



Review Article

<http://dx.doi.org/10.47587/SA.2020.1102>



## Antibiotic potential of actinomycetes from different environments against human pathogens and microorganisms of industrial importance: a review

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Received Date: Dec 23, 2019 / Accepted Date: June 20, 2020 / Published Date: June 26, 2020

### Abstract

Actinomycetes are Gram-positive, aerobic and thread like bacteria with high DNA G+C contents. They are free-living, saprophytic, and abundant in soil, water, and colonizing nodulating plants. Actinomycetes assume a significant job in reusing squanders in the earth and they are additionally the makers of thousands of metabolic items, which display organic action. Due to the outstanding history of actinomycetes in the production of bioactive molecules for human interest, a large number of efforts have been made on the isolation, characterization and identification from terrestrial sources in the past half-decade. Secondary metabolites obtained from various potential strains of actinomycetes are very effective against Gram-positive and Gram-negative bacteria. Many researchers both nationally and internationally isolated this potential group of microorganisms from soil, water, sediment etc. and checked their potential antimicrobial activity. In the present review, antibiotic potential of actinomycetes from different environments against human pathogens and microorganisms of industrial importance have been discussed along with novel antimicrobial compounds.

**Keywords:** Actinomycetes, human pathogens, antimicrobial compounds and antibiotic potential

### Introduction

Human diseases caused by pathogenic microorganisms are growing year by year and they are becoming a big hazard to community health (Binder et al., 1999; Smolinski et al., 2003; Morens et al., 2004; Jones et al., 2008). Globally researchers have been conducted studies to discover new antimicrobials to control diseases caused by microorganism for the benefits of society and mankind (Soussi et al., 2009; Holmalahti et al., 1998; Solanki et al., 2008). Microbes isolated from soil, water and sediment samples are the most significant sources for potential antibacterial and antifungal against an extensive range of bacterial as well as fungal species along with antibiotic resistant microbial strains. Some microorganisms are also even explored for anticancer, antiviral activities. Microbes are known to produce bioactive molecules in their log phase which are avoidable for their growth and progress but beneficial in protection mechanism. Soil microorganisms in specific are explored extensively.

Actinomycetes are prokaryotic, great G+C content, Gram-positive filamentous bacteria. They are infinite sources of new bioactive substances with many medical applications and embrace a projecting place due to their diversity and confirmed capability to harvest several new antimicrobial compounds including antibiotics, immune modulators, anticancer drugs, antiviral drugs, herbicides, and insecticides. So far, approximately twenty-two thousand known bioactive metabolites, Seventeen percent of which are isolated by actinomycetes, twenty percent from fungi, seven percent from the genera of *Bacillus* and approximately three percent by other microorganisms. *Streptomyces* produce 50–55% antibiotics out of the more than 10,000 known antibiotics from actinomycetes group. Presence of number and kinds of actinomycetes in soil affected by numerous factors i.e. type of soil, content of organic matter, temperature of soil, aeration, moisture content, cultivation and pH of soil ( El-khawaga et al., 2012).

### Antibiotic potential of actinomycetes from different environments

Actinomycetes are most significant group of bacteria extensively screened from various sources to harvest a varied range of bioactive substances with varied biological activity. Secondary metabolites obtained from various potential strains of Actinomycetes are very effective against microorganism. Many researchers both nationally and internationally isolated this potential group of microorganisms from soil, water, sediment etc. and checked for the potential antimicrobial activity. Actinomycetes are also explored against *C. albicans* and various pathogenic fungi.

Bioactive compounds/antimicrobial compounds/antibacterial agent/molecules discovered from this group of microorganisms are used in medicine and agriculture. They are also known to produce branching mycelium of two types first one is substrate and second one is aerial mycelium. They are extensively dispersed in natural and manmade environments and reported by researchers their significant part in the decay of organic matter. The genus *Streptomyces* is extensively study for antimicrobial potential and to produce bioactive molecules (the biggest producer of antibiotics).

Since actinomycetes have outstanding track record in the production of bioactive molecules for human interest, a large number of efforts have been made on the isolation, characterization and identification from terrestrial sources in the past 50 years. The rate of exploring new substances from soil actinomycetes has declined, whereas the amount of isolating known bioactive molecule has increased. Thus, new strain of Actinomycetes must be isolated from unexplored or underexploited habitats for the progress of novel bioactive substances for the benefits of society and mankind.

### Antibiotic potential of actinomycetes recovered from soil samples

Research of Oskay et al., (2004) have focused on antibacterial potential of certain Actinomycetes recovered from farming soils of Turkey. Fifty strain of different Actinomycete were isolated to check their antimicrobial potential against phytopathogenic and 6 pathogenic bacteria such as *E. amylovora*, *A. tumefaciens*, *Michiganensis* sp., *P. viridiflova*, *B. subtilis* ATCC 6633, *C. michiganensis* subsp., *E. faecalis* ATCC 10541, *E. coli* ATCC 29998, *K. pneumoniae* ATCC 10031, *S. lutea* ATCC 9341 and *S. aureus* ATCC 6538. Antibiotic spectrum of isolates indicates their use as a source of new antimicrobial compounds.

*Streptomyces* sp. strain (US80) recovered from soil was investigated for antifungal and antibacterial potential (Fguira et al., 2005). The isolate was evaluated against bacterial and fungal species such as *B. subtilis* ATCC 6633, *E. coli* ATCC 8739, *S. aureus* ATCC 6538, *M. luteus* LB 14110 and fungi such as *Fusarium* sp., *V. dahliae* and *C. tropicalis* R2 CIP203. Purification and structure elucidation of the

potential molecules was done using spectral analysis. Three pure active molecule irumamycin, X-14952B and 17-hydroxy-venturicidin A were isolated. The results showed that US-80 is the one defined strain, which yields entirely these three active molecules at once.

Rare actinomycetes explored from soil samples of various natural habitats in KwaZulu-Natal, South Africa for antimicrobial potential (Aokudoh et al., 2007). Primary screening was done using modified agar-streak method and selective isolation media. Eight isolates display potential antimicrobial activity. Among all isolates, N8 hesitantly identified as an intra sporangium species formed broad-range antibiotic active against both bacteria and fungi such as *P. fluorescens*, *S. aureus*, *S. marcescens*, *E. coli*, *S. faecalis* and *X. campestris* pv. *campestris*, and the yeast *C. utilis*. Investigators have stated that members of this actinomycete genus have not been linked before with antibiotic invention. Such potential antibiotic producing isolate should become more commercially significant if the present movement near the use of biocontrol agents rather than chemical treatments of plant diseases continues.

Jeffrey et al., (2007) assessed the Malaysian soil for the screening, characterization, antimicrobial potential and enzymatic activities. In their study, two hundred actinomycetes species were recovered from soil samples. Ninety-one out of two hundred actinomycetes showed the ability to degrade cellulose. Isolates were checked for their antimicrobial properties against selected phytopathogens. The result showed that strain 161 and 176 showed positive result towards *X. campestris*.

Soil samples collected from forest rock, Tamil Nadu were analyzed for the isolation, characterization and antimicrobial potential of *Streptomyces* spp. ERI-329. After study the physiological, biochemical and molecular features, it was found that the isolate fits to *Streptomyces*. Initial screening discovered that the isolate was exhibited antibacterial properties against pathogenic bacteria (*S. aureus* ATCC 29213, *S. aureus* ATCC 25923, *B. subtilis* MTCC 44, *S. epidermidis* MTCC3615, *E. coli* ATCC 25922, *E. faecalis* ATCC 29212, *K. pneumoniae* ATCC 15380, *P. aeruginosa* ATCC 27853, MTCC 1688, and *Xanthomonas* spp.), anticandidal properties was checked against pathogenic yeast *C. albicans* MTCC 227 and antifungal activity against Filamentous fungi such as *C. luenata* 46/01, *A. flavus*, *A. niger* MTCC 1344 and *B. cinerea*. Shake-flask technique was used maintaining growth parameters such as temperature, pH and cultural condition were optimized for the production of antimicrobial substances. Hexane, ethyl acetate, ether and chloroform extract were prepared using partition chromatography. The result showed that ethyl acetate extract exhibited strong activity. MIC values were reported as 0.25 mg/ml for *S. epidermidis*, *Xanthomonas* spp., *S. aureus*, and *C. albicans*. Their study showed that ethyl acetate soluble extracellular product of novel isolate of *Streptomyces* spp. ERI-3 effective against pathogenic test bacteria and *C. albicans*. To discover new bioactive

molecule, the isolate ERI-3 would lead to some valuable products of human interest (Arasu et al., 2008).

El-khawaga et al. (2012) have reported the antibacterial and insecticidal potential of crude extract of twenty Actinomycetes recovered from sandy soil of Cairo-Egypt. They have found that isolate No. A11 exhibited potential antibacterial activity against *S. aureus*, *S. pyogenes*, *B. subtilis* and Gram-negative bacteria such as *P. aeruginosa*, *P. vulgaris*, *S. typhimurium*, *K. pneumoniae* and *E. coli*. The potential isolate were selected for morphological, physiological characteristics and phylogenetic analysis using 16S rRNA sequencing (Gene Bank database by using the BLAST). The MIC values of the bioactive agent were also determined by using the agar plate dilution technique to know the minimum concentration of active molecule responsible for the activity. It was found that isolates matched with *S. bikiniensis* and was given the name *S. bikiniensis* (A1) based on phenotypic, genotypic characteristics and key's of Bergey's Manual for identification of actinomycetes. They have found that secondary metabolites (chloroform. Fraction No. 17) was the most potent fraction against the tested bacteria. After separation, purification and characterization of the active metabolite(s), investigators stated that the purified bioactive molecules might be belonged to aminoglycosidic antibiotic.

Alharbi et al., (2012) studied the antibacterial potential of Actinomycetes recovered from soil of Saudi Arabia. The study was designed to isolate, characterize and evaluate the antibacterial potential of actinomycetes isolates gained from earthly environment and to exploit the antibacterial creation commercially for the suppression of bacteria causing disease to human. The Actinomycetes isolates were identified using cross streak plate technique and selected for further antibacterial activity against bacteria. Before the evaluation, isolates were studied for colony morphology on different media, physiological and biochemical characterization. Group has found that *Streptomyces* isolates exhibited the potential antibacterial effect against selected human pathogens such as *E. coli*, *B. subtilis*, *S. aureus* and *P. aeruginosa*. Investigators have concluded that the *Streptomyces* may offer a possible application in the progress of new antibacterial molecules for the benefits of society and mankind.

#### Antibiotic potential of actinomycetes recovered from coal mine soils

In the year 2013, Gopinath et al., (2013) studied the bioactive characteristics of *Actinomycetes* from coal mine soils of Godavari belt region, saying that new antibiotics development is needed to overcome the problems regarding the existing antibiotics. They isolated eight actinomycetes strains, which were cultured in glycerol-broth at 28°C; Agar well diffusion method was applied to determine the antimicrobial activity of isolates. Ethyl acetate along with phosphate buffer is used for the extraction process. Strain called MMKK5, which was found to be extremely active against test microorganisms like *B. megaterium*, *B. subtilis*

and *B. stearothermophilus* and moderately active against *B. cereus*, *S. aureus*, *M. luteus* and *E. coli* showed slightly active inhibition.

Patel et al., 2014 worked on drug resistant microbes and improved therapeutic compounds. The aim was to study physiologically distinct soil samples to evaluate the pattern of antimicrobial actinomycetes. A total of one hundred seventy-one actinomycetes were recovered from forty five samples that were collected from over five districts. Out of all 79% of isolates were active against one of the 18 tested pathogens, for the isolation of actinomycetes crowded plate technique used, and was carried out on actinomycetes isolation. Bacterial strains *X. campestris* MTCC 2286, *E. carotovora* MTCC 1428, *L. monocytogenes* MTCC 657, *B. subtilis* MTCC 441, *S. typhimurium* MTCC 98, *S. aureus* MTCC 96, *P. aeruginosa* MTCC 741, *E. coli* MTCC 443, *Y. enterocolitica* MTCC 861, *V. vulnificus* MTCC 1145, *R. oryzae-sativae* MTCC 2162, *T. rubrum* MTCC 296, *C. albicans* MTCC 183, *A. ricifei* MTCC 3570, *M. furfur* MTCC 1374, *F. oxysporum* MTCC 284, *M. gypseum* MTCC 2830 and *U. maydis* MTCC 1474.

