ejpmr, 2020,7(4), 322-341

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 2394-3211

EJPMR

RECENT UPDATES ON ANTIMICROBIAL POTENTIAL OF NOVEL COUMARIN DERIVATIVES

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Article Received on 31/01/2020 **Article Revised on 21/02/2020** **Article Accepted on 11/03/2020**

ABSTRACT

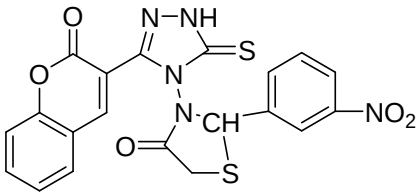
Microbial diseases and inflammatory disorders are claiming millions of deaths worldwide every year as per reports of World Health Organization (WHO) therefore discovery and development of effective antimicrobial and anti-inflammatory drugs with novel mechanism of action has become the highest priority task for researchers in this area. Bacterial resistance development has become a very serious clinical problem for many classes of antibiotics. Approximately half of all deaths caused by infectious diseases each year can be attributed to just three diseases: tuberculosis, malaria, and AIDS. Tuberculosis causes nearly 2 million deaths every year, and WHO estimates that nearly 1 billion people will be infected between 2000 and 2020 if more effective preventive procedures are not adopted. Infectious diseases are common diseases all over the world.

KEYWORDS: effective antimicrobial and anti-inflammatory drugs.

Antibacterial and Antifungal Activity

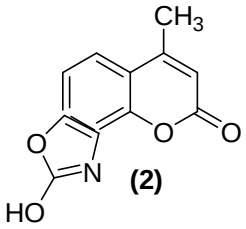
Coumarin derivatives are a broad class of chemical compounds, many with important pharmacological properties, which contain a core coumarin heterocyclic nucleus. A slight change in the substitution pattern in the coumarin nucleus causes distinguishable difference in their pharmacological activities. Literature survey of the recent studies done on coumarin derivatives indicates that they have antimicrobial activities like anti-bacterial and antifungal activities which have been summarized as given below.

Bhat *et al.* reported the synthesis of series of 2-(substituted phenyl)-3-[3-(2-oxo-2*H*-chromen-3-yl)-5-thioxo-1,5-dihydro-4*H*-1,2,4-triazol-4-yl]-1,3-thiazolidin-4-ones.[1] The compounds showed significant inhibition against *S. aureus*. These compounds showed significant inhibition against *E. coli* and *C. albicans* The synthesized compounds were screened for their antibacterial activity against Gram positive *S. aureus* and Gram negative *E.coli* strains and antifungal activity against *C.albicans* by cup plate method and agar diffusion method. Ciprofloxacin used as the standard drug. The test compounds and standard drugs were evaluated at 100ug/mL concentration. Some compounds showed significant antimicrobial activity when compared with standard drug.[1]



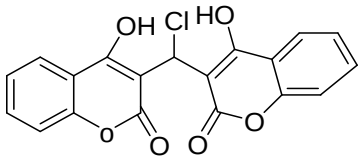
(1)

Sahoo *et al.* synthesized and evaluated the novel 8-Amino-7-hydroxy-4-methyl coumarin derivatives.[2] and there biological evaluations. These newly formed Coumarin derivatives were screened for their antibacterial activity against *Staphylococcus aureus* as well as *Escherichia coli* by cup plate method. The synthesized coumarin derivatives were administered orally in the dose of 10 mg/kg. Amoxicillin was taken as standard for antibacterial activity. The antibacterial activity of newly synthesized Coumarin were conducted against Gram positive bacteria *Stophylococcus aureus* and Gram negative bacteria *Escherichia coli* by using cup plate method. All the compounds were tested at a concentration of 0.05 ml. One compound showed maximum antimicrobial activity when compared to the standard drugs.[2]



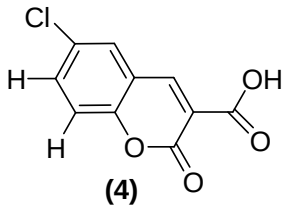
(2)

Rehman *et al.* synthesized and evaluated, *in vitro* antimicrobial activity of different coumarin derivatives.[3] The compounds were screened against pathogenic micro organisms such as *E.coli* and *S. aureus* showed that the compounds with intermolecular H-bonding were found more active revealing a possible relationship among hydrogen bonding and antimicrobial activities. Few compounds showed significant antimicrobial activity when compared with standard drug.[3]



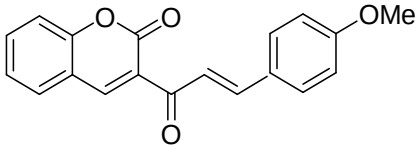
(3)

Creaven *et al.* synthesized and evaluated the antimicrobial activity of series of substituted coumarin-3-carboxylatosilver (I) complexes.[4] A series of new coumarin derived carboxylate ligands and their silver (I) complexes are screened for their in vitro antibacterial activity against a range of Gram-positive and Gram-negative bacteria are well as for their antifungal activity against a clinical isolate of *Candida albicans* potent activity against the clinically important methicillin-resistant *Staphylococcus aureus*. The Gram-positive strains studied were clinical isolates of *S. aureus* (SA), methicillin-resistant *S. aureus* (MRSA), *S. simulans* and *M. luteus* whilst the Gram-negative stains were *E. coli*, *B. olenius* and *P. agglumerans*. The anti-Candida activity of each of the complexes and their respective ligands were also determined using a clinical isolate of *C. albicans*. The standard drug used was ketoconazole. One compound showed maximum antimicrobial activity when compared to the standard drug.[4]



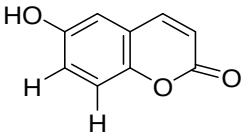
(4)

Gendy *et al.* reported antimicrobial activity of (3-(3-(4-Methoxyphenyl)acryloyl)- 2*H*- Chromen-2-one.[5] Gram- positive bacteria *Staphylococcus aureus* and *Bacilli subtilis*(ATCC 6635), Gram - negative bacteria *Escherichia coli* and *Salmonella typhimurium* (ATCC 14028), Yeast *Candida albicans* and Fungus *Aspergillus fumigates*. The antibiotic chloramphencol was used as standard reference in the case of Gram-negative bacteria, Cephalothin was used as standard reference in the case of Gram-positive bacteria and cycloheximide was used as standard reference in the case of yeasts and fungi. Some compounds showed significant antimicrobial activity when compared with standard drug.[5]



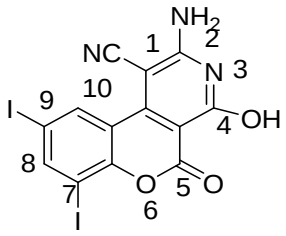
(5)

Souza *et al.* reported antibacterial activity of coumarins The antibacterial activity of coumarin and other 45 coumarin derivatives was tested against strains of *Bacillus cereus* MIP 96016, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, and *Staphylococcus aureus* ATCC 25923. Some compounds showed the most effective antibacterial activity against Gram-positive bacteria with MIC values ranging between 12.5 and 62.5μg/ml. The antibacterial activity against Gram-negative bacteria, but diminished against Gram-positive stains when compared to the parent nucleus coumarin. one compound showed significant antimicrobial activity when compared with standard drug.[6]



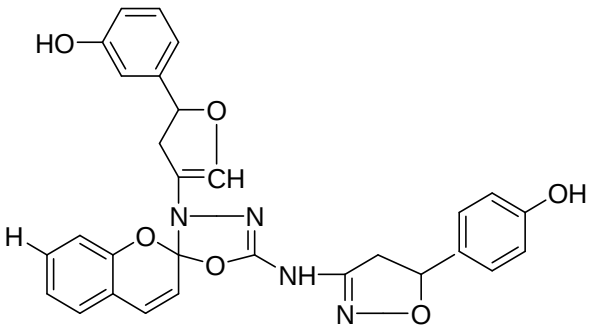
(6)

Mohamed *et al.* synthesized and characterized some new diiodocoumarin derivatives with promising antimicrobial activities All compounds were evaluated for their antimicrobial activity and some compound, exhibited a pronounced effect on all tested microorganisms. The newly synthesized compounds were screened for their antimicrobial activities *in vitro* against two species of Gram-positive bacteria, namely *Staphylococcus aureus*, *Bacillus cereus*, and two Gram-negative bacteria, namely *Escherichia coli* , *Serratia marcescens*, and against two species of fungi, namely *Aspergillus fumigatus* and *Candida albicans*. The compounds were tested by using the disc diffusion method for bacteria and the paper-disk-diffusion method for fungi. The standard drug used were ampicillin (MIC=30 µg mL) as the standard .one compound showed most potent activity against *B.sublitis* than standard drug ciprofloxacin.[7]



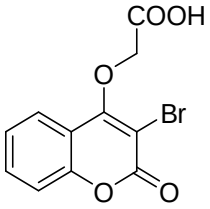
(7)

