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Review on : An Overview of an Actinomycetes and its application

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Abstract

This article provides an overview of actinomycetes, which are widespread in various habitats and involved in important processes, and their applications. Assessing the distribution of actinomycetes is necessary to understand their ecological role. Actinobacteria have broad habitats and can be isolated from terrestrial soils, plant root rhizospheres, and marine sediments. They produce a variety of bioactive secondary metabolites with antibacterial, antifungal, and antiviral properties useful for human, veterinary, and agricultural applications. Main objective of this current study This study focuses on isolating actinomycetes from different soil samples using different selective media. It plays an important ecological role in the transformation of organic matter. Many actinomycetes have evolved to live symbiotically with plants, fungi, insects, animals, and light. It serves as a rich reservoir of medicinal antibiotics and is of great importance to scientists: pharmaceutical industry, agriculture and industry. It is well known to manufacturers of enzymes, antibiotics and anti-cancer drugs and plays an important role in the recycling of organic matter. Isolation of actinomycetes can meet all new requirements related to actinomycetes.

Keyword :- Actinomycetes, isolation, Metabolites.

.INTRODUCTION

Actinomycetes are free-living Gram-positive mycelial bacteria with aerial hyphae and substrates known as actinomycetes. They produce over 20,000 bioactive microorganisms and 40% of the 160 microbial-based antibiotics. Bioactive secondary metabolites such as enzymes, antibiotics and antioxidants (1). It is a spore-forming, mycelium-like, filamentous bacterium that resembles members of the fungi (2). Varies from region to region due to content, pH, soil nutrient content, planting zone, etc. They are found in soil, but also in plant parts such as roots, leaves, and stems. Free-living actinomycetes, also called saprophytes, and other endophytic fungi are associated with plants (2). Actinomycetes are filamentous and have a high G+C content (2,3). They are also known as rich producers of enzymes such as amylase, lipase, protease (87), cellulose (88) and glucose isomerase (89). Plant hormones (90) and other secondary metabolites. Phylum - Actinomycetes Order - Actinomycetes Family:- Actinomycetes. domain:- Bacteria. Phylum - *Actinobacteria* Order -*Actinomycetales* *family:- Actinomycetacae.* Domain :- *Bacteria.*

History

The word actinomycetes comes from the Greek ray (atkis or atkin) and fungi (mukes). Because of their ray-like structure, traditionally considered intermediate between fungi and actinomycetes (83-74), **Cohn** identified the actinomycetes species Strephrotix foersteri in his 1875 morphology was first reported as containing features of both bacteria and fungi (73). Actinomycetes, which arise in an oxygen-poor environment about 270 million years ago, were obligate anaerobes, non filamentous and nonsporogenous with simple morphological features (71). Actinomycetes have complex hyphal morphologies, including linear or aerial hyphae and the presence or absence of sporulation patterns. It can be in the form of cocci, including Micrococcus, cocci, including Arthrobacter fragmented mycelium, including Nocardia spp., and mycelia, including Streptomyces spp. (76). Whiplash. They form pigments. H. Melanoid polymer. These pigments are not required for bacterial growth, but they aid survival (1). Actinobacteria are the largest group of prokaryotes. Actinomycetes are prime candidates for the production of secondary metabolites that are studied in medicine as antibiotics and immunosuppressants. In agriculture, their ability to produce organic acids, fix atmospheric nitrogen, and decompose organic matter is of great importance (68). Secondary metabolites of actinomycetes account for approximately two-thirds of all naturally occurring bioactive substances of pharmacological importance (70)

Structure

Actinomycetes are a group of branched unicellular filamentous fungi. They reproduce either by fission or by specialized spores and are usually characterized by the formation of branched filaments or rods. The hyphae are generally septate. Septa can be observed in several shapes, straight or spiral. Spores can be branched or unbranched, straight or spiral. Spores are spherical, cylindrical and elliptical. They produce micro colonies composed of filaments of a branching system that degrade into diphteroid, short chain and cocci forms after 24–48 hours (6). The cell wall is rigid, maintaining its shape and preventing cell rupture due to high osmotic pressure (6-7). Actinomycete taxonomy has changed over time due to knowledge based on 16s rRNA sequences and phylogenetic relatedness and the availability of existing molecular tools. There are 6 classes, 6 orders, and 14 suborders of actinomycetes. The actinomycetes class is the largest of the 43 families, with the highest number of orders (79). they are heterotrophic in nature (66).

Distribution of an actinomycetes

It is widely distributed in actinomycetes distribution environments (soil, freshwater, seawater, etc.) and has strong biological activity against plant pathogens such as fungi and oomycetes, making it a kind of powerful resource for preventing plant fungal diseases (3).

Rhizospheres soil :-

There are various groups that are stable in soil and rhizosphere plants. Due to their metabolic diversity, actinomycetes are said to be excellent sources of lytic enzymes, antibiotics, and other secondary metabolites.