Antimicrobial antibiotics screened and partially purified from soil borne *Streptomyces* sp. SCA 7 by Kumar et al., 2014. Thirty-seven species of actinomycetes recovered from soil samples obtained from agriculture field, Tamil Nadu, India. All the isolates first checked for antibacterial properties against five bacteria such as *M. luteus* MTCC 106, *S. aureus* MTCC 96, *S. aureus* (MRSA), *S. aureus* ATCC 25923, *S. epidermidis* MTCC 3615 and seven Gram-negative bacteria such as *E. aerogenes* MTCC 111, *K. pneumoniae* MTCC 109, *S. typhimurium* MTCC 1251, *S. typhi*-B, *S. typhi*, *P. vulgaris* MTCC 1771 and *S. flexneri* MTCC 1457, and two fungi such as *C. parapsilosis* and *M. pachydermatis*. Among the all the isolates, strain no. SCA 7 showed strong antibacterial activity. The active extract of the strain was partially purified using column chromatography. It was found that fraction 10 exhibited good activity (31.25 mg/mL) and 500 mg/mL against two microorganisms: *S. epidermidis* and *M. pachydermatis* respectively. The antibiotic molecule identified as 2, 4-bis (1, 1-dimethylethyl) phenol. The identification of the isolate carried out using morphological, physiological, biochemical and molecular features and organism identified as *Streptomyces* sp. SCA 7. It has been stated that the organism has a great potential and could be used for the development of new substance for pharmaceutical and agricultural application.

Balachandran et al., (2015) reported the isolation and characterization of antimicrobial metabolite producing *Streptomyces* sp. from samples collected in western ghats, India. Primary screening of the strains found that a novel *Streptomyces* sp. (ERINLG-51) has been found. It was established that the strain is *Streptomyces* sp. ERINLG-51. Primary antimicrobial activity was evaluated on modified nutrient glucose agar medium test organisms used in this study were *S. paratyphi*-B, *S. flexneri* MTCC 14570, *S. aureus* MTCC 96, *K. pneumoniae* MTCC 109, *P. vulgaris* MTCC 1771, *B. subtilis* MTCC 441, *S. epidermidis* MTCC

3615, *M. luteus* MTCC 106, *E. aerogenes* MTCC 111, *P. aeruginosa* MTCC 741, *S. typhimurium* MTCC 1251, *S. epidermidis* MTCC 3615, *S. typhimurium* MTCC 1251, *M. luteus* MTCC 106.

The studies conducted by Gurung et al., (2009) have focused on actinomycetes isolated from soils of Kalapatthar Mount Everest. The isolates were characterized by morphological (macroscopic and microscopic) and biochemical (catalase, oxidase, nitrate reduction, urea hydrolysis, citrate utilization, gelatin hydrolysis, esculin hydrolysis, starch hydrolysis, tween 20, acid production from sugar, and physiological methods. The isolates investigated for antibacterial properties against bacterial species by perpendicular streak method. The results of their studies showed that isolates named as K.6.3, K.14.2, and K.58.5 exhibited more activity in terms of zone of inhibition (20 mm) and broad range antibacterial properties including two *S. aureus* (MRSA) strains. MIC values of antibacterial substances were also studied by serial dilution method using nutrient broth against *S. aureus* ATCC 29213. The results of the study shown that more isolates were exhibited antibacterial properties against bacterial species. The finding displayed that antibiotic agent producer K.14.2 recovered from extreme environment can be promising candidate for discovering novel and potent antibiotic molecules.

#### Antibiotic potential of actinomycetes recovered from plant root

Endophytic actinobacteria were isolated from plants (root materials, stem segments and leaf). Fermentation broth endophytic *Streptomyces* were evaluated against five pathogenic micro-organisms (*S. epidermidis* ATCC 12228, *S. aureus* ATCC 25923, *K. pneumoniae* ATCC 13883, *E. coli* ATCC 25922 and *C. albicans* ATCC 1023) using agar well diffusion methods (Li et al., 2008). Varied activities in terms of zone of inhibition were observed against all the tested organisms. The Actinomycetes isolates were finally identified using molecular sequencing. Based on the results, it was stated that endophytes can be considered potential sources of novel bioactive compounds.

Antimicrobial behavior and cytotoxic potential of *Streptomyces* spp. isolated from lake were characterized against *S. typhi*, *E. coli*, *B. subtilis*, *S. aureus* and *P. vulgaris*. Findings of the investigators indicate good antibacterial and anti-cancerous property by metabolites needs to be study further to know the compound responsible for the activities (Kharat et al., 2009)

Productions of antibiotics from isolates of actinomycetes were evaluated using various nitrogen and carbon sources for their antimicrobial patterns against both bacteria and fungi (Nanjwade et al., 2010). For maximum production of antibiotics, several growth conditions were optimized. Research findings reveal that the mutant isolates exhibited strong antimicrobial potential.

#### Antibiotic potential of actinomycetes recovered from mangrove sediment

Naikpatil and Rathod (2011) studied the rare actinomycetes isolated from mangrove sediment of Karwar for antimicrobial potential. Several pretreatment measures and selective media were used to achieve the optimal environment essential for the isolation of rare actinomycetes from this environment. After morphological and chemical characteristics, it was found that isolates belong to genera such as *Microbispora*, *Micromonospora*, *Actinomadura* Later *Micromonospora*, *Actinoplanes* and *Actinomadura*. Several extracts were prepared using organic solvent to check their antibacterial activity. Minimum bactericidal concentration (MBC) of the ethyl acetate extracts were evaluated against *S. aureus*. TLC of the extract was also carried out, RF value also determined followed by bioautographic studies (using *S. aureus* as test organism). It has been concluded that crude extract checked for the study has a potential to use as an antimicrobial.

The antimicrobial properties of actinomycetes were studied. For the study twenty-five soil samples were collected to develop an antibiotic produced by *Streptomyces* spp. against dermatophytic fungi using cross streak plate assay method. Five isolates were selected for antimicrobial spectrum of ethyl acetate extract. MIC of active extract was also determined. Study concluded with the statement that naturally occurring Actinomycetes have a potential to produce antimicrobial compounds against dermatophytes supporting the discovery of new antimicrobial molecules (Nurkanto et al., 2012).

Indonesian soil collected from Raja Ampat, West Papua was checked for antimicrobial study against bacterial species and yeast using agar dilution method (Nurkanto et al., 2012). Two hundred extracts were prepared using polar and non-polar solvent and their activity were checked against *B. subtilis* NBRC 3134, *M. luteus* NBRC 1367, *S. aureus* NBRC 13276, *E. coli* NBRC 14237, *S. cerevisiae* NBRC 10217 and *C. albicans* NBRC 1594. Varied antimicrobial activity observed, isolates were identified using molecular methods (16S rRNA gene sequence data). The results showed sequence similarities to *S. narbonensis* (92%), *S. kanamyceticus* (92%), *S. hygroscopicus* (96%) *S. verne* (92%) and *S. malachitofuscus* (98%) by BLAST program.

Actinomycetes spp. isolated from different samples of Pichavaram mangrove were studied for antibacterial potential using cross streak method. The isolates were evaluated against *Klebsiella* sp., *E. coli*, *Proteus* sp., *Staphylococcus* sp., *Salmonella* sp., and *Bacillus* sp. (Sweetline et al., 2012). The results revealed that seventeen isolates out of thirty-eight showed antibacterial compound producing activity and could be source of bioactive agent.

Coringa mangrove forest soils from Andhra Pradesh were studied to isolate actinomycetes for enzyme production and antimicrobial activity (Arasu et al., 2009). The isolation were

done using serial dilution methods. Twenty-seven isolates were characterized morphologically, biochemically, physiologically. This strain also exhibited antimicrobial activity against test microorganisms like *P. aeruginosa*, *P. fluorescence*, *S. aureus*, *L. casei*, *L. acidophilus*, *C. albicans*, *B. subtilis*, *S. mutans*, *Xanthomonas* and *B. megaterium*. It was concluded that isolate exhibited maximum activity against *Xanthomonas* sp. and minimum activity against *C. albicans* could be a great source for enzyme and antimicrobials.

In a recent study by Jiang et al., 2018 endophytic actinobacteria recovered from mangrove plants from china were evaluated for antimicrobial potential along with their diversity. One hundred and one endophytic actinobacteria were screened by culture-based method. Isolates dispersed in seven orders, fifteen families, and twentyeight genera including *Micrococcus*, *Curtobacterium*, *Streptomyces*, *Mycobacterium*, *Kineococcus*, *Microbacterium*, Actinoplanes, Amnibacterium, Citricoccus, Citricoccus, Isopterocola, Nocardia, Pseudokineococcus, Pseudokineococcus, Nocardiosis, Nocardioidea, Brachybacterium, Marmoricola, Micromonospora, Agrococcus, Dermacoccus, Gordonia, Janibacter, Verrucosipora and Leucobacter. Seven species were active novel species of genera such as *Leucobacter*, *Nocardioidea*, *Amnibacterium*, *Streptomyces* and *Marmoricola*. Sixty-three strains out of one hundred and one were selected to check

antibacterial potential against *S. aureus* ATCC 25923, 2641, *E. faecalis* ATCC 29212, ATCC 51299, *K. pneumoniae* ATCC 10031, ATCC 700603, *P. aeruginosa* ATCC 27853, 2774, *A. baumannii* ATCC19606, 2799, *E. coli* ATCC 25922, 2800 by paper-disk diffusion method.

**Antibiotic potential of actinomycetes recovered from marine sediments**

Mohanraj et al., 2013 explored actinomycetes from marine sediments for their potential to produce bioactive molecules to combat disease caused by pathogenic microorganisms. Fifty-two species of actinomycetes isolated from marine sediment collected from twenty-eight locations from the Bay of Bengal showed huge potential to produce bioactive substances. Identification of the isolates revealed that all isolates belong to the genus *Streptomyces*. Using cross streak method investigators screened antimicrobial properties of isolated marine actinomycetes against pathogenic bacteria such as *S. aureus*, *S. typhi*, *B. cereus*, *E. coli*, and *K. pneumoniae* and fungal phytopathogens *F. oxysporum* f. sp. *lycopersici*, *F. udum*, *R. solani* and *M. phaseolina* varied antibacterial and antifungal activity observed. The marine isolate named *Streptomyces* sp. LCJ85 discovered by investigators was found to be most active in the production of bioactive molecules. They have anticipated that further study can be designed to know the nature of bioactive compounds responsible for the activity for the benefit of society currently facing problem of antibiotic resistance.