Kaur *et al.* reported the synthesis, and antibacterial activity of various substituted oxadiazolyl pyrazolinyl isoxazolinyl coumarin derivatives.[8] All the newly synthesized compounds were screened for their antibacterial activity against K. *pneumoniae, S. aureus, E. coli, B. sublitis* and were compared with the standard drug ciprofloxacin. All the newly synthesized compounds were tested for their antibacterial activity. Antibacterial activity was determined by agar cup plate method at a concentration of 100mg/ml. The gram negative bacteria were *Escherichia coli, Staphlococcus aureus, Klebsiella, Pneumoniae* and *B. sublitis*. The activity was compared with known standard drug ciprofloxacin at 10 µg/ml concentration. Some compounds showed considerable antimicrobial activity when compared with their respective standard drugs.[8]



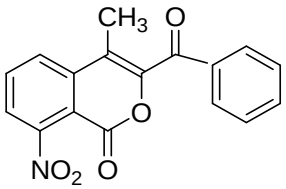
(8)

Dahiya *et al.* synthesized and evaluated screening of peptidyl derivatives of bromocoumarins methylimidazoles acid derivatives.[9] The antibacterial and antifungal effects of synthesized peptide derivatives were studied against eight pathogenic microbes. One compound showed good antimicrobial activity against *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Trichophyton mentagrophytes* and *Microsporum audouinii*, and displayed good antifungal activity against *Candida albicans* with minimum inhibitory concentration of 6.25 g/ml. All newly synthesized peptide derivatives were evaluated for their antimicrobial potential against two Gram-positive bacteria *Bacillus subtilis*, *Staphylococcus epidermidis* and two Gram-negative bacteria *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* at 50—6.25 g/ml concentration by using modified Kirby-Bauer disc diffusion method. One compound showed potent antifungal activity against *C.albicans* comparable to reference drug-griseofulvin.[9]



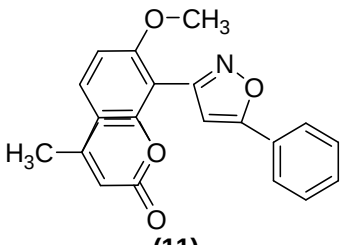
(9)

Yadav *et al.* reported the antibacterial activity of 3,4-disubstituted, 3,4,8 trisubstituted isocoumarin.[10] The antimicrobial activity of the target compounds were tested in vitro against bacterial strains *E. Coli* (gram negative), *S. Aureus* (gram positive) and fungal strains *F. Pallidoroseum* and Cheatomium by using serial agar dilution and Potato Dextrose Agar medium respectively. The same series of compounds was screened against gram negative *E. Coli* bacteria. The significant antimicrobial activity was seen with all the compounds and exhibited even better activity than standard antibiotic ampicillin. Some compounds showed considerable antimicrobial activity when compared with their respective standard drug.[10]



(10)

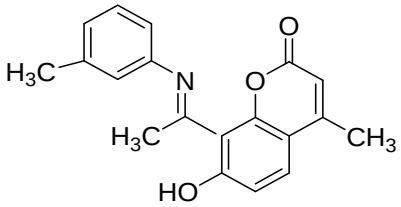
Gummudavelly *et al.* reported biological screening of some novel coumarin derivatives.[11] The anti microbial activity of all the synthesized compounds, and was determined by cup-plate method and evaluated their antimicrobial activity against *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus and Bacillus subtilis*. The fungi used are *Aspergillus niger, Aspergillus flavus* and *candida albicans*. Ciprofloxacin and fluconazole was used as standard drugs for anti bacterial and antifungal activities respectively. One compound showed considerable antimicrobial activity when compared with their respective standard drug.[11]



(11)

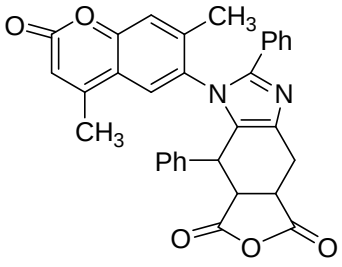
Balaji *et al.* synthesized the Schiff bases derived from acetyl coumarin.[12] and evaluated for anti-microbial activity. All synthesized compounds were screened for antibacterial and antifungal activity by cup plate method

.The two concentrations were taken i.e. 50 & 100 µg/ml for different bacterial stains and fungal stains . The values obtained were compared with the values produced from the standard drugs like Ampicillin and Streptomycin for antibacterial and Flucanazole for antifungal. Some of the compounds showed significant antimicrobial activity when compared with the standard drugs.[12]



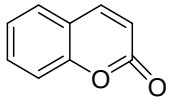
(12)

Choudhari *et al.* reported synthesis and antimicrobial screening of 5*H*,7*H*-N-(coumarin-6-yl)-2,8-diphenyl-5,7-dioxo-4,5,6,7-tetrahydrobenzimidazo[5,6-c]-furan derivatives.[13] The compounds were screened for their antibacterial activity against *S.aureus* and *S. typhi* and antifungal activity against *A.niger* and *C.albicans*. The minimum inhibitory concentration was determined using tube dilution method. Ciprofloxacin and miconazole were used as the antibacterial and antifungal standard drugs respectively. The biological studies reveals that all the compounds showed good antimicrobial activity with MIC values ranging from 50ug/ml to 200ug/ml. One compound showed significant antimicrobial activity when compared with standard drug.[13]



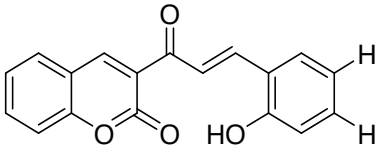
(13)

Kinza *et al.* reported the synthesis of coumarin derivatives and evaluated.[14] them against two bacterial strains; *E.coli* and *S.aureus*. The antibacterial activities of different samples of coumarin were investigated by Agar disc diffusion technique. The standard drug used was chloramphanicol with MIC 80 mg/mL. Some compounds showed significant antimicrobial activity when compared with standard drug.[14]



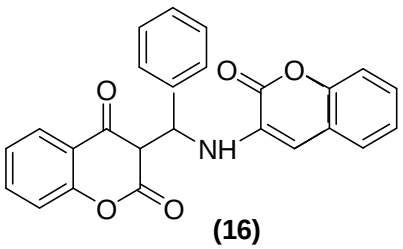
(14)

Saleta *et al.* reported the efficient synthesis of coumarin chalcone hybrids.[15] as new scaffold with antibacterial activity. The new coumarin-chalcone hybrids containing different sustituents as antimicrobial agents. The compounds were screened for their antibacterial activity against *S.aureus* and *S typhi* and antifungal activity against *A.niger* and *C.albicans*. One compound showed maximum antimicrobial activity when compared to the standard drugs.[15]



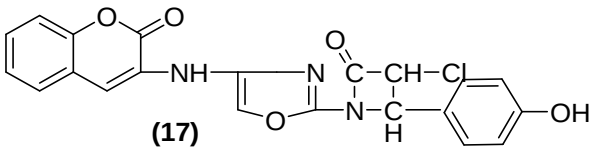
(15)

Haiza *et al.* reported the synthesis of some new coumarin derivatives.[16] with biological activity. The Synthesized compounds were screened for their antimicrobial activity against the Gram-positive bacteria *Staphylococcus aureus*, *Bacillus Subtilis*, *Bacillus cereus*, Gram-negative bacteria, *Pseudomonas aurignosa*, *Echerichia coli*, *Enterobacter aerogenes*, as well as fungi *Aspergillus niger*, *Penicillium italicum*, *Fusarium oxysporum*. The standard antibiotic drug amoxicillin for bacteria and mycostatin for fungi were used as standard drugs. Some compounds showed considerable antimicrobial activity when compared with their respective standard drugs.[16]



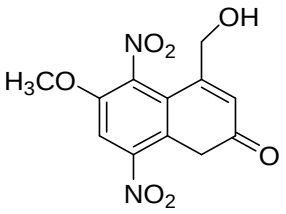
(16)

Singh *et al.* reported and synthesized the new coumarin derivatives as antibacterial agents.[17] All the synthesized compounds were screened for their antibacterial and antifungal activities and compared with reference drug ciprofloxacin. All the synthesized compounds were evaluated for antibacterial and antifungal activities. For antibacterial screening various bacteria, *staphylococcus aureus* 209 P, *E. Coli* ESS 2231, *proteus vulgaris*, *K. Pneumoniae* were used. Antifungal activity were performed against *candida albicans*, *candida albicans* ATCC 10231. The screening results were compared with gatifloxacin and ciprofloxacin for antibacterial and fluconazole for antifungal activities respectively. One compound showed maximum antimicrobial activity when compared to the standard drugs.[17]



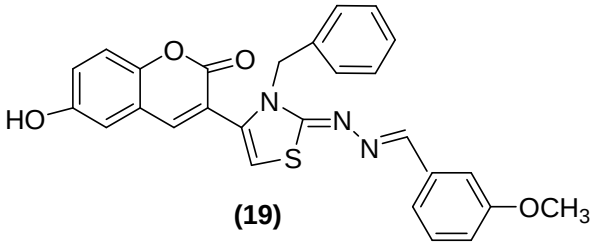
(17)

