fidelity	Bactericidal
Ribosomes	Chloramphenicol	Protein synthesis	Bacteriostatic
DNA and/or RNA	Rifampin	mRNA synthesis	Bactericidal
	Mitomycin C	DNA synthesis	Pancidal

Cell membrane	Nystatin	Membrane function	Fungicidal
	Polymyxins	Membrane integrity	Bactericidal
	Amphotericin B	Membrane function	Fungicidal
Cell wall	Penicillins	Cell wall cross-linking	Bactericidal
	Cephalosporin	Cell wall cross-linking	Bactericidal
	Vancomycin	Mucopeptide synthesis	Bactericidal
	Cycloserine	Synthesis of cell wall peptides	Bactericidal
	Bacitracin	Mucopeptide synthesis	Bactericidal

Alkaloids use a number of strategies to exert their antibacterial effects. Among the primary modes of action are:

• Inhibition of nucleic acid and protein synthesis

A key component of alkaloids' antibacterial activity is their substantial capacity to interfere with the production of proteins and nucleic acids inside bacterial cells. Chelerythrine, for example, has been shown to inhibit nucleic acid synthesis and cellular division in several species such as: SARM. Berberine functions as an efficient DNA intercalator, interfering with DNA replication, RNA transcription, and protein production. These interactions generate structural changes in DNA and RNA that prevent them from serving as regular templates for essential biological processes.

• Effects on bacterial cell membrane permeability

Altering the permeability of bacterial cell membranes is one of alkaloids' key antibacterial properties. Because of their high lipophilicity, alkaloids like 8-hydroxyquinoline can pass through bacterial cell membranes, reach their target sites, and exert antibacterial effects. In a similar vein, the PA-1 cell line's increased membrane permeability causes a notable uptake of crystal violet, indicating serious membrane damage, which contributes to its bactericidal activity.

• Inhibition of efflux pumps

A number of alkaloids are potent efflux pump inhibitors (EPIs), which are essential in the battle against bacterial resistance. For instance, piperine inhibits the NorA efflux pump in *S. aureus*, which increases the accumulation of medicines like ciprofloxacin. This inhibition boosts the antibacterial effectiveness of antibiotics by enabling higher intracellular concentrations of the drugs. Additionally, the alkaloid reserpine is known to reverse multidrug resistance by blocking the efflux of drugs from bacterial cells.

• Interference with metabolic pathways

The capacity of alkaloids to interfere with bacterial metabolism is another essential component of their antibacterial effect. For example, the activity of essential enzymes to bacterial viability is inhibited by Michellamine B. The growth and proliferation of dangerous bacteria (*Staphylococcus aureus, Bacillus subtilis, Yersinia enterocolitica, Escherichia coli, Klebsiella pneumoniae*, and *Candida albicans*) are considerably inhibited by this disruption of enzymatic processes, which results in a poor bacterial metabolism [15].

As mentioned in **Fig. 5**, the antibacterial activity of coumarins is demonstrated by a number of important characteristics, including:

- Introduction of different groups to revise their impact on antibacterial activity.
- R_1: benzyl substituents may modulate physicochemical properties and affect transport and absorption of antibacterial agents.
- Different substituents introduce into aromatic ring to tune the lipid barrier permeability.
- Coumarin -α- aminophosphonate based pharmacophores may provide extraordinary antibacterial activity.
- R_2: CF3 group contributes to a number of biologically important molecular properties that may increase the lipophilicity and thus enhance the rate of cell penetration, which is a very important feature in drug delivery [16].

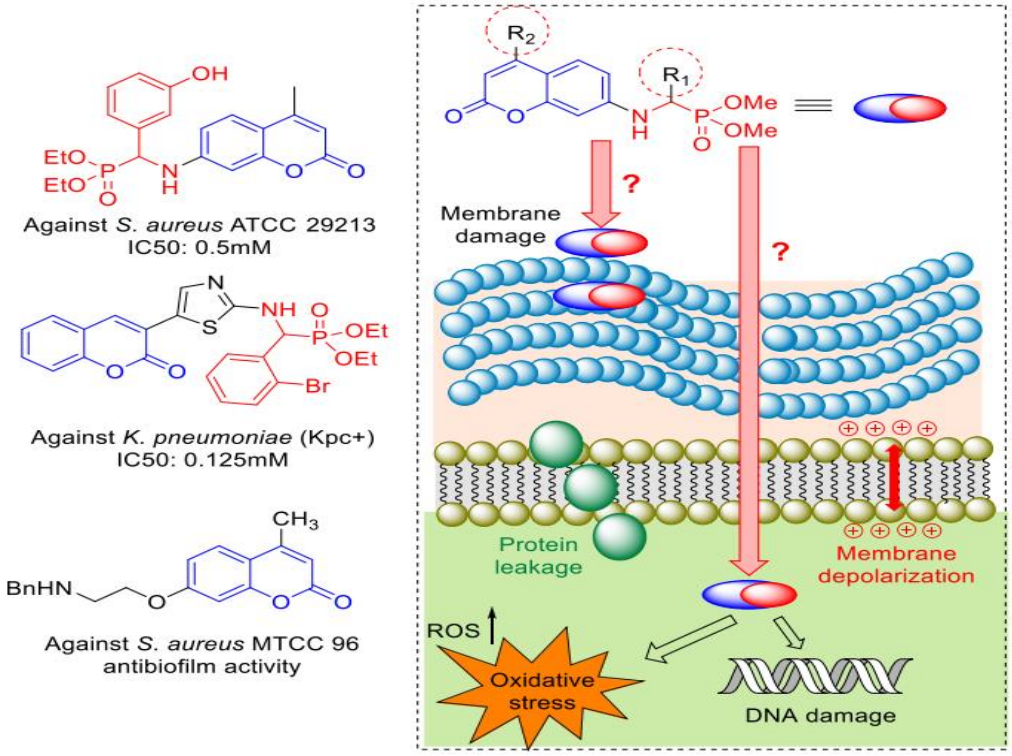

Figure 5. Biologically active antibacterial derivatives of coumarin and α-aminophosphonate. Model of antimicrobial action on Gram-positive bacteria possessing the peptidoglycan (PG) layer [16].

4. Conclusion

Since the relatively introduction of high-throughput organic synthesis in the drug development process, screening libraries have been established using a variety of design methodologies. These strategies include synthetic items that behave like natural substances and libraries of natural product derivatives. Some recent works outline the functional strategies of these libraries based on natural products. The real synthetic challenges, corresponding to antimicrobial molecules derived from natural product compounds, are intended to find rapid access to the fundamental properties and basic structure of the natural product in short, efficient synthetic steps. Moreover, access to easily modifiable units is highly dependent on the availability of a basic structure, either from a natural source or via an appropriate

The development of such methods and the design of suitable routes, such as multi-component reactions, represent the basis of useful combinatorial approaches, especially for natural products. Before a combinatorial method can be initiated, structurally more complex compounds still need years of synthesis and development time. This makes promise only for very special candidate compounds that are intended to be antimicrobial agents. At the present time, semisynthetic combinatorial modification seems to offer a more efficient, less expensive, and not inherently less diversified alternative for many complicated natural products.

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