**Table 1: Antimicrobial activity of Actinomycetes spp. against microorganisms other than food borne isolates (2002-2019)**

Name of Actinomycetes	Test Microorganism	References
73 Actinomycetes ( <i>Streptomyces</i> sp. AOK-30)	<i>M. luteus</i> , <i>E. coli</i> , <i>S. aureus</i> and <i>B. subtilis</i>	Nishimura et al., 2002
Basidiomycetes (8 isolates)	<i>E. coli</i> , <i>S. pneumoniae</i> , <i>B. cereus</i> , <i>S. aureus</i> , <i>S. pyogenes</i> , <i>B. subtilis</i> , <i>S. saprophyticus</i> , <i>E. faecalis</i> , <i>S. typhimurium</i> , <i>L. monocytogenes</i> , <i>S. epidermidis</i> , <i>P. aeruginosa</i> , <i>C. glabrata</i> , <i>C. tropicalis</i> , <i>C. albicans</i> , <i>C. krusei</i> , <i>C. glabrata</i> and <i>C. parapsilosis</i>	Rosa et al., 2003
235 <i>Streptomyces</i> spp.	<i>B. subtilis</i> , <i>E. faecium</i> , <i>S. aureus</i> , <i>P. aeruginosa</i> and <i>S. marcescens</i> , one mycobacterium ( <i>M. smegmatis</i> , two yeasts and one filamentous fungus ( <i>A. fumigatus</i> )	Basilio et al., 2003
106 Actinomycetes isolates	<i>B. subtilis</i> , <i>S. aureus</i> , <i>E. aerogenes</i> , <i>E. coli</i> , <i>Klebsiella</i> sp., <i>Proteus</i> spp., <i>Pseudomonas</i> spp., <i>S. typhi</i> and <i>Shigella</i> sp.	Pandey et al., 2004
62 strains of Actinomycetes	<i>E. coli</i> , <i>B. subtilis</i> and <i>S. aureus</i>	Leiva et al., 2004
One strain, Strain 606 classified as <i>Streptomycin</i>	<i>F. solani</i> , <i>A. parasiticus</i> , <i>F. graminearum</i> , <i>Fusarium</i> sp., <i>C. gloeosporioides</i> <i>C. albicans</i> , <i>S. aureus</i> <i>S. saprophyticus</i> , <i>T. pyogenes</i> , <i>P.</i>	Sacramento et al., 2004

species.	<i>aeruginosa</i> and <i>E. coli</i>	
Total of 50 Actinomycetes	<i>E. amylovora</i> , <i>P. viridiflova</i> , <i>A. tumefaciens</i> , <i>C. michiganensis</i> subs. <i>B. subtilis</i> , <i>K. pneumoniae</i> , <i>E. faecalis</i> , <i>S. aureus</i> , <i>E. coli</i> and <i>S. lutea</i>	Oskay et al., 2004
563 Actinomycetes	<i>Candida</i> sp., <i>P. chrysogenum</i> , <i>C. musae</i> and <i>T. mentagrophytes</i> and <i>B. subtilis</i> , <i>S. aureus</i> , <i>Enterococcus</i> spp., <i>E. coli</i> and <i>A. calcoaceticus</i> (clinical isolate).	Iznaga et al., 2004
50 different Actinomycetes strains	<i>E. amylovora</i> , <i>A. tumefaciens</i> , <i>P. viridiflova</i> , <i>C. michiganensis</i> subs., <i>B. subtilis</i> , <i>K. pneumoniae</i> , <i>E. faecalis</i> , <i>S. aureus</i> , <i>E. coli</i> and <i>S. lutea</i>	Oskay et al., 2004
20 different isolates	<i>Staphylococcus aureus</i> , <i>S. epidermidis</i> , <i>Ba. anthracis</i> , <i>B. subtilis</i> , <i>P. mirabilis</i> , <i>P. aeruginosa</i> , <i>E. coli</i> , <i>Enterococcus</i> group D, <i>B. cinerea</i> , <i>S. lutea</i> , <i>S. cerevisiae</i> , <i>Herpes simplex</i> and <i>C. albicans</i>	Ilić et al., 2005
122 Actinomycete isolates	<i>A. niger</i> , <i>A. alternata</i> , <i>A. mellea</i> , <i>C. albicans</i> , <i>S. cerevisiae</i> , <i>S. pastorianus</i> , <i>P. ultimum</i> P8, <i>R. solani</i> , <i>F. oxysporum</i> , <i>B. subtilis</i> , <i>E. coli</i> , <i>E. faecalis</i> , <i>S. aureus</i> , <i>S. agalactiae</i> and <i>P. aeruginosa</i>	Esquilín et al., 2005
25 Strains	<i>S. aureus</i> , <i>P. vulgaris</i> , <i>S. faecalis</i> , <i>E. coli</i> and <i>P. aeruginosa</i>	Kitouni et al., 2005
40 Actinomycete strains	<i>S. aureus</i> , <i>P. putida</i> , <i>P. aeruginosa</i> , <i>M. luteus</i> , <i>S. cerevisiae</i> , <i>E. faecalis</i> , <i>E. coli</i> , <i>P. syringae</i> p.v. <i>syringae</i> , <i>P. syringae</i> p.v. <i>tabaci</i> , <i>X. campestris</i> p.v. <i>vesicatoriae</i> ; phytopathogenic fungi - <i>Alternaria</i> sp., <i>A. melonis</i> , <i>C. fulvum</i> , <i>Cladosporium</i> sp., <i>Fusarium avenaceum</i> , <i>F. culmorum</i> , <i>F. moniliforme</i> , <i>F. oxysporum</i> , <i>H. gramineum</i> , <i>P. expansum</i> , <i>V. dahlia</i> and <i>Verticillium</i> sp.	Nedialkova et al., 2005
An Actinomycete designated AC104	<i>M. luteus</i> , <i>B. subtilis</i> , <i>E. coli</i> , <i>P. aeruginosa</i> , <i>S. aureus</i> , <i>K. pneumoniae</i> , <i>S. enterica</i> , and <i>Alternaria</i> sp., <i>C. albicans</i> , <i>F. oxysporum</i> f.sp. <i>lini</i> , <i>K. lactis</i> , <i>F.oxysporum</i> f.sp. <i>albedinis</i> , <i>Penicillium</i> sp, <i>M. ramannianus</i> , <i>B. coagulans</i> , <i>A. tumefaciens</i> and <i>S. Cerevisiae</i>	Badji et al., 2006
37 Actinomycetes	<i>K. pneumoniae</i> , <i>S. aureus</i> , <i>B. subtilis</i> , <i>E.coli</i> , <i>M. lutes</i> , <i>M. phlei</i> , <i>C. albicans</i> and <i>F. moniliforme</i>	Singh et al., 2006
100 Actinomycete isolates identified as <i>Streptomyces</i> , 20 were <i>Micromonospora</i> , and one was <i>Nocardia</i> .	<i>P. aeruginosa</i> , <i>S. aureus</i> , <i>E. coli</i> , <i>B. subtilis</i> and <i>C. albicans</i>	Anansiriwattana et al., 2006
Actinomycetes (80 Isolates)	<i>E. coli</i> , <i>S. aureus</i> , <i>P. fluorescens</i> , <i>S. marcescens</i> , <i>S. faecalis</i> and <i>X. campestris</i> pv <i>campestris</i> , and <i>C. Utilis</i>	Okudoh et al., 2007
212 Isolates, (Strain 161 and strain 176 Potential isolates)	<i>Phytophthora</i> spp., <i>X. campestris</i> and <i>R. solanacearum</i>	Jeffrey et al., 2007
<i>Streptomyces</i> spp. (41	<i>C. albicans</i> , <i>S. aureus</i> , <i>K. pneumoniae</i> , <i>E. coli</i> and <i>S. epidermidis</i>	Li et al., 2008

isolates)		
A new Actinomycete isolate ERI-26	<i>B. subtilis</i> , <i>S. epidermidis</i> , <i>S. aureus</i> , <i>E. faecalis</i> , <i>C. albicans</i> , <i>A. flavus</i> , <i>A. niger</i> , <i>B. cinerea</i> and <i>C. Lunata</i>	Arasu et al., 2008
<i>Streptomyces</i> spp. (ERI-3)	<i>E. coli</i> , <i>B. subtilis</i> , <i>S. epidermidis</i> , <i>S. aureus</i> , <i>E. faecalis</i> , <i>P. aeruginosa</i> , <i>K. pneumoniae</i> , <i>Xanthomonas</i> spp. and pathogenic yeast <i>C. albicans</i> , <i>A. niger</i> , <i>A. flavus</i> , <i>C. luenata</i> and <i>B. cinerea</i>	Arasu et al., 2009
79 Actinomycetes	<i>E. coli</i> , <i>P. mirabilis</i> , <i>P. vulgaris</i> , <i>K. oxytoca</i> , <i>K. pneumoniae</i> , , , <i>B. subtilis</i> , <i>Shigella</i> sp., <i>S. aureus</i> <i>S. typhi</i> and <i>S. paratyphi</i>	Gurung et al., 2009
25 strains (VITSVK5)	<i>E. coli</i> , <i>E. faecalis</i> , <i>K. pneumoniae</i> , <i>P. aeruginosa</i> , <i>B. cereus</i> and <i>S. aureus</i> , Fungal pathogens, <i>A. flavus</i> , <i>A. fumigatus</i> and <i>A. niger</i> , Yeasts- <i>C. cruzi</i> , <i>C. tropicalis</i> and <i>C. albicans</i>	Vimal et al., 2009
11 heterotrophic Actinomycetes, marine sponge <i>D. nigra</i> among these <i>Nocardiopsis dassonvillei</i> MAD08 (Potential sp.)	<i>E. coli</i> , <i>P. aeruginosa</i> , <i>K. pneumoniae</i> , <i>P. mirabilis</i> , <i>V. cholerae</i> PC6, <i>S. typhi</i> , <i>P. aeruginosa</i> , <i>E. coli</i> ., Nonhemolytic <i>Streptococcus</i> , <i>S. epidermidis</i> , <i>S. aureus</i> , <i>S. aureofaciens</i> , <i>S. peuceticus</i> , <i>M. luteus</i> and <i>R. rhodochrous</i>	Selvin et al., 2009
208 marine isolates	<i>E. coli</i> , <i>S. epidermidis</i> , <i>P. aeruginosa</i> , <i>B. subtilis</i> and <i>C. albicans</i>	Ramesh et al., 2009
24 isolates	<i>B. subtilis</i> , <i>S. aureus</i> , <i>S. typhi</i> , <i>E. coli</i> and <i>P. vulgaris</i>	Kharat et al., 2009
9 Actinomycete strains.	<i>E. coli</i> K12, <i>B. subtilis</i> , <i>M. luteus</i> , <i>S. aureus</i> , <i>P. aeruginosa</i> , <i>C. albicans</i> and <i>S. cerevisiae</i>	Gaskell et al., 2010
117 Actinomycetes	<i>S. aureus</i> , <i>B. subtilis</i> , <i>Escherichia coli</i> and <i>Pseudomonas putida</i>	Kumar et al., 2010
50 Actinomycetes (Marine isolates)	<i>S. aureus</i> , <i>E. coli</i> <i>B. subtilis</i> , <i>K. pneumoniae</i> , <i>A. niger</i> , <i>A. fumigatus</i> and <i>C. albicans</i> .	Suthindhiran et al., 2010
Halotolerant alkaliphilic Actinomycete sp.	<i>B. cereus</i> , <i>S. aureus</i> , <i>B. subtilis</i> , <i>B. megaterium</i> and Gram negative organisms; <i>E. coli</i> , <i>E. aerogens</i> , <i>P. vulgaris</i> , <i>S. dysenteriae</i> , <i>P. aeruginosa</i> and <i>S. typhosa</i> para B	Thumar et al., 2010
One Actinomycete ( KUAP 106)	<i>S. aureus</i> , <i>B. subtilis</i> , <i>E. coli</i> , <i>P. aeruginosa</i> and <i>S. faecalis</i>	Usha et al., 2010
290 isolates	<i>P. aeruginosa</i> , <i>C. albicans</i> , <i>G. candidum</i> , <i>A. flavus</i> , <i>A. parasiticus</i> , <i>B. cereus</i> , <i>S. aureus</i> , <i>E. coli</i> , <i>F. culmorum</i> , <i>F. Moniliforme</i> , <i>S. aureus</i> (MRSA), <i>E. faecium</i> (VRE) and <i>A. baumannii</i> .	Yücel et al., 2010
316 Actinomycetes spp.	<i>T. rubrum</i> , <i>M. gypseum</i> , <i>M. canis</i> , <i>A. flavus</i> , <i>A. fumigatus</i> and <i>C. albicans</i> .	Bharti et al., 2010