Basanagouda *et al.* reported the synthesis of some new 4-aryloxmethylcoumarins.[18] and screened for their antibacterial and antifungal activities. The antibacterial activity was carried out against three Gram-negative bacteria, *Escherichia coli*, *Psuedomonus aeruginosa*, *Klebsiella pneumoniae*, and two Gram-positive bacteria, *Staphylococcus aureus*, and *Streptococcus faecalis* by using cup plate method. Ciprofloxacin was used as standard. Antifungal activity was carried out against five fungi, viz. *Aspergilus flavus, Aspergilus fumigatus*, *Candida albicans, Penicillium notatum* and *Rhizopus* by using cup plate method. Fluconazole used as standard drug. The investigation of antibacterial screening data revealed that all the tested compounds showed moderate to good bacterial inhibition. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[18]



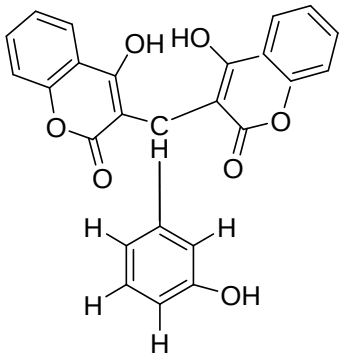
(18)

Aysel *et al.* reported synthesis, characterization and primary antitubercular activity evaluation.[18] of 4-(3-coumarinyl)-3-benzyl-4-thiazolin-2-one derivatives and evaluated for antituberculosis activity against *Mycobacterium tuberculosis* H37Rv in BACTEC 12B medium using the BACTEC 460 radiometric system. These compounds reported to exhibit antibacterial and antifungal activities also. One compound showed maximum antimicrobial activity when compared to the standard drugs.[19]



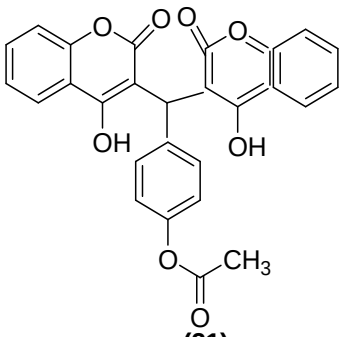
(19)

Petnapapun *et al.* synthesized and evaluated their antibacterial activity of dicoumarols.[20] The synthesized dicoumarols showed the antibacterial activity but are selective against Gram positive *S. aureus* bacteria over Gram negative *E. coli* cell. Dicoumarol and its analogs have been shown to be biologically active against many bacteria including *Staphylococcus aureus*, *Bacillus anthracis* and *Streptococcus pyogenes*. The synthesized compounds with a hydroxyl substitution showed the smallest inhibition zone against *S.aureus* in comparison with those of the other compounds. Many compounds showed maximum antimicrobial activity when compared to the standard drugs.[20]



(20)

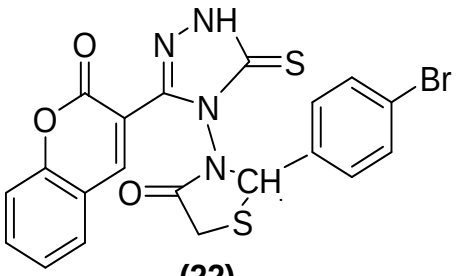
Chiang *et al.* synthesis and antimicrobial evaluation of coumarin derivatives.[20] The compounds were screened for their antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterococcus* species, *Streptococcus pyogenes*, and *Streptococcus pneumoniae* . Certain compounds showed good or moderate antimicrobial activity on *Staphylococcus aureus*, and *Streptococcus pneumonia*. The standard drug used were gentamycin, vancomycin and penicillin saturated antibiotics were used as positive controls. One compound showed maximum antimicrobial activity when compared to the standard drugs.[21]



(21)

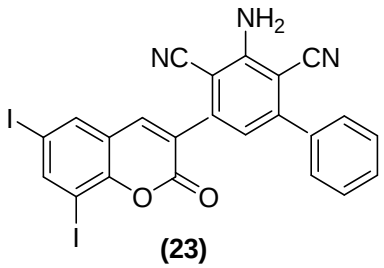
Bhat *et al.* reported the synthesis of Triazolothiazolidinone derivatives.[22] of coumarin with antimicrobial activity. The synthesized compounds were screened for their antibacterial activity against Gram positive *S. aureus* and Gram negative *E. coli* stains and antifungal activity against *C. albicans* by cup-plate method and agar diffusion method. Ciprofloxacin and ketoconazole were used as the standards. The compound with Chloro substitution showed the highest activity against *S. aureus* and the compounds without substitution showed the highest activity against *E. coli*. The compounds with methoxy, dimethylamino, showed

the highest antifungal activity against *C. albicans*. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[22]



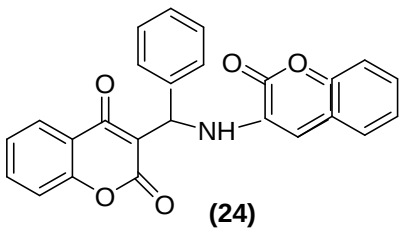
(22)

Wahab *et al.* reported the synthesis of some new diiodocoumarin derivatives.[23] bearing side chains. The newly synthesized compounds were screened for their antimicrobial activity. These compounds showed moderate inhibition towards *Aspergillus fumigatus* and *Candida albicans* relative to Claforan. The activities of these compounds were tested using the disc diffusion method. The area of zone of inhibition were measured using Ampicillin, as standard antibacterial and Calforan was used as a reference antifungal. One compound showed maximum antimicrobial activity when compared to the standard drugs.[23]



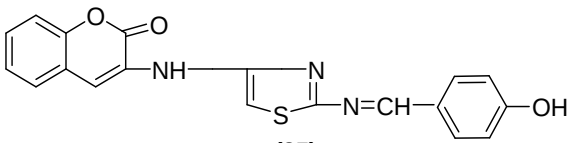
(23)

Haiza *et al.* reported synthesis of some new coumarin derivatives.[23] with antibacterial activity. All the prepared compounds were screened for their antimicrobial activity against the Gram-positive bacteria, *Staphylococcus aureus*, *Bacillus Subtilis*, *Bacillus cereus*), Gram-negative bacteria, *Pseudomonas aurignosa*, *Echerichia coli*, *Enterobacter aerogenes*, as well as fungi *Aspergillus niger*, *Penicillium italicum*, *Fusarium oxysporum.* Standard antibiotic drug Amoxicillin against bacteria and Mycostatin against fungi were used for comparisons. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[24]



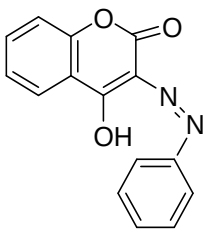
(24)

Singh *et al.* reported the synthesis of new coumarin derivatives.[25] as antibacterial agents. These compounds were screened for their antibacterial and antifungal activities and compared with reference drugs ciprofloxacin, gattifloxocin, luconazole. For antibacterial screening various bacteria, *staphylococcus aureus*, *proteus vulgaris*, *K. Pneumoniae* were used. Antifungal activity were performed against *candida albicans*, *candida albicans*. The screening results were compared with gattifloxacin and ciprofloxacin for antibacterial and fluconazole for antifungal activities respectively. One compound showed maximum antimicrobial activity when compared to the standard drugs.[25]



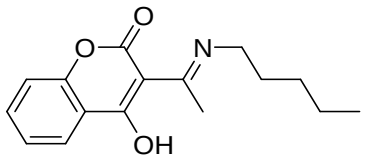
(25)

Kumar *et al.* reported synthesis and antimicrobial evaluation of some novel 4-hydroxy coumarin derivatives bearing azo moiety.[26] The antibacterial activity of screened compounds viz., *E.coli*, *S.aureas*, *S. typhi* and *Pseudomonas* species. Antibacterial activity of each compound was compared with standard drug ciprofloxacin. Some compounds showed excellent antibacterial activity against all bacterial species. One compound showed maximum antimicrobial activity when compared to the standard drugs.[26]



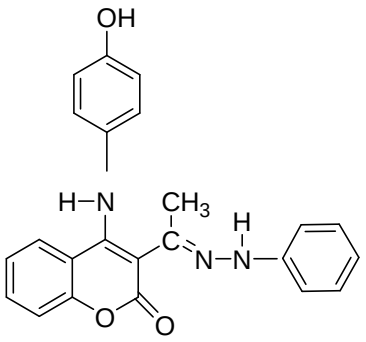
(26)

Girgaokar *et al.* synthesized a series of Schiff base, 4-hydroxy-3-(1-(arylimino)ethyl)chromen-2-one.[27] These compounds were evaluated for antibacterial and antifungal activities. These compounds were evaluated for antimicrobial activity *in-vitro* against gram positive bacteria *S. aureus*(ATCC 9144), *B. subtilis* (AT 6633) and *S. epidermis*(ATCC 12228) and gram negative bacteria *E. coli*(ATCC 25922), *S. typhi* and *P. aeruginosa* (ATCC9027) using Grisiofulvin and Penicillin as standard drugs for antibacterial and antifungal activities respectively. One compound was found to be most active with an MIC of 20 ug/mL against all the tested organisms. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[27]



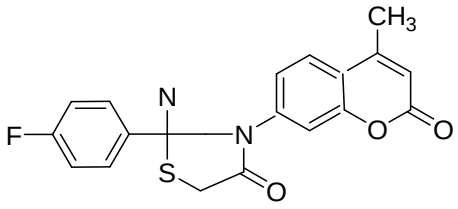
(27)

Vaso *et al*. reported synthesis and antibacterial activity of 4-(4-Hydroxy-phenylamine)-3-[1-(Phenylhydrazine]-Ethyl]-2*H*-[1]-benzopyran-2-one.[28] derivatives**.** The compound were screened for its antibacterial activity against Gram positive bacteria i.e. *Staphylococcus aureus and Bacillus cereus* and against Gram negative bacteria i.e. *Escherichia coli,* by using Kirby-Bayerm method or disc method. Streptomycine and Cephalexine as standard drugs. One compound showed maximum antimicrobial activity when compared to the standard drugs.[28]



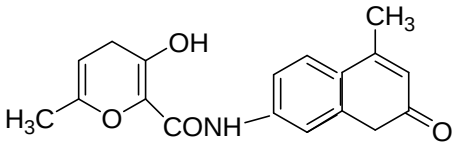
(28)

Ronad *et al*. reported the synthesis and antimicrobial activity of 7-(2-substituted phenylthiazolidinyl)-benzopyran-2-one derivatives.[29] The results showed that one compound with MIC (100 mg/ml) exhibited good antibacterial and antifungal activity as that of standard antibiotics Ciprofloxacin and Griseofulvin. Some compound showed maximum antimicrobial activity when compared to the standard drug.[29]



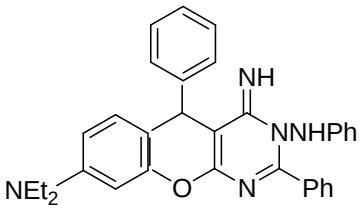
(29)

Dilok *et al*. reported the synthesis and evaluation of antimicrobial activity of new 3-hydroxy-6-methyl-4-oxo-4H-pyran-2-carboxamide derivatives.[30] Antimicrobial activities were determined as MIC values using the microdilution broth method against *Staphylococcus aureus*, *Entrococcus faecalis*, *Escherichia coli* and *Pseudomonas aeruginosa* for bacteria and *Candida albicans*, *C: krusei* and *C. parapsilosis* for fungi. Fluconazole and ceftazidime were used as the reference compounds for fungi and bacteria, respectively. The amide derivative is the most active the compound in the entire series against *P. aeruginosa*. One compound showed maximum antimicrobial activity when compared to the standard drugs.[30]



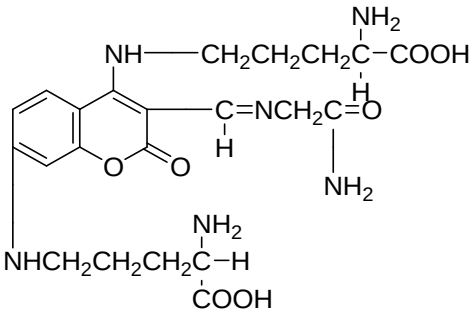
(30)

Nermien *et al.* demonstrated the synthesis of 4*H*-chromene, coumarin,12*H*-chromeno[2,3-d]pyrimidine derivatives.[31] and evaluated their antimicrobial activities. The compounds were tested in vitro for their antimicrobial activities by agar diffusion method using g-negative Escherichia coli and g positive Bacillus *pumilus, Bacillus subtilis, Staphylococcus aureus* and *Staphylococcus epidermidis* pathogenic bacteria using ampicillin as a reference compound and two fungi *Candida albicans* and *Saccharomyces cervesia* using mycostatine reference compound. One compound showed maximum antimicrobial activity when compared to the standard drug.[31]



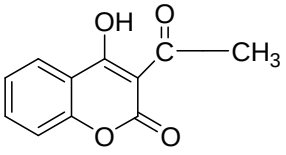
(31)

Behrami *et al* synthesized "4,7-dihydroxy-2-oxo-2*H*-chromene-3-carbaldehyde.[32] and tested against three strains of bacterial culture, *Staphylococcus aureus, E.coli* and *Bacillus cereus*. These compounds showed bacteriostatic and bactericidal activity. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[32]



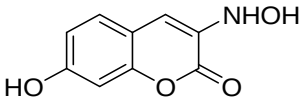
(32)

Redha *et al*. reported synthesis of new pyrazole derivatives derived from 4-hydroxy coumarin.[33] and evaluated antimicrobial activity against some test compounds were investigated against Gram positive and Gram negative bacteria like *Staphlococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa* and *Escherchia coli*, using agar media, and fungi *Candida albicans*. One compound showed maximum antimicrobial activity when compared to the standard drugs.[33]



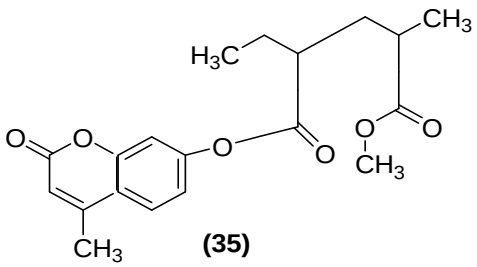
(33)

Krasniqi *et al.* demontrated synthesis and antibacterial activities of some 7-hydroxy-3-nitro-chromen-2-one derivatives against *Staphylococcus aureus* and *Klebsiella*.[34] The antibacterial activity of compounds was investigated applying the Kirby-Bayer method or disc method. The antibacterial activity of screened compounds was compared with standard drug of Cefalexine. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[34]



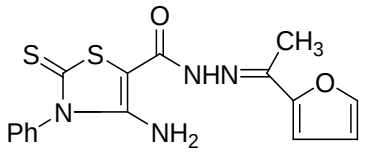
(34)

Patel *et al*. synthesized and tested for antimicrobial activities of poly(acrylates)bearing 4-methyl derivatives.[35] of coumarin against bacterial stains *Bacillus subtilis*, *Escherichia coli*, and *Staphylococcus citreus*, fungal stains *Aspergillus niger*, *Sporotichum pulveruletum*, and *Trichocerma lignorum* and yeast stains *Candida utilis*, *Saccharomyces cerevisiac*, and *Pichia stipitis*. One compound showed maximum antimicrobial activity when compared to the standard drugs.[35]



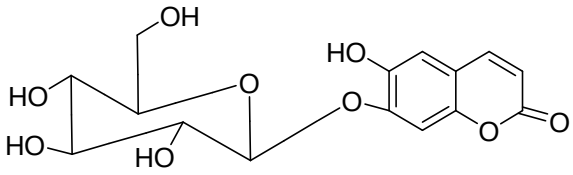
(35)

Rafat *et al.* synthesized some novel coumarin derivatives.[36] with potential antimicrobial activities. The MIC values for the newly synthesized products were tested against *E. coli, B. cereus, B. subtilis and C. albicans* and compared with ampicilline and cycloheximide as reference drugs. The antimicrobial activity of the newly heterocyclic derivatives against two stains of Gram positive bacteria *Bacillus subtilis* and *Bacillus cereus* , one stain of Gram negative bacteria *Escherichia coli* and *Candida albicans*. The ampicillin and cycloheximide were used as standard drugs. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[36]



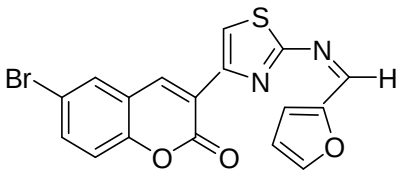
(36)

Bassuony *et al.* synthesized.[37] These compounds were screened for antimicrobial activities against compounds against two Gram-positive bacteria *Bacillus cereus, Staphylococcus aureus* and Gram-negative bacteria *Serratia Sp., Pseudomonos Sp., Escherichia coli* using ampicillin and amoxillin as a reference standards. Ampicillin used as standard drug. One compound showed maximum antimicrobial activity when compared to the standard drugs.[37]



(37)

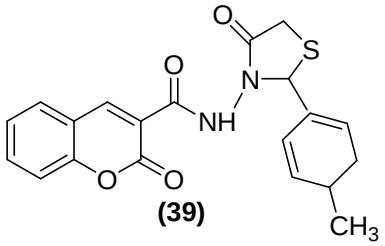
Rajasekaran *et al.* reported design and antibacterial and 2*H*-benzopyran-2-one derivatives.[38] The activity were subjected for antibacterial activity against both gram positive and gram negative bacteria. All the synthesized compounds were tested for their antibacterial activity against both gram positive and gram negative organisms like *Bacillus subtilis, Staphylococcus auereus, Escherichia coli* and *Klebsella pneumonia*. The activity was performed by cup plate agar diffusion method. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[38]



(38)