192 Actinomycetes spp.	<i>B. subtilis</i> , <i>E. coli</i> , <i>C. albicans</i> and <i>C. neoformans</i>	Vijaykumar et al., 2010
A-4	<i>S. aureus</i> , <i>K. pneumoniae</i> , <i>B. subtilis</i> , <i>P. aeruginosa</i> , <i>E. coli</i> , Fungi <i>C. albicans</i> and <i>S. cerevisiae</i>	Nanjwade et al., 2010
<i>Nocardia</i> , <i>Intrasporangium</i> , <i>Pseudonocardia</i> , <i>Micromonospora</i> , <i>Streptomyces</i> , <i>Actinosynnema</i> , <i>Rhodococcus</i> , <i>Nocardiodes</i> , <i>Gordona</i> , <i>Kitasatospora</i> and <i>Streptoalloteichus</i>	<i>S. bovis</i> , <i>S. typhimurium</i> , <i>S. senftenberg</i> , <i>S. typhi</i> , <i>S. mgulani</i> , <i>S. enteritidis</i> , <i>S. welteverden</i> , <i>S. bareilly</i> , <i>V. cholerae</i> , <i>B. subtilis</i> , <i>E. coli</i> -12 and <i>E. coli</i> -78	George et al., 2011
55 Actinomycetes	<i>S. aureus</i> , <i>E. coli</i> , <i>M. luteus</i> , <i>M. smegmatis</i> and <i>B. subtilis</i>	Arifuzzaman et al., 2010
71 Actinomycetes	<i>A. niger</i> , <i>C. albicans</i> , <i>S. aureus</i> , <i>B. subtilis</i> , <i>L. monocytogenes</i> , <i>E. coli</i> , <i>P. aeruginosa</i> , and <i>M. smegmatis</i>	Silva et al., 2011
15 strains	<i>S. aureus</i> , <i>E. coli</i> and <i>P. Aeruginosa</i>	Pandey et al., 2011
30 Actinomycetes colonies were isolated from pure culture.	<i>S. aureus</i> , <i>B. cereus</i> , <i>S. agalactiae</i> and <i>B. megaterium</i> QL-40, <i>E. coli</i> , <i>S. sonnei</i> , <i>S. flexneri</i> and <i>S. dysenteriae</i> ,	Rahman et al., 2011
134 Actinomycetes isolated from soil sample, among these 51 showed antimicrobial activity	<i>K. pneumoniae</i> sub sp. <i>pneumoniae</i> , <i>B. subtilis</i> , <i>S. typhi</i> , <i>E. aerogenes</i> , <i>E. coli</i> , <i>P. mirabilis</i> , <i>C. albicans</i> and <i>R. rubra</i> .	Sharma et al., 2011
<i>S. rochei</i> (MTCC 10109)	<i>C. tropicana</i> , <i>C. albicans</i> , <i>A. niger</i> , <i>S. cerisaie</i> , <i>M. luteus</i> , <i>S. aureus</i> , <i>V. alginolyticus</i> , <i>E. coli</i> , <i>P. aeruginosa</i> , <i>P. fluorescence</i> and <i>A. hydrophylla</i> . The pathogenic microorganism <i>C. tropicana</i> , <i>V. alginolyticus</i> and <i>A. hydrophylla</i>	Reddy et al., 2011
5 Actinomycetes strains	<i>S. typhi</i> , <i>P. aeruginosa</i> , <i>E. coli</i> , <i>V. cholerae</i> , <i>K. pneumoniae</i> , <i>A. niger</i> , <i>F. oxysporum</i> , <i>R. solani</i> , <i>C. albicans</i> and <i>P.citrinum</i> .	Sathiyaseelan et al., 2011
<i>Streptomyces</i> sp. <i>Micromonospora Oerskovia</i> , <i>Nonomuraea</i> , <i>Promicromonospora</i> and <i>Rhodococcus</i> .	<i>E. coli</i> , <i>S. aureus</i> , <i>A. niger</i> <i>V. dahliae</i> <i>Kleb.</i> , <i>F.oxysporum</i> f. sp. <i>Niveum</i> , , <i>F. graminearum</i> , <i>C. orbiculare</i> , <i>E. turcicum</i> , , <i>B. cinerea</i> , <i>C. lunata</i> and <i>F. oxysporum</i> f. sp. <i>Vasinfectedum</i>	Zhao et al., 2005
five isolates	<i>Microsporium</i> spp.	Deepa et al., 2011
5 isolates labeled as A5, A4, A3, A3, A1	<i>S. aureus</i> , <i>B. subtilis</i> , <i>P. aeruginosa</i> , <i>P. vulgaris</i> , <i>E. coli</i> , <i>K. pneumoniae</i> , <i>C. albicans</i> and <i>A. Niger</i>	Mathur et al., 2012



Strain T-4 ( <i>Streptomyces torulosus</i> )	<i>P. aeruginosa</i> , <i>M. luteus</i> , <i>B. subtilis</i> , <i>B. pumilus</i> , <i>K. pneumoniae</i> , <i>E. coli</i> , <i>S. cerevisiae</i> , <i>C. albicans</i> , <i>A. flavus</i> , <i>A. niger</i> , <i>A. fumigatus</i> , <i>F. oxysporum</i> ; <i>R. solani</i> ; <i>A. alternata</i> ; <i>B. fabae</i> and <i>P. chrysogenum</i>	Atta et al., 2015
48 isolates ( <i>Streptomyces rochei</i> )	<i>S. aureus</i> , <i>B. subtilis</i> , <i>P. aeruginosa</i> , <i>E. coli</i> , <i>C. albicans</i> , <i>M. canis</i> and <i>T. rubrum</i> , <i>A. fumigatus</i> , <i>M. phaseolina</i> , <i>F. oxysporum</i> and <i>R. Solani</i>	Kumar et al., 2012
200 crude extracts from 100 isolates	<i>E. coli</i> , <i>M. luteus</i> , <i>B. subtilis</i> , <i>S. aureus</i> , <i>S. Cerevisiae</i> and <i>C. albicans</i>	Nurkanto et al., 2012
<i>Streptomyces</i> sp. VITSTK7	<i>A. fumigates</i>	Thenmozhi et al., 2012
7 Actinomycetes isolates	<i>S. aureus</i> , Vancomycin-Resistant <i>Enterococci</i> and <i>E. coli</i>	Singh et al., 2012
210 Actinomycetes (Potential Strains: AP-70, AP-41, AP-18, AP-5)	<i>E. coli</i> , <i>S. aureus</i> , <i>B. subtilis</i> , <i>E. faecalis</i> , <i>P. vulgaris</i> , <i>S. epidermidis</i> , <i>K. pneumoniae</i> , <i>Erwinia</i> sp. and <i>P. aeruginosa</i> , <i>A. niger</i> , <i>E. floccosum</i> , <i>B. cinerea</i> , <i>C. lunata</i> , <i>Scopulariopsis</i> sp., <i>T. simii</i> , <i>T. mentagrophytes</i> and <i>T. rubrum</i>	Arasu et al., 2013
49 Actinomycete strains	<i>F. oxysporum</i> , <i>P. cinnamomi</i> , <i>P. debaryanum</i> , <i>S. sclerotiorum</i> and <i>T. cucumeris</i> and <i>A. tumefaciens</i> .	Cuesta et al., 2012
21 strains (Potential Strains C11 and C12)	<i>E. coli</i> , <i>S. typhi</i> , <i>Staphylococcus</i> sp., <i>B. subtilis</i> , <i>P. mirabilis</i> , <i>K. pneumoniae</i> , <i>Pseudomonas</i> spp., <i>P. vulgaris</i> , <i>V. harveyi</i> and <i>V. fischeri</i>	Valli et al., 2012
38 isolates	<i>E. coli</i> , <i>Staphylococcus</i> sp., <i>Salmonella</i> sp., <i>Klebsiella</i> sp., <i>Bacillus</i> sp. and <i>Proteus</i> sp.	Sweetline et al., 2012
36 Actinomycetes	<i>Listeria</i> sp., <i>V. cholerae</i> , <i>B. cereus</i> , <i>S. typhi</i> , <i>S. aureus</i> , and <i>E. coli</i>	Varghese et al., 2012
<i>Streptomyces</i> sp. VPTS3-1, <i>S. afghaniensis</i> VTPS3-1	<i>B. subtilis</i> , <i>E. coli</i> , <i>P. mirabilis</i> , <i>P. vulgaris</i> , <i>K. pneumoniae</i> and <i>C. albicans</i>	Vijaykumar et al., 2012
Actinomycetes 20 Isolates A-1 to A20)	<i>S. pyogenes</i> , <i>B. subtilis</i> , <i>K. pneumoniae</i> , <i>S. aureus</i> , <i>S. typhimurium</i> , <i>P. aeruginosa</i> , <i>E. coli</i> and <i>P. vulgaris</i>	Khawaga et al., 2012
<i>Streptomyces</i> spp. (27 Isolates)	<i>S. aureus</i> , <i>P. aeruginosa</i> , <i>P. fluorescens</i> , <i>L. casei</i> , <i>L. acidophilus</i> , <i>C. albicans</i> , <i>S. mutans</i> , <i>B. subtilis</i> , <i>Xanthomonas</i> sp. and <i>B. megaterium</i>	Deepthi et al., 2012
31 Actinomycetes isolated, AS14, AS27, AS28	<i>S. dysenteriae</i> , <i>K. pneumoniae</i> , <i>S. pyogenes</i> , <i>S. aureus</i> , <i>S. epidermidis</i> , <i>Staphylococcus xylosus</i> , <i>E. faecalis</i> , <i>S. aureus</i> (Methicillin-resistant), Vancomycin-resistant enterococci, <i>B. cereus</i> and <i>B. subtilis</i> .	Chaudhary et al., 2013
<i>Streptomyces</i> sp. (AP-123)	<i>B. subtilis</i> , <i>S. epidermidis</i> , <i>E. faecalis</i> , <i>S. aureus</i> , <i>E. coli</i> , <i>K. pneumoniae</i> , <i>P. vulgaris</i> , <i>P. aeruginosa</i> and <i>Erwinia</i> sp. and fungi: <i>T. rubrum</i> , <i>T. Simii</i> , <i>T. mentagrophytes</i> , <i>E. floccosum</i> , <i>Scopulariopsis</i> sp. <i>C.</i>	Arasu et al., 2013

	<i>albicans, C. lunata, A. niger</i> and <i>B. cinerea</i> .	
31 strains	<i>E. coli, P. aeruginosa, S. typhi, K. pneumoniae</i> and <i>S. aureus</i>	Gebreyohannes et al., 2013
Three Isolates (Ab18, Ab28, Ab43)	<i>S. typhi, K. pneumoniae, P. aeruginosa, S. aureus</i> and <i>E. coli</i>	Bizuye et al., 2013
52 Actinomycetes <i>Streptomyces</i> s. LCJ85, Potential 43 out of 52)	<i>E. coli, S. typhi, B. cereus</i> and <i>K. pneumoniae, Fusarium udum, Fusarium oxysporum</i> f. sp. <i>lycopersici</i> and <i>M. phaseolina</i>	Mohanraj et al., 2013
6 isolates of Actinomycetes	<i>S. aureus, E. coli, Streptococcus</i> sp., <i>P. vulgaris B. subtilis, A. niger, C. albicans, Penicillium</i> sp., <i>Mucor</i> sp. and <i>Rhizopus</i> sp.	Poosarla et al., 2013
Actinomycetes isolates (Most active MMKK5)	<i>S. aureus, B. subtilis, B. stearothermophilus, B. megaterium, B. cereus, M. luteus, E.coli, E. aerogenes, K. pneumoniae,</i> and <i>P. vulgaris</i>	Gopinath et al., 2013
171 Actinomycetes (Soil Isolates)	<i>V. vulnificus, X. campestris, Y. enterocolitica, M. furfur, F. oxysporum, U. maydis., A. recifei, C. albicans, R. oryzaesativae, M. gypseum</i> and <i>T. Rubrum, S. aureus, S. typhimurium, B. subtilis, L. monocytogenes, P. aeruginosa, E. carotovora</i> and <i>E. coli</i>	Patel et al., 2014
New actinobacteria strain 2At	<i>B. subtilis, M. smegmatis, S. epidermidis, E. coli, K. pneumoniae</i> sub sp. <i>pneumoniae, E. aerogenes, S. typhi,</i> multi-drug resistant <i>E. coli</i> (resistant to ciprofloxacin, rifampicin, cephotaxime and cefoperazone), MRSA, VRE, <i>C. albicans, R.rubra, C. acutatum, C. beticola, F. oxysporum</i> f.sp. <i>dian- thi</i> and <i>A. brassicicola</i>	Sharma et al., 2014
<i>Streptomyces sannanesis</i> SU118	<i>B. subtilis, B. megaterium, B. circulans, S. aureus, M. luteus, M. phlei, M. smegmatis, E. coli, K. pneumoniae</i> and <i>P. aeruginosa</i> .	Singh et al., 2014
37 Actinomycetes ( Potential isolate SCA 7)	<i>S. aureus, M. luteus, K. pneumoniae, S. epidermidis, S. aureus, E. aerogenes, S. typhimurium, S. flexneri, P. vulgaris, S. typhi-B,</i> and <i>S. typhi, C. parapsilosis, M. pachydermatis</i> and <i>S. aureus</i> (MRSA)	Kumar et al., 2014
25 Actinomycetes	<i>S. aureus, B. cereus S. citreus, E. coli, S. marcescens, S. typhi, P. aeruginosa, P. mirabilis,</i> and <i>K. pneumoniae, A. flavus, A. niger, Fusarium</i> sp, <i>Penicillium</i> sp., <i>C. parapsilosis, C. albicans, T. mentagrophytes T. rubrum,</i> and <i>C. neoformans</i>	Das et al., 2014
42 Endophytic Actinomycete	<i>P. aeruginosa, S. aureus, E. coli</i> and <i>C. albicans</i>	Passari et al., 2015
54 Actinomycetes isolates	<i>E. coli, S. typhi, S. aureus, B. subtilis, V. cholera, P. aeruginosa, S. typhimurium, S. cerevisiae, C. albicans, A. niger, Ustilago maydis SG200, R. solani AG1-1A</i> and <i>M. phaseolina R9</i>	Sengupta et al., 2015
Novel <i>Streptomyces</i>	<i>S. aureus, S. aureus</i> (MRSA), <i>P. aeruginosa, P. vulgaris, E. aerogenes, S. paratyphi-B, S. flexneri, B. Subtilis, K. pneumoniae, S. typhimurium, M.</i>	Balachandran et al.,