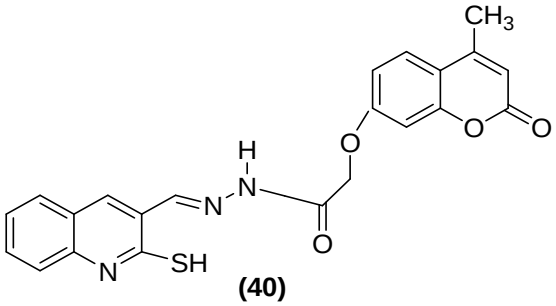
Rama *et al.* reported the synthesis and biological evaluation of some innovative coumarin derivatives containing thiazolidin-4-one ring.[39] The newly synthesized compounds were screened for antibacterial activity. The antibacterial activity were carried out

against *staphylococcus aureus, bacillus subtilis, klebsiella pneumonia* and *Escherichia coli* .The compounds tested for antibacterial activity. some compounds showed high activity against *S.aureus, B.subtilis* and moderate activity against *K. pneumoniae* and *E.coli* when compared to the standard drugs.[39]



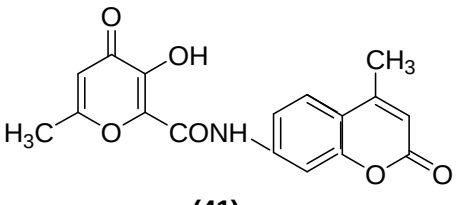
(39)

Nath *et al.* synthesized 2-[(4-Methyl-2-oxo-2*H*-chromen-7-yl)oxy]acetohydrazide.[40] The antibacterial and antifungal activities were evaluated against bacteria *Escherichia coli and Staphylococcus aureus* and fungi *Aspergillus niger and Penecillium chrysogenum* stains. The Standard drugs used were Steptomycin and Nyastatin. One compound showed maximum antimicrobial activity when compared to the standard drugs.[40]



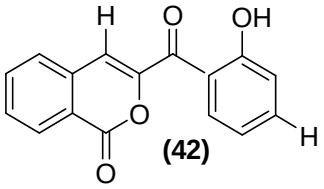
(40)

3-hydroxy-6-methyl-4-oxo-4*H*-pyran-2-carboxamide.[41] were synthesized by Aytemir *et al* and evaluated for antimicrobial activities. The antimicrobial activities against *Staphylococcus aureus, Entrococcus faecalis, Escherichia coli* and *Pseudomonas aeruginosa* for bacteria and *Candida albicans, C: krusei* and *C. parapsilosis* for fungi .some compounds exhibited higher antibacterial activity against *S. aureus, E. faecalis* and *E. coli* than the other compounds. The antibacterial activities of the amide derivatives were investigated, and were found to be the most active compounds against *S. aureus, E. faecalis* and *E. coli*. One compound showed most potent antimicrobial activity when compared to the standard drugs.[41]



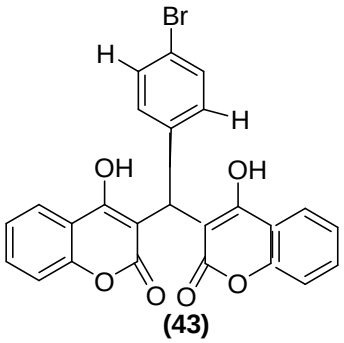
(41)

Yadav *et al.* synthesized and discovered microbial studies of some new oxygen heterocycles.[43] These compounds were screened for their antibacterial activity against gram positive *S.aureus* and gram negative *E.coli* bacteria. Most of the isocoumarin derivatives were active against gram positive bacteria and the best result were with dihydroisocoumarin. Antibacterial activity of the target compounds were tested against bacterial stains *E. Coli* and *S. Aureus* using serial agar dilution cup plate method. One compound showed maximum antimicrobial activity when compared to the standard drugs.[43]



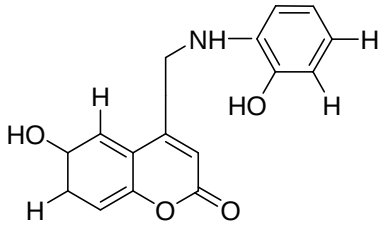
(42)

Davorka *et al*. reported the synthesis and antimicrobial activity of some 4-hydroxycoumarin derivatives.[43] The newly synthesized derivatives exhibited antibacterial activities manifested as growth inhibition on Gram-positive bacteria types *Bacillus, Staphylococcus*, while the antifungal activity against *Candida* was much weaker. The same compound did not show any antimicrobial activity against two Gram-negative bacteria types *Escherichia coli, Pseudomonas aeruginosa*. some compounds showed significant antimicrobial activity when compared to the standard drugs.[43]



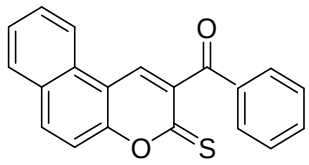
(43)

Khan *et al.* synthesized and pharmacologically evaluated novel coumarin derivatives.[44] All the synthesized compounds were evaluated for antibacterial activity against *S. aureus, E. coli, B.substillus, P. aerugenosa*. Some compounds exhibited high activity against *P. aeruginasa*. The compounds possessing hydroxy, chloro and nitro substituted coumarin showed higher activity compared to the remaining against both Gram-positive and Gram-negative bacteria. The remaining compounds exhibited moderate activity. The chloro, hydroxy and nitro group containing coumarin compounds showed better activity than their parent compounds. Substituted amine moiety fused with 4-bromo coumarin is seems to be beneficial bactericidal compound against the bacterial stain *B.substillus, E. coli., S. aureus* and *P. aeuriginosa* when compared to the standard drugs.[44]



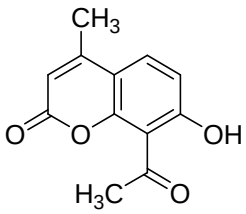
(44)

Ali *et al.* reported facile synthesis of coumarin under solvent-free condition.[51] 2-hydroxy-1- naphthaldehyde and *β*-oxodithioester. All the synthesized compounds were evaluated for antibacterial activity against *S. aureus, E. coli, B.substillus, P. aerugenosa* by using cup plate method. One compound showed maximum antimicrobial activity when compared to the standard drugs.[45]



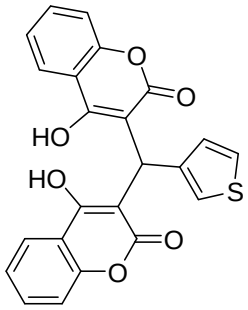
(45)

Nagamallu *et al.* reported synthesis of 8-acetyl-4-methyl-7-hydroxy coumarin hydrazones and their biological evaluation as potent antimicrobial agents.[46] The synthesized new compounds were screened for their antibacterial, antifungal activities. These compounds were screened for their antibacterial activity against gram positive *S.aureus* and gram negative *E.coli* bacteria. *Candida albicans*, *C. krusei* and *C. parapsilosis* for fungi. some compounds exhibited promising antifungal and antibacterial activity against the different organisms. some compounds showed potent antimicrobial activity when compared to the standard drugs.[46]



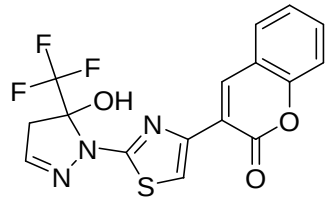
(46)

Asad *et al.* reported 4-hydroxy-3-[(4-hydroxy-2-oxo-2*H*-3-chromenyl)(3-thienyl)methyl]-2*H*-2-chromenon derivatives.[47] The one compound was found to be the most promising compound, active against Mycobacterium tuberculosis H37Rv and isoniazid resistant Mycobacterium tuberculosis (INHR-Mtb). One compound showed maximum antimicrobial activity when compared to the standard drugs.[47]



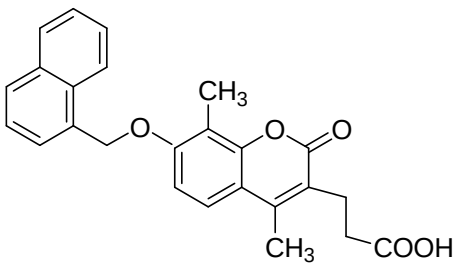
(47)

Aggarwal *et al.* reported synthesis and antimicrobial evaluation of some novel 2-(5-hydroxy-5-trifluoromethyl-4,5-dihydropyrazol-1-yl)-4-(coumarin-3-yl)thiazoles.[48] All the tested compounds displayed significant to moderate antimicrobial activity when compared to the standard drug ciprofloxacin, and good broad spectrum antibacterial activity against three Gram-positive and four Gram-negative bacteria when compared with standard drug cefixime. Some compounds showed maximum antimicrobial activity when compared to the standard drugs.[48]



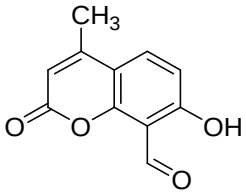
(48)

Li *et al.* reported Coumarin-based inhibitors of *Bacillus anthracis* and *Staphylococcus aureus* replicative DNA helicase.[49] chemical optimization, biological evaluation, and antibacterial activities. The synthesis and evaluation of optimized coumarin-based inhibitors with 9-18-fold increased potency against *Staphylococcus aureus* and *Bacillus anthracis* helicases against the DNA duplex strand-unwinding activities of both *B. anthracis* and *S. aureus* helicases without affecting the single strand DNA-stimulated ATPase activity. The potent antibacterial activity against multiple ciprofloxacin-resistant MRSA strains, with MIC values ranging between 0.5 and 4.2 µg/mL. One compound showed maximum antimicrobial activity when compared to the standard drugs.[49]