sp.(ERINLG-51)	<i>luteus</i> and <i>S. epidermidis</i>	2015
<i>Streptomyces</i> strain-INACH30 <i>S. fildensis</i> ; <i>S. beijiagensis</i> and <i>S. purpureus</i>	<i>S. aureus</i> , <i>E.coli</i> , <i>S. biafra</i> , <i>S. braenderup</i> , <i>K. pneumonia</i> , <i>E. cloacae</i> , <i>E. faecalis</i> , <i>S. eqorum</i> , <i>V. parahaemolyticus</i> , <i>B. cereus</i> , <i>E.coli</i> and <i>Staphylococcus species</i>	Lavin et al., 2016
133 isolates of Actinomycetes	<i>S. typhi</i> , <i>E. coli</i> and <i>S. typhimurium</i>	Patil et al., 2011
13 active isolates	<i>B. subtilis</i> , <i>E. coli</i> , <i>B. pumilus</i> , <i>S. aureus</i> , <i>S. typhi</i> , <i>P. vulgaris</i> , <i>P. aeruginosa</i> , <i>C. albicans</i> , <i>C. tropicalis</i> , <i>S. cerevisiae</i> , <i>Cryptococcus terreus</i> , <i>A. niger</i> , <i>T. rubrum</i> , <i>P. chrysogenum</i> and <i>B. bassiana</i>	Singh et al., 2016
Mesophilic Actinomycete strain PB-52 , <i>Nocardia niigatensis</i> IFM 0330(NR_12195)	<i>S. aureus</i> , <i>B. cereus</i> , <i>S. epidermidis</i> , <i>B. subtilis</i> , <i>B. megaterium</i> , <i>M. luteus</i> , Gram-negative bacteria, <i>E. coli</i> , <i>S. marcescens</i> , <i>P. aeruginosa</i> , <i>K. pneumoniae</i> , <i>P. vulgaris</i> , <i>C. albicans</i> and <i>C. tropicalis</i>	Sharma et al., 2016
150 strains of Actinomycetes isolated from soil samples	<i>B. subtilis</i> , <i>S. epidermidis</i> , <i>S. aureus</i> , <i>E. faecalis</i> , <i>P. aeruginosa</i> , <i>E. coli</i> , <i>K. pneumoniae</i> , <i>X. campestris PV oryzae</i> and <i>Erwinia amylovora</i> and seven fungi viz., <i>A. niger</i> , <i>A. flavus</i> , <i>B. cinerea</i> , <i>Curvularialunata</i> sp., <i>Scopulariopsis</i> sp., <i>Trychophytonsimii</i> sp. and <i>C. albicans</i>	Devadass et al., 2016
Actinomycetes isolates TGH-30, FMS-20, , TGH-31, IS-4 and TGH-31-1	<i>S. aureus</i> , <i>M. luteus</i> , <i>P. mendocina</i> , <i>K. pneumonia</i> , <i>B. subtilis</i> , <i>Proteus vulgaris</i> , <i>V. parahaemolyticus</i> , <i>E. faecalis</i> , <i>E. aerogenes</i> , <i>S. epidermidis</i> , <i>Y. enterocolitica</i> , <i>S. flexneri</i> , <i>S. cerevisiae</i> , <i>C. tropicalis</i> , <i>C. krusei</i> , <i>C. albicans</i> , <i>C. parapsilosis</i> , <i>A. brasiliensis</i> , <i>T. mentagrophytes</i> , <i>B. cinerea</i> , and <i>A. niger</i>	Ganesan et al., 2017
24 isolates (Endophytic Actinobacteria)	<i>S. aureus</i> , <i>E. faecalis</i> , <i>K. pneumoniae</i> , <i>P. aeruginosa</i> , <i>A. baumannii</i> and <i>E. coli</i>	Jiang et al., 2018

**Table 2: Antimicrobial compounds described from different strains of Actinomycetes**

Antimicrobial Compounds	Activity	Sources	References
Munumbicins A-D	Antibiotic	<i>Streptomyces</i> sp.	Castillo et al., 2002
Celastramycins A and B	Antibacterial and Antifungal	<i>Streptomyces</i> sp.	Pullen et al., 2002
Kakadumycins	Antibiotic	<i>Streptomyces</i> sp.	Castillo et al., 2003
24-demethyl-bafilomycin C1	Antibacterial and Antifungal	<i>Streptomyces</i> sp.	Lu and Shen., 2003
24-demethyl-bafilomycin A2	Antibacterial and Antifungal	<i>Streptomyces</i> sp.	Lu and Shen, 2004
Coronamycins	Antibiotic	<i>Streptomyces</i> sp.	Ezra et al., 2004

Demethylnovobiocins	Antibacterial and Antifungal	<i>Streptomyces</i> sp.	Igarashi, 2004
7-(4-aminophenyl)-2,4-dimethyl-7-oxo- hept-5-enoic acid; 9-(4-aminophenyl)- 7-hydroxy-2,4,6-trimethyl-9-oxo-non- 2-enoic acid; 12-(4-aminophenyl)-10-hydroxy-6-(1-hydroxyethyl)-7,9-dimethyl- 12-oxo-dodeca-2,4-dienoic acid	Antibacterial and Antifungal	<i>Streptomyces</i> sp.	Guan et al., 2005
Chloro-dihydroquinones	Antibacterial	Novel Actinomycetes	Soria-Mercado. 2005
Glaciapyrroles	Antibacterial	<i>Streptomyces</i> sp.	Macherla et al., 2005
Frigocyclinone	Antibacterial	<i>Streptomyces griseus</i>	Bruntner et al., 2005
Lajollamycin	Antibacterial	<i>Streptomyces nodosus</i>	Manam et al., 2005
1-hydroxy-1-Norresistomycin	Antibacterial	<i>Streptomyces chinaensis</i>	Gorajana et al., 2005 and Kock et al., 2005
Resistoflavin methyl ether	Antibacterial	<i>Streptomyces</i> sp.	Kock et al., 2005
Dimeric dinactin and Dimeric nonactin	Antibacterial and Antifungal	<i>Streptomyces</i> sp.	Zhao et al., 2005
Marinomycins A-D	Antibacterial and Antifungal	<i>Marinispora</i>	Kwon et al., 2006
Bisanthraquinone	Antibacterial	<i>Streptomyces</i> sp.	Socha et al., 2006
Munumbicins E-4 and E-5	Antibiotic	<i>Streptomyces</i> sp.	Castillo et al., 2006
Lipoxazolidinones A–C	Antibacterial	<i>Marinispora</i> sp.	Macherla et al., 2007
Abyssomicins G, H and atrop-Abyssomicin C	Antibacterial	<i>Verrucosipora</i> sp.	Keller et al., 2007
Pacificanones A & B	Antibacterial	<i>Salinispora pacifica</i>	Oh et al., 2008
Proximicins	Antibacterial	<i>Verrucosipora</i> sp.	Fiedler et al., 2008
Ayamycin	Antibacterial	<i>Nocardia</i> sp.	El-Gendy et al., 2008
Pacificanones A and B	Antibacterial	<i>Salinispora pacifica</i>	Oh et al., 2008
Lynamicins A–E	Antibacterial	<i>Marinispora</i> sp.	McArthur et al., 2008

Rifamycin	Antibacterial	<i>Micromonospora rifamycinica</i>	Huang et al., 2008 Huang et al., 2009)
2-Allyloxyphenol	Antibacterial and Antifungal	<i>Streptomyces</i> sp.	Arumugam et al., 2010
Tirandamycins	Antibacterial	<i>Streptomyces</i> sp.	Carlson et al., 2009
Caboxamycin	Antibacterial	<i>Streptomyces</i> sp.	Hohmann et al., 2009
Phthalates	Antibacterial	<i>Nocardia levis</i>	Kavitha et al., 2009
Rifamycin S	Antibacterial	<i>Micromonospora rifamycinica</i>	Huang et al., 2009
Erythromycin	Antibacterial	<i>Actinopolyspora</i> sp.	Huang et al., 2009
Arenimycin	Antibacterial	<i>Salinispora arenicola</i>	Asolkar et al., 2010
Thiopeptide TP-1161	Antibacterial	<i>Nocardiopsis</i> sp.	Engelhardt et al., 2010
Arenimycin	Antibacterial	<i>Salinispora arenicola</i>	Asolkar et al., 2010
Kanamycin	Antibacterial	<i>Streptomyces kanamyceticus</i> 12-6	Patil et al <sup>147</sup>
Oxytetracycline	Antibacterial	<i>Streptomyces rimosus</i>	Patil et al <sup>147</sup>
Asukamycin	Antibacterial	<i>Streptomyces nodosus</i> subsp. <i>Asukaensis</i>	Patil et al <sup>147</sup>
Tylosin	Antibacterial	<i>Streptomyces fradiae</i>	Patil et al <sup>147</sup>
Fosfomysin	Antibacterial	<i>Streptomyces fradiae</i>	Patil et al <sup>147</sup>
Chloramphenicol	Antibacterial	<i>Streptomyces venezuelae</i>	Patil et al <sup>147</sup>
Rifamycin	Antibacterial	<i>Amycolatopsis mediterranei</i> U- 32	Patil et al <sup>147</sup>
Amythiamicins	Antibacterial	<i>Amycolatopsis</i> sp.	Patil et al <sup>147</sup>
Ipomicin	Antibacterial	<i>Streptomyces ipomoeae</i>  group III	Patil et al <sup>147</sup>
Streptomycin	Antibacterial	<i>Streptomyces griseus</i>	Patil et al., 2011
Capuramycin	Antibacterial	<i>Streptomyces griseus</i>  SANK 60196	Patil et al., 2011
Frigocyclinone	Antibacterial	<i>Streptomyces griseus</i>	Patil et al., 2011

		strain NTK 97	
Tubelactomicin A	Antibacterial	<i>Nocardia</i> sp.	Patil et al., 2011
Avilamycin A	Antibacterial	<i>Streptomyces viridochromogenes</i> Tu57	Patil et al., 2011
atrop-abyssoomicin C and proximicin A	Antibacterial	<i>Verrucospora maris</i>	Roh et al., 2011
Pseudonocardians A–C	Antibacterial	<i>Pseudonocardia</i> sp.	Li et al., 2011
Pyridinium	Antibacterial	<i>Amycolatopsis alba</i>	Dasari et al., 2012
3-((6-Methylpyrazin-2-yl)methyl)-1H-indole	Weak antibacterial	<i>Serinicoccus profundi</i>	Yang et al., 2013
Kocurin	Antibacterial	<i>Kocuria</i> sp.	Palomo et al., 2013

## Conclusions

Although abundance of antibiotics has been obtained from actinomycetes, these represent only a pie of fraction of the repertoire of bioactive compounds produced. Therefore, there is an urgent need for isolation of new species from natural resources and their characterization for secondary metabolites is a valuable endeavor. Presently, the rate of exploring new compounds from soil actinomycetes has fallen, whereas the amount of isolating commercialized bioactive molecule has inflated. Thus, new strain of actinomycetes must be isolated from unexplored or underexploited habitats for the development of innovated antimicrobial compounds for the benefits of society and humankind.

## References

Abdallaoui, M. S., Kamal, N., & Guessous-Idrissi, N. (2009). Mycoses nosocomiales systémiques à *Trichosporon asahii*: à propos de trois cas au CHU Ibn Rochd de Casablanca (Maroc). *Revue Francophone des Laboratoires*, 2009(416), 15-18.

Alharbi, S. A., Arunachalam, C., Murugan, A. M., & Wainwright, M. (2012). Antibacterial activity of actinomycetes isolated from terrestrial soil of Saudi Arabia. *Journal of Food, Agriculture & Environment*, 10(2), 1093-1097.

Anansiriwattana, W., Tanasupawat, S., Amnuoypol, S., & Suwanborirux, K. (2006). Identification and antimicrobial activities of actinomycetes from soils in Samed Island, and geldanamycin from strain PC4-3. *Thai J Pharm Sci*, 30, 49-56.

Arasu, M. V., Duraipandiyar, V., & Ignacimuthu, S. (2013). Antibacterial and antifungal activities of polyketide metabolite from marine *Streptomyces* sp. AP-123 and its cytotoxic effect. *Chemosphere*, 90(2), 479-487.

Arasu, M. V., Duraipandiyar, V., Agastian, P., & Ignacimuthu, S. (2008). Antimicrobial activity of *Streptomyces* spp. ERI-26 recovered from Western Ghats of Tamil Nadu. *Journal de Mycologie Médicale*, 18(3), 147-153.

Arasu, M. V., Duraipandiyar, V., Agastian, P., & Ignacimuthu, S. (2009). In vitro antimicrobial activity of *Streptomyces* spp. ERI-3 isolated from Western Ghats rock soil (India). *Journal de Mycologie Médicale*, 19(1), 22-28.

Arasu, M. V., Duraipandiyar, V., Agastian, P., & Ignacimuthu, S. (2009). In vitro antimicrobial activity of *Streptomyces* spp. ERI-3 isolated from Western Ghats rock soil (India). *Journal de Mycologie Médicale*, 19(1), 22-28.

Arifuzzaman, M., Khatun, M. R., & Rahman, H. (2010). Isolation and screening of actinomycetes from Sundarbans soil for antibacterial activity. *African journal of biotechnology*, 9(29), 4615-4619.

Arumugam, M., Mitra, A., Jaisankar, P., Dasgupta, S., Sen, T., Gachhui, R., ... & Mukherjee, J. (2010). Isolation of an unusual metabolite 2-allyloxyphenol from a marine actinobacterium, its biological activities and applications. *Applied microbiology and biotechnology*, 86(1), 109-117.

Asolkar, R. N., Kirkland, T. N., Jensen, P. R., & Fenical, W. (2010). Arenimycin, an antibiotic effective against rifampin-and methicillin-resistant *Staphylococcus aureus* from the marine actinomycete *Salinispora arenicola*. *The Journal of antibiotics*, 63(1), 37.

Atta, H. M. (2015). Biochemical studies on antibiotic production from *Streptomyces* sp.: Taxonomy, fermentation, isolation and biological properties. *Journal of Saudi Chemical Society*, 19(1), 12-22.

Badji, B., Zitouni, A., Mathieu, F., Lebrihi, A., & Sabaou, N. (2006). Antimicrobial compounds produced by *Actinomadura* sp. AC104 isolated from an Algerian Saharan soil. *Canadian journal of microbiology*, 52(4), 373-382.

Balachandran, C., Duraipandiyar, V., Emi, N., & Ignacimuthu, S. (2015). Antimicrobial and cytotoxic properties of *Streptomyces* sp.(ERINLG-51) isolated from Southern

- Western Ghats. South Indian Journal of Biological Sciences, 1(1), 7-14.
- Basilio, A., Gonzalez, I., Vicente, M. F., Gorrochategui, J., Cabello, A., Gonzalez, A., & Genilloud, O. (2003). Patterns of antimicrobial activities from soil actinomycetes isolated under different conditions of pH and salinity. *Journal of applied microbiology*, 95(4), 814-823.
- Bharti, A., Kumar, V., Gusain, O., & Bisht, G. S. (2010). Antifungal activity of actinomycetes isolated from Garhwal region. *Journal of Sci. Engg. & Tech. Mgt. Vol.* 2, 2.
- Binder, S., Levitt, A. M., Sacks, J. J., & Hughes, J. M. (1999). Emerging infectious diseases: public health issues for the 21st century. *Science*, 284(5418), 1311-1313.
- Bizuye, A., Moges, F., & Andualem, B. (2013). Isolation and screening of antibiotic producing actinomycetes from soils in Gondar town, North West Ethiopia. *Asian Pacific journal of tropical disease*, 3(5), 375-381.
- Bruntner, C., Binder, T., Pathom-aree, W., Goodfellow, M., Bull, A. T., Potterat, O., ... & Wagner, K. (2005). Frigocyclinone, a novel angucyclinone antibiotic produced by a *Streptomyces griseus* strain from Antarctica. *The Journal of antibiotics*, 58(5), 346.
- Carlson, J. C., Li, S., Burr, D. A., & Sherman, D. H. (2009). Isolation and characterization of tirandamycins from a marine-derived *Streptomyces* sp. *Journal of natural products*, 72(11), 2076-2079.
- Castillo, U. F., Strobel, G. A., Ford, E. J., Hess, W. M., Porter, H., Jensen, J. B., ... & Stevens, D. (2002). Munumbicins, wide-spectrum antibiotics produced by *Streptomyces* NRRL 30562, endophytic on *Kennedia nigricans*. *Microbiology*, 148(9), 2675-2685.
- Castillo, U. F., Strobel, G. A., Mullenberg, K., Condrón, M. M., Teplow, D. B., Folgiano, V., ... & Codde, M. (2006). Munumbicins E-4 and E-5: novel broad-spectrum antibiotics from *Streptomyces* NRRL 3052. *FEMS Microbiology letters*, 255(2), 296-300.
- Castillo, U., Harper, J. K., Strobel, G. A., Sears, J., Alesi, K., Ford, E., ... & Yaver, D. (2003). Kakadumycins, novel antibiotics from *Streptomyces* sp. NRRL 30566, an endophyte of *Grevillea pteridifolia*. *FEMS Microbiology Letters*, 224(2), 183-190.
- Ceylan, O., Okmen, G., & Ugur, A. (2008). Isolation of soil *Streptomyces* as source antibiotics active against antibiotic-resistant bacteria. *EurAsian Journal of BioSciences*, 2(9), 73-82.
- Chaudhary, H. S., Yadav, J., Shrivastava, A. R., Singh, S., Singh, A. K., & Gopalan, N. (2013). Antibacterial activity of actinomycetes isolated from different soil samples of Sheopur (A city of central India). *Journal of advanced pharmaceutical technology & research*, 4(2), 118.
- Cuesta, G., García-de-la-Fuente, R., Abad, M., & Fornes, F. (2012). Isolation and identification of actinomycetes from a compost-amended soil with potential as biocontrol agents. *Journal of Environmental Management*, 95, S280-S284.
- Das, A., Bhattacharya, S., Mohammed, A. Y. H., & Rajan, S. S. (2014). In vitro antimicrobial activity and characterization of mangrove isolates of streptomycetes effective against bacteria and fungi of nosocomial origin. *Brazilian Archives of Biology and Technology*, 57(3), 349-356.
- Deepa, L. S., Gowthami, K., & Kumar, K. S. (2011). In vivo screening of antimicrobial activity of soil Actinomycetes against human pathogens. *World Journal of Agricultural Sciences*, 7(5), 624-628.
- Deepthi, M. K., Sudhakar, M. S., & Devamma, M. N. (2012). Isolation and screening of *Streptomyces* sp. from Coringa mangrove soils for enzyme production and antimicrobial activity. *International J of Pharmaceutical, Chemical and Biological Sciences*, 2(1), 110-116.
- Dehnad, A., Parsa, L., Bakhshi, R., & Mokhtarzadeh, A. (2010). Investigation of antibacterial activity of *Streptomyces* isolates from soil samples, West of Iran. *African Journal of Microbiology Research*, 4(14), 1542-1549.
- Donadio, S., Carrano, L., Brandi, L., Serina, S., Soffientini, A., Raimondi, E., ... & Gualerzi, C. O. (2002). Targets and assays for discovering novel antibacterial agents. *Journal of biotechnology*, 99(3), 175-185.
- El-Gendy, M. M., Hawas, U. W., & Jaspars, M. (2008). Novel bioactive metabolites from a marine derived bacterium *Nocardia* sp. ALAA 2000. *The Journal of antibiotics*, 61(6), 379.
- El-khawaga, M. A., & Megahed, M. M. M. (2012). Antibacterial and insecticidal activity of actinomycetes isolated from sandy soil of (Cairo-Egypt). *Egypt Acad J Biol Sci*, 4(1), 53-67.
- Engelhardt, K., Degnes, K. F., Kemmler, M., Bredholt, H., Fjærвик, E., Klinkenberg, G., ... & Zotchev, S. B. (2010). Production of a new thiopeptide antibiotic, TP-1161, by a marine *Nocardiopsis* species. *Appl. Environ. Microbiol.*, 76(15), 4969-4976.
- Ezra, D., Castillo, U. F., Strobel, G. A., Hess, W. M., Porter, H., Jensen, J. B., ... & Hunter, M. (2004). Coronamycins, peptide antibiotics produced by a verticillate *Streptomyces* sp.(MSU-2110) endophytic on *Monstera* sp. *Microbiology*, 150(4), 785-793.
- Fguira, L. F. B., Fotso, S., Ameer-Mehdi, R. B., Mellouli, L., & Laatsch, H. (2005). Purification and structure elucidation of antifungal and antibacterial activities of newly isolated *Streptomyces* sp. strain US80. *Research in Microbiology*, 156(3), 341-347.
- Fiedler, H. P., Bruntner, C., Riedlinger, J., Bull, A. T., Knutsen, G., Goodfellow, M., ... & Schneider, K. (2008). Proximicin A, B and C, novel aminofuran antibiotic and anticancer compounds isolated from marine strains of the actinomycete *Verrucosipora*. *The Journal of antibiotics*, 61(3), 158.
- Ganesan, P., Reegan, A. D., David, R. H. A., Gandhi, M. R., Paulraj, M. G., Al-Dhabi, N. A., & Ignacimuthu, S. (2017). Antimicrobial activity of some actinomycetes from Western Ghats of Tamil Nadu, India. *Alexandria journal of medicine*, 53(2), 101-110.
- Gaskell, E. E., Sihanonth, P., Rostron, C., Hutcheon, G. A., & Hobbs, G. (2010). Isolation and identification of mucinolytic actinomycetes. *Antonie van Leeuwenhoek*, 97(3), 211-220.
- Gebreyohannes, G., Moges, F., Sahile, S., & Raja, N. (2013). Isolation and characterization of potential antibiotic producing actinomycetes from water and sediments of Lake Tana, Ethiopia. *Asian Pacific journal of Tropical biomedicine*, 3(6), 426-435.
- Gopinath, B. V., Vootla, P. K., Jyothi, R., & Reddy, S. K. (2013). Antimicrobial activity of actinomycetes isolated from coal mine soils of godavari belt region, AP, India. *Asian Journal of Experimental Biological Sciences*, 4(4) 518-523.
- Gorajana, A., Kurada, B. V., Peela, S., Jangam, P., Vinjamuri, S., Poluri, E., & Zeeck, A. (2005). 1-Hydroxy-1-norresistomycin, a new cytotoxic compound from a