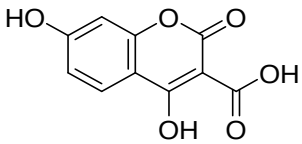
(49)

Halli *et al.* reported the synthesis of 8-formyl-7-hydroxy-4-methyl coumarin.[50] Synthesis, biological evaluation studies of Schiff's base derived from naphthofuran-2-carbohydrazide with 8-formyl-7-hydroxy-4-methyl coumarin and its metal complexes. The Schiff's base and its metal complexes were screened for their antibacterial and antifungal activities by MIC method. Many compounds showed promising antimicrobial activity when compared to the standard drugs.[50]



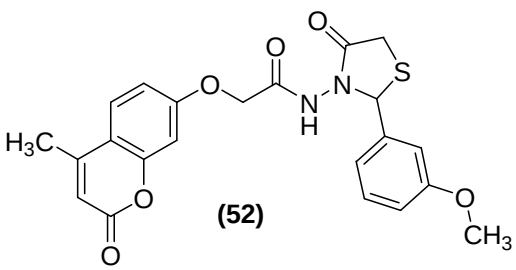
(50)

Lin *et al.* reported synthesis and antibacterial activities of some novel 4-hydroxy-7-hydroxy- and 3-carboxycoumarin derivatives.[51] One compound showed maximum antimicrobial activity when compared to the standard drugs. The synthesized new compounds were screened for their antibacterial, antifungal activities. These compounds were screened for their antibacterial activity against gram positive *S.aureus* and gram negative *E.coli* bacteria. *Candida albicans*, *C. krusei* and *C. parapsilosis* for fungi when compared to the standard drugs.[51]



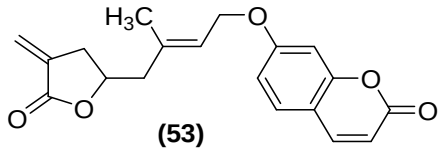
(51)

Hamdi *et al.* reported (2-(4-methyl-2-oxo-2*H*-chromen-7-yloxy)-N-(4-oxo-2-phenylthiazolidin-3-yl)acetamide.[52] synthesis and evaluation of new thiazolidinones containing coumarin moieties and their antibacterial activities. The new compounds were screened for antibacterial activity. Most of them were more active against *E. coli S. aureus* and *B. subtilis* than standard compounds. One compound showed maximum antimicrobial activity when compared to the standard drugs.[52]



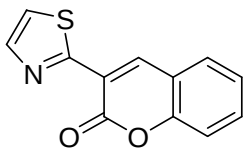
(52)

Kumar *et al.* reported 7((2E)-4(4,5-dihydro-3-methylene-2-oxo-5-furanyl)-3-methylbut-2-enyloxy) coumarin.[53] a new antifungal coumarin from *Clausena excavata*. A new γ-lactone coumarin, named as excavarin-A, showing antifungal activity was isolated from the leaves of *Clausena excavata* by bioassay guided fractionation method. The least MIC was recorded against the human pathogen, *Candida tropicalis* and the plant pathogens *Rhizoctonia solani* and *Sclerotinia sclerotiorum*. Antifungal activities against the human pathogens, *Aspergillus fumigatus* and *Mucor circinelloides* and plant pathogens, *Colletotrichum gloeosporioides, Lasiodiplodia theobromae, Fusarium oxysporum and Rhizopus stolonifer* were stronger than that of the standard antimicrobials. some compounds showed potent antimicrobial activity when compared to the standard drugs.[53]



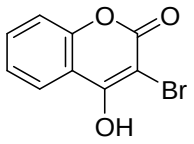
(53)

Arshad *et al.* reported synthesis and antimicrobial properties of some new thiazolyl coumarin derivatives.[54] All of these derivatives, were screened for antimicrobial activity against various bacteria species including *Mycobacterium tuberculosis* and *Candida albicans*. These compounds exhibited very good activities against all of the tested microbial stains when compared to the standard drugs.[54]



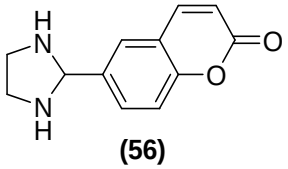
(54)

Siddiqui *et al.* reported synthesis of 4-hydroxycoumarin heteroarylhybrids as potential antimicrobial agents.[55] A new series of 4-hydroxycoumarin derivatives was synthesized by the reaction of 3-bromo-4-hydroxy coumarin with various heteroaldehydes in good yields. All target compounds were evaluated for their antimicrobial activity against *Streptococcus pyogenes*, methicillin-resistant *Staphylococcus aureus*, *Pseudomonas aeruginosa, Klebsiella pneumonia*, and *Escherichia coli* bacterial stains and fungal cultures of *Candida albicans, Aspergillus fumigatus*, *Trichophyton mentagrophytes*, and *Penicillium marneffei* by disk diffusion assay with slight modifications. The minimum inhibitory concentration (MIC) was determined for the test compounds as well as for reference standards. One compound showed maximum antimicrobial activity when compared to the standard drugs.[55]



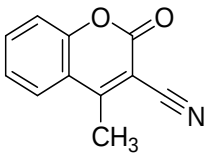
(55)

Mulwad *et al.* reported synthesis of novel biologically active heterocyclic compounds from 2-oxo-2*H*-benzopyran-6-yl-imidazolidin .[56] All the compounds were screened for their antimicrobial activities against three bacterial strains *S. aureus, S. typhi* and *E. coli*. The compounds with the presence of methyl groups at C7 and C8 of coumarin moiety were found to be more active than others. Few compounds showed potent antimicrobial activity when compared to the standard drugs.[56]



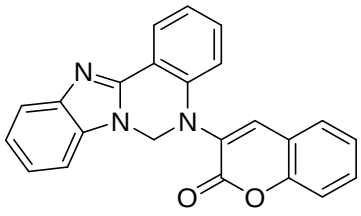
(56)

Upadhyay *et al.* reported synthesis and biological evaluation of 4-styrylcoumarin derivatives.[57] as inhibitors of TNF-α and IL-6 with anti-tubercular activity. These compounds showed very good anti-tubercular activity against *Mycobacterium tuberculosis* H37Rv strain at <6.25 μM. Many compounds showed promising antimicrobial activity when compared to the standard drugs.[57]



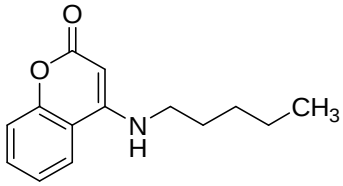
(57)

Kuarm *et al.* reported 3-[Benzimidazo- and 3-[benzothiadiazoleimidazo-(1,2-c)quinazolin-5-yl]-2*H*-chromene-2-ones.[58] as potent antimicrobial agents. These analogs were evaluated for their antimicrobial activity *against Bacillus subtilis, Staphylococcus aureus, Streptococcus pyogenes (Gram-positive bacteria), Escherichia Coli, Klebsiella pneumonia, Salmonella typhimurium (Gram-negative bacteria), and Aspergillus niger, Candida albicans,* and *Aspergillus flavus* . The MIC 15μg/mL, were identified as potent antifungal agents. Some compounds are most potent antimicrobial agents. One compound showed maximum antimicrobial activity when compared to the standard drugs.[58]



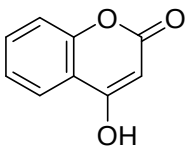
(58)

Virsdoia *et al.* Performed Screening for antimycobacterial activity and three-dimensional quantitative structure-activity relationship (3D-QSAR) study of 4-(arylamino) coumarin derivatives.[59] The compounds were evaluated for antimycobacterial activity against *Mycobacterium tuberculosis* H(37) Rv with rifampicin as the standard. The minimum inhibitory concentration >6.25 μg/mL for 100% inhibition. some compounds showed potent antimicrobial activity when compared to the standard drugs.[59]



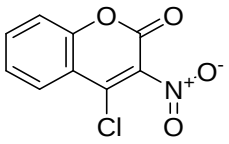
(59)

Mladenovi *et al.* designed some novel 4-hydroxy-chromene-2-one derivatives as antimicrobial agents.[60] The standard drug used is ketoconazole against *M. mucedo*. The QSAR study presents essential relation of antimicrobial activity and dominant substituents, 4-hydroxy, 3-acetyl and thiazole functional groups, also confirmed through molecular docking. The result was ten new designed compounds with much improved predicted inhibition constants and average biological activity. One compound showed maximum antimicrobial activity when compared to the standard drugs.[60]



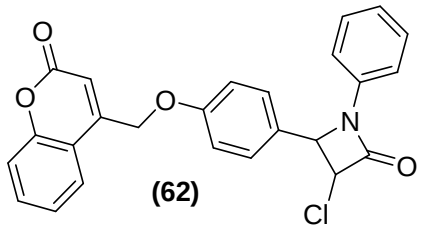
(60)

Dekic *et al.* reported 4-chloro-3-nitrocoumarin.[61] Synthesis and antimicrobial activity of new 4-heteroarylamino coumarin derivatives containing nitrogen and sulfur as heteroatoms. The synthesized compounds were tested for their antimicrobial activity, in a standard disk diffusion assay, against thirteen strains of bacteria and three fungal strains. They have shown a wide range of activity from one completely inactive compound to medium active ones. some compounds showed potent antimicrobial activity when compared to the standard drugs.[61]



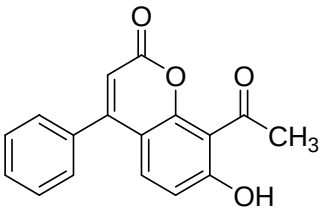
(61)

Keri *et al*. reported 3-chloro-4-[4-(2-oxo-2*H*-chromen-4-ylmethoxy)phenyl]-1-phenylazetidin-2-ones (62) Synthesis and antimicrobial studies of novel azetidinone derivatives. These compounds were screened for their antibacterial activity agaisnst two Gram-positive *(Staphylococcus aureus* and Vancomycin resistant *enteroccoccus)* and two Gram-negative (*Escherichia coli* and *Shigella* dysentery) bacterial strains and antifungal activity against *Aspergillus fumigatus, Candida albicans,* and *Penicillium.* The presence of a chlorine group in the coumarin moiety, its effect on their antibacterial activity when compared to the standard drugs.[62]



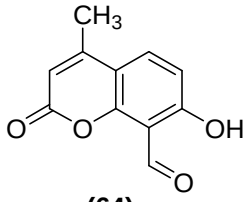
(62)

Farag *et al.* reported design, synthesis and docking studies of new furobenzopyranones and pyranobenzopyranones as photoreagent towards DNA and as antimicrobial agents.[63] A number of new furobenzopyranones and pyranobenzopyranones carrying an electron-withdrawing function at the position 3 are synthesized in order to obtain new photoreagents towards DNA were the most active compounds against *Bacillus subtilis, Staphylococcus aureus*, and *Escherichia coli*. These compounds were revealed the potent antimicrobial activity referred to the natural antimicrobial Clorobiocin which forms two hydrogen bonds. One compound showed promising antimicrobial activity when compared to the standard drugs.[63]



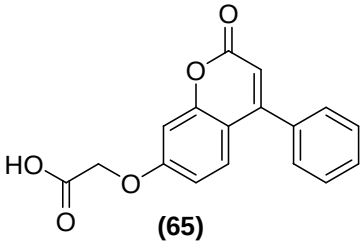
(63)

Kulkarni *et al.* reported synthesis of 8-formyl-7-hydroxy-4-methylcoumarin.[64] synthesis, and evaluation DNA cleavage and antimicrobial studies of La(III), Th(IV) and VO(IV) complexes with Schiff bases of coumarin derivatives. The Schiff bases and their complexes have been screened for their antibacterial (*Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa and Salmonella typhi*) and antifungal activities (*Aspergillus niger, Aspergillus flavus and cladosporium)* by Minimum Inhibitory Concentration method. some compounds showed potent antimicrobial activity when compared to the standard drugs.[64]



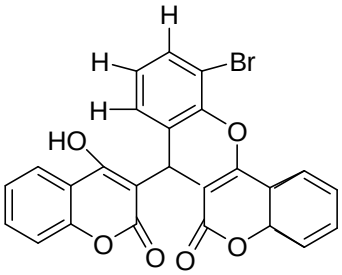
(64)

Hassan *et al.* Designed and synthesized some novel benzopyran-2-one derivatives.[65] having expected antimicrobial activity through DNA gyrase-B inhibition. The synthesized compounds were also screened for antibacterial activity against four different species of Gram-positive and Gram-negative bacteria; as well as screening against *C. albicans* for antifungal activity. The molecular modeling data were in accordance with the antimicrobial screening results. One compound showed significant antimicrobial activity when compared to the standard drugs.[65]



(65)

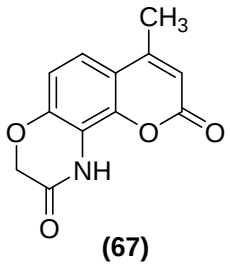
Muratovic *et al.* synthesized 3-(6-oxo-(1*H*)-18-bromobenzopyrano [4,3-b]benzopyran-7-yl)-4-hydroxycoumarin biscoumarin derivatives.[66] as antimicrobial agents. The synthesized compounds were screened for their antimicrobial activity against five strains of bacteria and two fungal strains using disk diffusion assay and dilution method. one compound was having greater antibacterial activity than the standard chloramfenicol drug with MIC 1.9 µg/mL against *Staphyloccocus aureus* and could be considered as leading compound in the future antimicrobial drug development. Few compounds showed potent antimicrobial activity when compared to the standard drugs.[66]



(66)

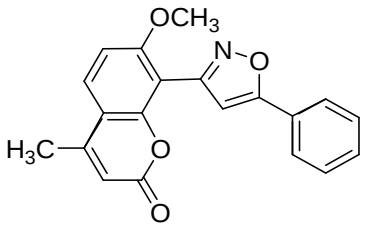
2.2.2. Anti-inflammatory Activity and Analgesic Activity

Sahoo *et al*. were synthesized and evaluated the novel coumarin derivatives and its biological evaluations,[67] These newly formed Coumarin derivatives were screened for anti-inflammatory activity by carrageenan induced rat paw edema model. The synthesized coumarin derivatives were administered orally in the dose of 10 mg/kg. Ibuprofen was used as standard drugs. The result of present investigation showed that the compounds showed significantly ($P < 0.001$) inhibition against Carrageenan induced rat paw edema. One compound showed maximum anti-inflammatory activity when compared to the standard drugs,[67]



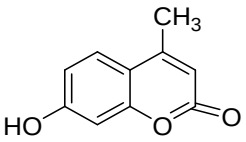
(67)

Sandeep *et al* reported the synthesis and biological screening of some Novel coumarin derivatives,[68] The anti inflammatory activities some of them exhibited significant activity. It was carried out by carrageenan-induced rat paw edema method of winter et al. All the synthesized compounds and standard drug, ibuprofen were tested at a concentration of 100 mg/ml. Ibuprofen showed 76% protection against edema. The compounds exhibited 72%, 70% and 68% protection respectively. These compounds showed significant activity as that of standard drug, ibuprofen,[68]



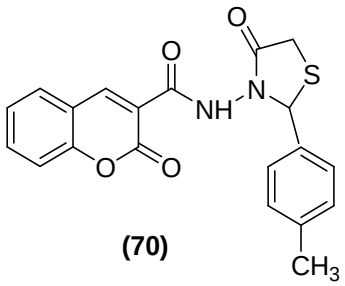
(68)

Mantri *et al*. were synthesized 7-hydroxy-4-methyl coumarin with different secondary amine,[69] Anti-inflammatory activity was determined *in vivo* using the carrageenan-induced mice paw edema test. A solution of 0.1 ml of 1% carrageenan43 in saline was injected subplantarly into the right hind paw of the mice 1 h after i.p. administration of the compounds. The ibuprofen were tested at a concentration of 100 mg/ml. Some compounds showed maximum anti-inflammatory activity when compared to the standard drugs,[69]



(69)

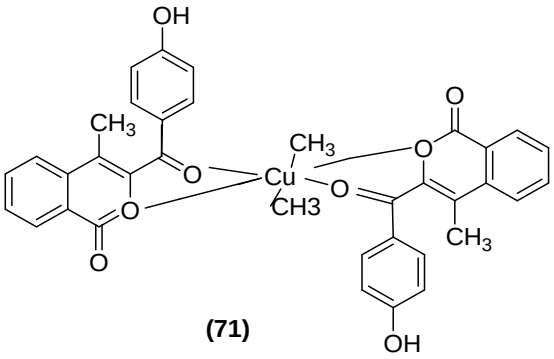
Yadav *et al*. reported synthesis and biological evaluation of some innovative coumarin derivatives containing thiazolidin-4-one ring,[70] The analgesic activity of the newly synthesized compounds was tested using adult Swiss albino mice by the abdominal constriction method. The mice were housed individually in polypropylene cages with paddy husk as bedding. The animals were maintained at the temperature of 25-27oC.and relative humidity of 30-70%. The six mice each were selected and 0.6%acetic acid was injected intraperitoneally. The acetyl salicylic acid was used as standard for the comparison of analgesic activity. Some compounds showed potent analgesic activity,[70]



(70)