- marine actinomycete, *Streptomyces chibaensis* AUBN 1/7. *The Journal of antibiotics*, 58(8), 526.
- Grasso, L.L., Martino, D.C., & Alduina, R. Production of Antibacterial Compounds from Actinomycetes. In *Actinobacteria-Basics and Biotechnological Applications*. 2016. IntechOpen.
- Guan, S. H., Sattler, I., Lin, W. H., Guo, D. A., & Grabley, S. (2005). p-Aminoacetophenonic Acids Produced by a Mangrove Endophyte: *Streptomyces griseus* subsp. *Journal of natural products*, 68(8), 1198-1200.
- Gurung, T. D., Sherpa, C., Agrawal, V. P., & Lekhak, B. (2009). Isolation and characterization of antibacterial actinomycetes from soil samples of Kalapatthar, Mount Everest Region. *Nepal Journal of Science and Technology*, 10, 173-182.
- Hohmann, C., Schneider, K., Bruntner, C., Irran, E., Nicholson, G., Bull, A. T., ... & Beil, W. (2009). Caboxamycin, a new antibiotic of the benzoxazole family produced by the deep-sea strain *Streptomyces* sp. NTK 937. *The Journal of antibiotics*, 62(2), 99.
- Holmalahti, J., Raatikainen, O., Von Wright, A., Laatsch, H., Spohr, A., Lyngberg, O. K., & Nielsen, J. (1998). Production of dihydroabikoviromycin by *Streptomyces anulatus*: production parameters and chemical characterization of genotoxicity. *Journal of applied microbiology*, 85(1), 61-68.
- Huang, H., Lv, J., Hu, Y., Fang, Z., Zhang, K., & Bao, S. (2008). *Micromonospora rifamycinica* sp. nov., a novel actinomycete from mangrove sediment. *International journal of systematic and evolutionary microbiology*, 58(1), 17-20.
- Huang, H., Wu, X., Yi, S., Zhou, Z., Zhu, J., Fang, Z., ... & Bao, S. (2009). Rifamycin S and its geometric isomer produced by a newly found actinomycete, *Micromonospora rifamycinica*. *Antonie Van Leeuwenhoek*, 95(2), 143.
- Huang, S. X., Zhao, L. X., Tang, S. K., Jiang, C. L., Duan, Y., & Shen, B. (2009). Erythronolides H and I, new erythromycin congeners from a new halophilic actinomycete *Actinopolyspora* sp. YIM90600. *Organic letters*, 11(6), 1353-1356.
- Ilić, S. B., Konstantinović, S. S., & Todorović, Z. B. (2005). UV/VIS analysis and antimicrobial activity of *Streptomyces* isolates. *Facta universitatis series: Med Biol*, 12, 44-46.
- Iznaga, Y., Lemus, M., González, L., Garmendia, L., Nadal, L., & Vallin, C. (2004). Antifungal activity of actinomycetes from Cuban soils. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, 18(6), 494-496.
- Jeffrey, L. S. H., Sahilah, A. M., Son, R., & Tosiah, S. (2007). Isolation and screening of actinomycetes from Malaysian soil for their enzymatic and antimicrobial activities. *Journal of tropical agriculture and food science*, 35(1), 159.
- Jiang, Z. K., Tuo, L., Huang, D. L., Osterman, I. A., Tyurin, A. P., Liu, S. W., ... & Li, F. N. (2018). Diversity, novelty, and antimicrobial activity of endophytic actinobacteria from mangrove plants in Beilun Estuary National Nature Reserve of Guangxi, China. *Frontiers in microbiology*, 9, 868.
- Jiménez-Esquifín, A. E., & Roane, T. M. (2005). Antifungal activities of actinomycete strains associated with high-altitude sagebrush rhizosphere. *Journal of Industrial Microbiology and Biotechnology*, 32(8), 378-381.
- Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L., & Daszak, P. (2008). Global trends in emerging infectious diseases. *Nature*, 451(7181), 990.
- Jose, P. A., & Jebakumar, S. R. D. (2013). Diverse actinomycetes from Indian coastal solar salterns-a resource for antimicrobial screening. *J. Pure Appl. Microbiol*, 7, 2569-2575.
- Kavitha, A., Prabhakar, P., Vijayalakshmi, M., & Venkateswarlu, Y. (2009). Production of bioactive metabolites by *Nocardia levis* MK-VL\_113. *Letters in applied microbiology*, 49(4), 484-490.
- Keller, S., Nicholson, G., Drahl, C., Sorensen, E., Fiedler, H. P., & Süßmuth, R. D. (2007). Abyssomicins G and H and atrop-abyssomicin C from the marine *Verrucospora* strain AB-18-032. *The Journal of antibiotics*, 60(6), 391.
- Keller, S., Nicholson, G., Drahl, C., Sorensen, E., Fiedler, H. P., & Süßmuth, R. D. (2007). Abyssomicins G and H and atrop-abyssomicin C from the marine *Verrucospora* strain AB-18-032. *The Journal of antibiotics*, 60(6), 391.
- Kharat, K. R., Kharat, A., & Hardikar, B. P. (2009). Antimicrobial and cytotoxic activity of *Streptomyces* sp. from Lonar Lake. *African Journal of Biotechnology*, 8(23).
- Kitouni, M., Boudemagh, A., Oulmi, L., Reghioia, S., Boughachiche, F., Zerizer, H., ... & Boiron, P. (2005). Isolation of actinomycetes producing bioactive substances from water, soil and tree bark samples of the north-east of Algeria. *Journal de Mycologie Médicale*, 15(1), 45-51.
- Kock, I., Maskey, R. P., Biabani, M. F., Helmke, E., & Laatsch, H. (2005). 1-Hydroxy-1-norresistomycin and resistoflavin methyl ether: new antibiotics from marine-derived streptomycetes. *The Journal of antibiotics*, 58(8), 530.
- Kumar, N., Singh, R. K., Mishra, S. K., Singh, A. K., & Pachouri, U. C. (2010). Isolation and screening of soil Actinomycetes as source of antibiotics active against bacteria. *International Journal of Microbiology Research*, 2(2), 12.
- Kumar, P. S., Duraipandiyan, V., & Ignacimuthu, S. (2014). Isolation, screening and partial purification of antimicrobial antibiotics from soil *Streptomyces* sp. SCA 7. *The Kaohsiung journal of medical sciences*, 30(9), 435-446.
- Kumar, V., Bharti, A., Negi, Y. K., Gusain, O., Pandey, P., & Bisht, G. S. (2012). Screening of actinomycetes from earthworm castings for their antimicrobial activity and industrial enzymes. *Brazilian Journal of Microbiology*, 43(1), 205-214.
- Kwon, H. C., Kauffman, C. A., Jensen, P. R., & Fenical, W. (2006). Marinomycins A–D, antitumor-antibiotics of a new structure class from a marine actinomycete of the recently discovered genus “*Marinispora*”. *Journal of the American Chemical Society*, 128(5), 1622-1632.
- Lavin, P. L., Yong, S. T., Wong, C. M., & De Stefano, M. (2016). Isolation and characterization of Antarctic psychrotroph *Streptomyces* sp. strain INACH3013. *Antarctic Science*, 28(6), 433-442.
- Lederberg, J., Hamburg, M. A., & Smolinski, M. S. (Eds.). (2003). *Microbial threats to health: emergence, detection, and response*. National Academies Press.
- Leiva, S., Yáñez, M., Zaror, L., Rodríguez, H., & García-Quintana, H. (2004). Actividad antimicrobiana de actinomycetes aislados desde ambientes acuáticos del sur de Chile. *Revista médica de Chile*, 132(2), 151-159.
- Lu C, & Shen, Y. (2003) A new macrolide antibiotic with antitumor activity produced by *Streptomyces* sp. CS, a