2.2.3. Antioxidant Activity

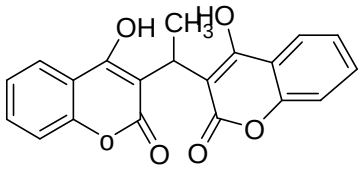
Rajeshirke *et al*. reported synthesis and antioxidant activity of Metal(II)complexes of isocoumarin derivatives **(71)** Antioxidant activity was tested by estimating scavenging activity for nitrous oxide using Griess reagent by test compounds.2.0 ml of sodium nitroprusside (10 mM) in 0.5ml phosphate buffer pH 7.4 was incubated with 0.5 ml, 1000 ppm concentration of test compounds dissolved in a suitable solvent (DMSO) (1.0 ml 1% sulfanilamide, 1.0 ml 5% ophosphoric,acid and 2.0 ml 0.1Nnaphthylethylenediamine dihydrochloride dissolved in distilled water). The absorbance of the chromophore formed during diazotization of nitrite with sulfanilamide and subsequent Nnaphthylethylenediamine dihydrochloride was read at λ 546 nm after 30 mins. One compound showed maximium antioxidant activity when compared to standard drug,[71]



(71)

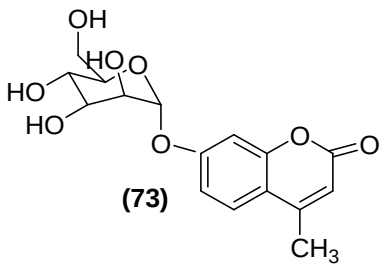
2.2.4. Anticancer Activity

Rehman *et al.* synthesized and characterized , in vitro U2OS tumoricidal activites of different coumarin derivatives,[72] The compounds were screened against U2OS cancerous cells and pathogenic micro organisms. The compounds with intermolecular H-bonding were found more active revealing a possible relationship among hydrogen bonding, cytotoxicity and antimicrobial activities. Some compounds showed maximum anticancer activity when compared with standard drug.[74]



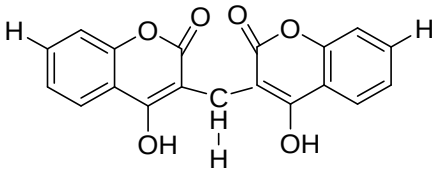
(72)

Touisni *et al.* reported Glycosyl Coumarin Carbonic Anhydrase IX and XII Inhibitors Strongly Attenuate the Growth of Primary Breast Tumors,[73] A series of 7-substituted coumarins incorporating various glycosyl moieties were synthesized and investigated for the inhibition of the zinc enzyme carbonic anhydrase. These coumarins were very weak or ineffective as inhibitors of the housekeeping, offtarget isoforms CA I and II, but some of them inhibited tumor-associated CA IX and XII in the low nanomolar range. They also significantly inhibited the growth of primary tumors by the highly aggressive 4T1 syngeneic mouse mammary tumor cells at 30 mg/kg, constituting interesting candidates for the development of conceptually novel anticancer drugs. Because CA IX is over expressed in hypoxic tumors and exhibits very limited expression in normal tissues, such compounds may be useful for treating cancers not responsive to classic chemo- and radiotherapy.[73]



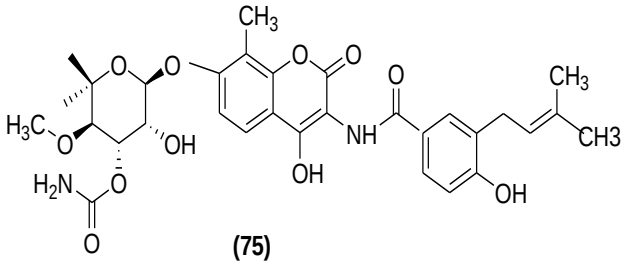
(73)

Nolan *et al.* reported coumarin based Inhibitors of human NADPH quinone Oxidoreductase-1. Identification,[74] and In Vitro Human Pancreatic Cancer Toxicity.The enzyme human NAD (P)H quinone oxidoreductase-1 . A comparison of NQO1 inhibition and off-target effects for dicoumarol and its derivatives suggests that the ability of dicoumarol to kill cancer cells is independent of NQO1 inhibition, that cellular superoxide production by dicoumarol does not seem linked to NQO1 inhibition but may be related to mitochondrial decoupling, and that superoxide does not appear to be a major determinant of cytotoxicity. Implications are discussed for NQO1 inhibition as an anticancer drug design target and superoxide generation as the dicoumarol-mediated mechanism of cytotoxicity,[74]



(74)

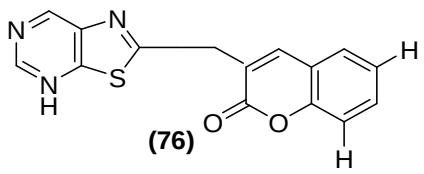
Donnelly *et al.* Synthesized coumarin ring derivatives of the novobiocin scaffold that exhibit antiproliferative activity novobiocin,[75] a known DNA gyrase inhibitor, binds to a nucleotide-binding site located on the Hsp90 *C*-terminus and induces degradation of Hsp90-dependent client proteins at ~700 μM in breast cancer cells (SKBr3). Many analogues of novobiocin have been synthesized, it was only recently demonstrated that monomeric species exhibit antiproliferative activity against various cancer cell lines. The studies have produced novobiocin analogues that manifest low micromolar activity against several cancer cell lines,[75]



(75)

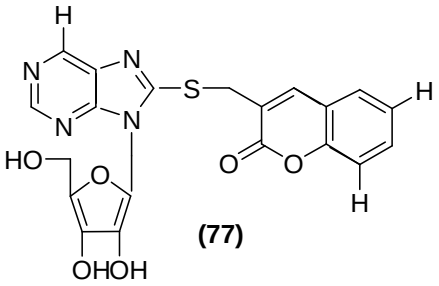
2.2.5. Antiviral Activity

Neyts *et al.* reported new anti-hepatitis C virus agents heterobicycle coumarin conjugates (76) The synthesized compounds were found to possess significant antiviral activities. Prominent examples included imidazopyridine coumarin , purine-coumarin and benzoxazole coumarin which inhibited HCV replication at an EC_{50} of 6.8, 2.0, and 12 μM, respectively,[76]



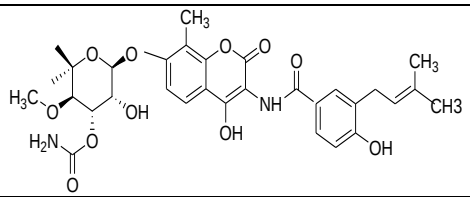
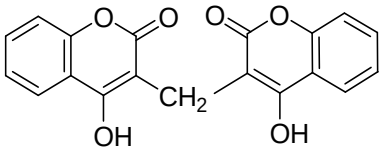
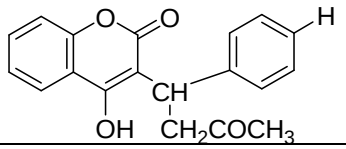
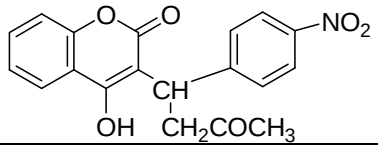
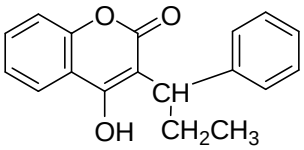
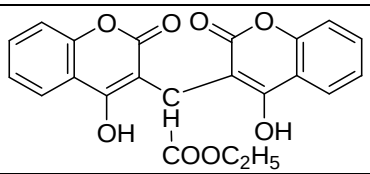
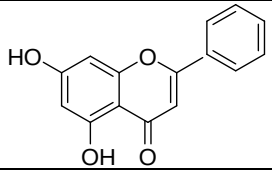
(76)

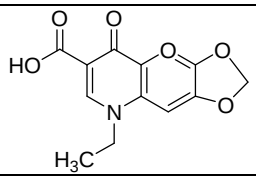
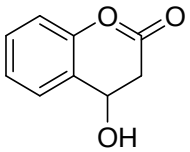
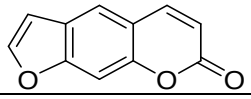
Hwu *et al*. reported 9-(β-D-ribofuranosyl)purine-8-thiones with 3-(chloromethyl)coumarins bearing various substituents. New Agents against Hepatitis C Virus,[77] About 3% of world's population is infected by the hepatitis C virus (HCV), for which prophylactic vaccine is not available yet. A $-SCH_2-$ unit was used to link the coumarin and the purine moieties. Their anti-HCV and cytostatic determination assays were performed, to inhibit HCV replication with EC_{50}between 5.5 and 6.6 μM and EC_{90} of ~20 μM. These data in the new compound library provide clues for the future in the development of anti-HCV leads for viral eradication,[77]



(77)

Table 2.2: Clinically Used Antimicrobial Drugs Based on Coumarin Ring.[78-80]

S.NO.	Brand Name	Chemical Structure	Pharmacological Use
1.	Novobiocin®		Antibiotic
2.	Dicoumarol®		Anti-microbial Agent
3.	Warfarin®		Oral Anti-coagulant
4.	Nicoumalone®		Oral Anti-coagulant
5.	Phenprocoumon®		Oral Anti-coagulant
6.	Ethyl Biscoumacetate®		Oral Anti-coagulant
7.	Chrysin®		Anti-microbial agent

8.	Oxolinic acid®		Antibiotic
9.	4-Hydroxy Coumarin®		Antibiotic
10.	Psoralen®		Antibiotic

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