- commensal microbe of *Maytenus hookeri*. *The Journal of antibiotics*, 56(4):415-418.
- Lu, C., & Shen, Y. (2004). Two new macrolides produced by *Streptomyces* sp. CS. *The Journal of antibiotics*, 2004; 57(9), 597-600.
- Maataoui, H., Iraqui, M., Jihani, S., Ibsouda, S., & Haggoud, A. Isolation, characterization and antimicrobial activity of a *Streptomyces* strain isolated from deteriorated wood. *African Journal of Microbiology Research*, 8(11): 1178-1186.
- Macherla, V. R., Liu, J., Bellows, C., Teisan, S., Nicholson, B., Lam, K. S., & Potts, B. C. (2005). Glaciapyrroles A, B, and C, pyrrolisosquiterpenes from a *Streptomyces* sp. isolated from an Alaskan marine sediment. *Journal of natural products*, 68(5), 780-783.
- Macherla, V. R., Liu, J., Sunga, M., White, D. J., Grodberg, J., Teisan, S., ... & Potts, B. C. (2007). Lipoxazolidinones A, B, and C: antibacterial 4-oxazolidinones from a marine actinomycete isolated from a Guam marine sediment. *The Journal of Natural Products*, 70(9), 1454-1457.
- Manam, R. R., Teisan, S., White, D. J., Nicholson, B., Grodberg, J., Neuteboom, S. T., ... & Potts, B. C. (2005). Lajollamycin, a Nitro-tetraene Spiro- $\beta$ -lactone- $\gamma$ -lactam Antibiotic from the Marine Actinomycete *Streptomyces* n. odosus. *Journal of natural products*, 68(2), 240-243.
- Mathur, N., Paliwal, A., Sharma, P., Kumar, M., & Bhatnagar, P. (2012). Antimicrobial Compound from *Streptomyces* Isolate Characterized Using HPLC. *Universal Journal of Environmental Research & Technology*, 2(4).
- Maya, G., Gisha, G., & Hatha, A. A. M. (2010). Diversity and antibacterial activity of actinomycetes from wetland. *The South Pacific Journal of Natural and Applied Sciences*, 28(1), 52-57.
- McArthur, K. A., Mitchell, S. S., Tsueng, G., Rheingold, A., White, D. J., Grodberg, J., ... & Potts, B. C. (2008). Lynamycin A–E, chlorinated bisindole pyrrole antibiotics from a novel marine Actinomycete. *Journal of Natural Products*, 71(10), 1732-1737.
- Mohanraj, G., & Sekar, T. (2013). Isolation and screening of actinomycetes from marine sediments for their potential to produce antimicrobials. *Int. J. Life Sci. Bt & Pharm. Res.*, 2(3): 116-125.
- Morens, D.M., Folkers, G.K., Fauci, A.S. (2004) The challenge of emerging and reemerging Infectious diseases. *Nature*, 430:242–9.
- Naikpatil, S.V., & Rathod, J.L. (2011) Selective isolation and antimicrobial activity of rare actinomycetes from mangrove sediment of Karwar. *Journal of Ecobiotechnology*.
- Nanjwade, B., Chandrashekhara, S., Goudanavar, P., Shamarez, A., & Manvi, F. (2010). Production of antibiotics from soil-isolated actinomycetes and evaluation of their antimicrobial activities. *Tropical Journal of Pharmaceutical Research*, 9(4).
- Nedialkova, D., & Naidenova, M. (2005). Screening the antimicrobial activity of actinomycetes strains isolated from Antarctica.
- Nishimura, T., Meguro, A., Hasegawa, S., Nakagawa, Y., Shimizu, M., & Kunoh, H. (2002). An endophytic actinomycete, *Streptomyces* sp. AOK-30, isolated from mountain laurel and its antifungal activity. *Journal of general plant pathology*, 68(4), 390-397.
- Nurkanto, A., Julistiono, H., Agusta, A., & Sjamsuridzal, W. (2012). Screening antimicrobial activity of actinomycetes isolated from Raja Ampat, West Papua, Indonesia. *Makara Journal of Science*, 21-26.
- Oh, D. C., Gontang, E. A., Kauffman, C. A., Jensen, P. R., & Fenical, W. (2008). Salinipyrones and pacificanones, mixed-precursor polyketides from the marine actinomycete *Salinispora pacifica*. *Journal of natural products*, 71(4), 570-575.
- Okudoh, V. I., & Wallis, F. M. (2007). Antimicrobial activity of rare actinomycetes isolated from natural habitats in KwaZulu-Natal, South Africa. *South African journal of science*, 103(5-6), 216-222.
- Oskay, A. M., Üsame, T., & Cem, A. (2004). Antibacterial activity of some actinomycetes isolated from farming soils of Turkey. *African journal of Biotechnology*, 3(9), 441-446.
- Pandey, A., Ali, I., Butola, K. S., Chatterji, T., & Singh, V. (2011). Isolation and characterization of Actinomycetes from soil and evaluation of antibacterial activities of Actinomycetes against pathogens. *International journal of applied biology and pharmaceutical technology*, 2(4), 384-392.
- Pandey, B., Ghimire, P., & Agrawal, V. P. (2004). Studies on the antibacterial activity of the Actinomycetes isolated from the Khumbu Region of Nepal. *J. Biol. Sci.*, 23, 44-53.
- Passari, A. K., Mishra, V. K., Saikia, R., Gupta, V. K., & Singh, B. P. (2015). Isolation, abundance and phylogenetic affiliation of endophytic actinomycetes associated with medicinal plants and screening for their in vitro antimicrobial biosynthetic potential. *Frontiers in microbiology*, 6, 273.
- Patel, J. D., Parmar, M., Patel, P., Rohit, P., Taviyad, R., Ansari, P., ... & Singh, P. K. (2014). Dynamism of antimicrobial activity of actinomycetes—a case study from undisturbed microbial niche. *Advances in Microbiology*, 4(06), 324.
- Patil, H. J., Srivastava, A. K., Singh, D. P., Chaudhari, B. L., & Arora, D. K. (2011). Actinomycetes mediated biochemical responses in tomato (*Solanum lycopersicum*) enhances bioprotection against *Rhizoctonia solani*. *Crop protection*, 30(10), 1269-1273.
- Patil, H. J., Srivastava, A. K., Singh, D. P., Chaudhari, B. L., & Arora, D. K. (2011). Actinomycetes mediated biochemical responses in tomato (*Solanum lycopersicum*) enhances bioprotection against *Rhizoctonia solani*. *Crop protection*, 30(10), 1269-1273.
- Poosarla, A., & Krishna, R. M. (2013). Isolation of potent antibiotic producing Actinomycetes from marine sediments of Andaman and Nicobar Marine Islands. *Journal of Microbiology and Antimicrobials*, 5(1), 6-12.
- Pullen, C., Schmitz, P., Meurer, K., Bamberg, D. D. V., Lohmann, S., Franca, S. D. C., ... & Gräfe, U. (2002). New and bioactive compounds from *Streptomyces* strains residing in the wood of Celastraceae. *Planta*, 216(1), 162-167.
- Rahman, M., Islam, M. Z., Islam, M., & Ul, A. (2011). Antibacterial activities of Actinomycete isolates collected from soils of Rajshahi, Bangladesh. *Biotechnology research international*, 2011.
- Ramesh, S., & Mathivanan, N. (2009). Screening of marine actinomycetes isolated from the Bay of Bengal, India for antimicrobial activity and industrial enzymes. *World Journal of Microbiology and Biotechnology*, 25(12), 2103-2111.
- eddy, N. G., Ramakrishna, D. P. N., & Raja Gopal, S. V. (2011). A morphological, physiological and biochemical studies of marine *Streptomyces rochei* (MTCC 10109) showing antagonistic activity against selective human pathogenic microorganisms. *Asian J Biol Sci*, 4(1), 1-14.
- Rosa, L. H., Machado, K. M. G., Jacob, C. C., Capelari, M., Rosa, C. A., & Zani, C. L. (2003). Screening of Brazilian

- basidiomycetes for antimicrobial activity. *Memórias do Instituto Oswaldo Cruz*, 98(7), 967-974.
- Sacramento, D. R., Coelho, R. R. R., Wigg, M. D., Linhares, L. F. D. T. L., dos Santos, M. G. M., Semêdo, L. T. D. A. S., & da Silva, A. J. R. (2004). Antimicrobial and antiviral activities of an actinomycete (*Streptomyces* sp.) isolated from a Brazilian tropical forest soil. *World Journal of Microbiology and Biotechnology*, 20(3), 225-229.
- Sathiyaseelan, K., & Stella, D. (2011). Isolation, identification and antimicrobial activity of marine actinomycetes isolated from Parangipettai. *Recent Research in Science and Technology*, 3(9).
- Selvin, J., Shanmughapriya, S., Gandhimathi, R., Kiran, G. S., Ravji, T. R., Natarajaseenivasan, K., & Hema, T. A. (2009). Optimization and production of novel antimicrobial agents from sponge associated marine actinomycetes *Nocardioopsis dassonvillei* MAD08. *Applied microbiology and biotechnology*, 83(3), 435.
- Sengupta, S., Pramanik, A., Ghosh, A., & Bhattacharyya, M. (2015). Antimicrobial activities of actinomycetes isolated from unexplored regions of Sundarbans mangrove ecosystem. *BMC microbiology*, 15(1), 170.
- Sharma, D., Kaur, T., Chadha, B. S., & Manhas, R. K. (2011). Antimicrobial activity of actinomycetes against multidrug resistant *Staphylococcus aureus*, *E. coli* and various other pathogens. *Tropical Journal of Pharmaceutical Research*, 10(6), 801-808.
- Sharma, D., Mayilraj, S., & Manhas, R. K. (2014). *Streptomyces amritsarensis* sp. nov., exhibiting broad-spectrum antimicrobial activity. *Antonie Van Leeuwenhoek*, 105(5), 943-949.
- Sharma, P., Kalita, M. C., & Thakur, D. (2016). Broad spectrum antimicrobial activity of forest-derived soil actinomycete, *Nocardia* sp. PB-52. *Frontiers in microbiology*, 7, 347.
- Silva, W. A., Pinheiro, A. M., Jahns, B., Bögli-Stuber, K., Droz, S., & Zimmerli, S. (2011). Breast abscess due to *Actinomyces europaeus*. *Infection*, 39(3), 255-258.
- Singh, L. S., Baruah, I., & Bora, T. C. (2006). Actinomycetes of Loktak habitat: isolation and screening for antimicrobial activities. *Biotechnology*, 5(2), 217-221.
- Singh, L. S., Sharma, H., & Talukdar, N. C. (2014). Production of potent antimicrobial agent by actinomycete, *Streptomyces sannanensis* strain SU118 isolated from phoomdi in Loktak Lake of Manipur, India. *BMC microbiology*, 14(1), 278.
- Singh, S., Kumar, P., Gopalan, N., Shrivastava, B., Kuhad, R. C., & Chaudhary, H. S. (2012). Isolation and partial characterization of actinomycetes with antimicrobial activity against multidrug resistant bacteria. *Asian Pacific Journal of Tropical Biomedicine*, 2(2), S1147-S1150.
- Singh, V., Haque, S., Singh, H., Verma, J., Vibha, K., Singh, R., ... & Tripathi, C. K. M. (2016). Isolation, screening, and identification of novel isolates of actinomycetes from India for antimicrobial applications. *Frontiers in microbiology*, 7, 1921.
- Socha, A. M., LaPlante, K. L., & Rowley, D. C. (2006). New bisanthraquinone antibiotics and semi-synthetic derivatives with potent activity against clinical *Staphylococcus aureus* and *Enterococcus faecium* isolates. *Bioorganic & medicinal chemistry*, 14(24), 8446-8454.
- Solanki, R., Khanna, M., & Lal, R. (2008). Bioactive compounds from marine actinomycetes. *Indian journal of microbiology*, 48(4), 410-431.
- Sujatha, P., Raju, K. B., & Ramana, T. (2005). Studies on a new marine streptomycete BT-408 producing polyketide antibiotic SBR-22 effective against methicillin resistant *Staphylococcus aureus*. *Microbiological research*, 160(2), 119-126.
- Suthindhiran, K., & Kannabiran, K. (2010). Diversity and exploration of bioactive marine actinomycetes in the Bay of Bengal of the Puducherry coast of India. *Indian journal of microbiology*, 50(1), 76-82.
- Sweetline, C., Usha, R., & Palaniswamy, M. (2012). Antibacterial activity of actinomycetes from Pichavaram Mangrove of Tamil Nadu. *Applied Journal of Hygiene*, 1(2), 15-18.
- Thenmozhi, M., & Kannabiran, K. (2012). Antimicrobial and antioxidant properties of marine actinomycetes *Streptomyces* sp VITSTK7. *Oxidants and Antioxidants in Medical Science*, 1(1):51-57.
- Thumar, J. T., Dhulia, K., & Singh, S. P. (2010). Isolation and partial purification of an antimicrobial agent from halotolerant alkaliphilic *Streptomyces aburaviensis* strain Kut-8. *World Journal of Microbiology and Biotechnology*, 26(11), 2081-2087.
- Usha, R., Ananthaselvi, P., Venil, C. K., & Palaniswamy, M. (2010). Antimicrobial and antiangiogenesis activity of *Streptomyces parvulus* KUAP106 from mangrove soil. *Eur J Biol Sci*, 2(4), 77-83.
- Valli, S., Suvathi, S. S., Aysha, O. S., Nirmala, P., Vinoth, K. P., & Reena, A. (2012). Antimicrobial potential of Actinomycetes species isolated from marine environment. *Asian Pacific Journal of Tropical Biomedicine*, 2(6), 469-473.
- Varghese, R., Nishamol, S., Suchithra, R., Jyothy, S., & Hatha, A. M. (2012). Distribution and antibacterial activity of actinomycetes from Shola soils of tropical Montane forest in Kerala, South India. *J. Environ*, 1(3), 93-99.
- Vijayakumar, R., Murugesan, S., & Panneerselvam, A. (2010). Isolation, characterization and antimicrobial activity of actinobacteria from point calimere coastal region, east coast of India. *Int Res J Pharam*, 1, 358-365.
- Vijayakumar, R., Panneerselvam, K., Muthukumar, C., Thajuddin, N., Panneerselvam, A., & Saravanamuthu, R. (2012). Optimization of antimicrobial production by a marine actinomycete *Streptomyces afghaniensis* VPTS3-1 isolated from Palk Strait, East Coast of India. *Indian journal of microbiology*, 52(2), 230-239.
- Vimal, V., Rajan, B. M., & Kannabiran, K. (2009). Antimicrobial activity of marine actinomycete, *Nocardioopsis* sp. VITSVK 5 (FJ973467). *Asian J Med Sci*, 1(2), 57-63.
- Yücel, S. E. M. R. A., & Yamaç, M. U. S. T. A. F. A. (2010). Selection of *Streptomyces* isolates from Turkish karstic caves against antibiotic resistant microorganisms. *Pak. J. Pharm. Sci*, 23(1), 1-6.
- Zhao, P. J., Fan, L. M., Li, G. H., Zhu, N., & Shen, Y. M. (2005). Antibacterial and antitumor macrolides from streptomycetes sp. Is9131. *Archives of pharmacal research*, 28(11), 1228-1232.
- Zhou, M. Y. (1998). Identification of marine actinomycetes S-216 strain and its biosynthetic conditions of antifungal antibiotic. *J. Xiamen Univ. Nat. Sci.*, 37, 109-114.

**How to cite this article:**

Dimri, A.G., Chauhan, A., Aggarwal, M.L. (2020) *Antibiotic potential of actinomycetes from different environments against human pathogens and microorganisms of industrial importance: a review*, *Science Archives*, Vol. 1 (1), 7-24 DOI: <http://dx.doi.org/10.47587/SA.2020.1102>