Fresh Water

In recent years, the value of freshwater as a source of actinomycetes has been established, and actinomycetes were prevalent in stream sediments. Actinobacteria in this habitat have antifungal activity. and antifungal agents against yeasts and molds that afflict terminally ill patients.(13)

Marine actinomycetes:-

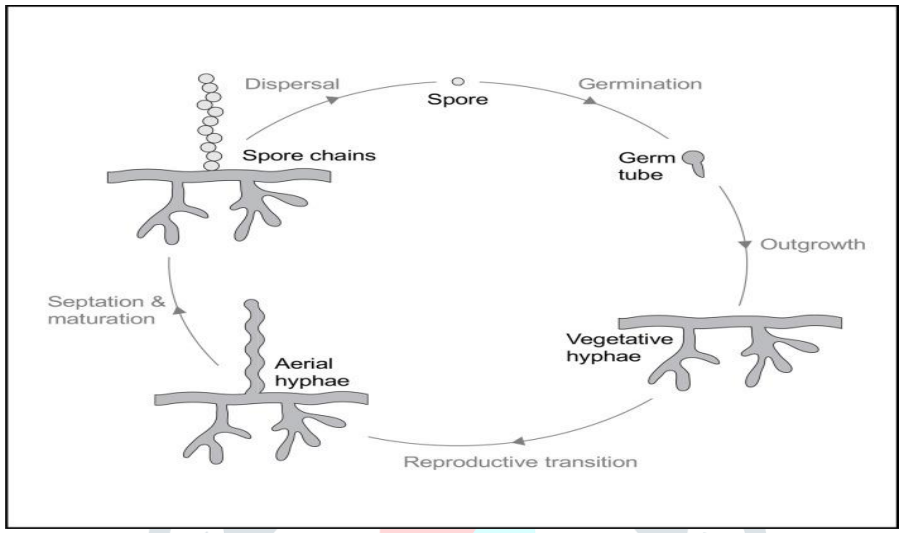
Extracted from the sea, it has excellent antagonistic properties and is a valuable compound used in the pharmaceutical industry (14).There are various groups that are stable in bulk soil and in rhizospheres plants .Due to their metabolic diversity ,actinomycetes are termed as good source of lytic enzymes , antibiotics ,other secondary metabolites .

Air:-the ability of actinomycetes spores to be in the air was detected where air contains different types of their spores like Nocardia Sp are responsible for different antimicrobial production(15).

Others :- hyper-saline soil, Sponges, volcanic cave-hot spot, Desert, Insects gut ,Earthworm castings goat feces, composts and vermicomposts (85,86) etc. Actimycorrhizal plants salt water . They are more abundant in soils than other media ,In most cases, Alkaline soils and soils rich in organic matter, constitute the most necessary part of the microbial population .It can be found both on the soil surface and at a depth of more than 2m below ground (84).

Life cycle Of an Actinomycetes

The life cycle of actinomycetes contains following stages(46):-



Selection of environmental soil samples for isolation of actinomycetes Mainly occurs as saprophytic in diverse natural habitat ,including soil ,the first focus of selective isolation studies . actinomycetes are found in soil and other substrates are greatly influenced by primary ecological factors ,such as aeration ,PH,temperature ,salinity, and moisture and organic matter content (31).marine ecosystem are rich source of navel taxa have great capacity produce new bioactive compounds (51) Indeed an encouraging stream of anticancer ,anti infective have been derived from marine source ,as exemplified by the discovery of abyssomicin C,a potent polycyclic polyketide active against methicillin -resistant Staphylococcus aureus and synthesized by Verrucosisporamaris (54)and salinosporamide A,an anticancer agent produced by Salinispora tropica (24). endophytic bacteria are also important source of anticancer and anti tumour agent (56,25) ,copper -polluted sediments (58).and root nodules of legumes (27), are useful sources of actinomycetes .

❖ Different sources of and media used for the isolation of an actinomycetes

source	Media
Forest soil	Starch -casein medium (19)
Humus layer of forest soil	Humic acid -vitamin agar (19)
Lake soil	Chitin agar(19)
Marine soil	Starch -casein nitrate agar medium

From water :-Stream sediments &Lake mud's	A) Chitin agar b)M3 agar medium B) Bennett's medium
Marine sediments	A)starch -casein agar b)Asparginate agar c) Glycerol glycine agar (20)

Enrichment methods for isolation of an actinomycetes

different genera of actinomycetes can be isolated by addition nutritional or non nutritional ingredients in media for the purpose of selective isolation . it is one of the best method in terms of diversity and abundance of culturable bacteria (30).

Nutritional selection

Some of carbon ,nitrogen and other complex substances have been considered for selective substrates for isolation of actinomycetes .Use of selective media is always preferred for isolation of actinomycetes eliminating other microorganisms .(35) . Nitrogen sources like proteins ,amino acids play an important role .Use of L-arginine and L-Asparagine as a nitrogen source which favour s actinomycetes over a bacteria was reported by Porter et. al.,(1960) . glycine can also be used for isolation of some spp actinomycetes . Use of some other substrates like starch, glycerol, nitrate ,casein,etc were most selective is chitin as a source of carbon and nitrogen source . some of the selective media reported for isolation of an actinomycetes ; Glycerol-aspargine agar ,chitin starch agar, starch nitrate agar ,Humic acid vitamin actinomycetes isolation agar, starch casein agar, inorganic salt starch agar, glycerol -glycine agar,Gause,s no -1 medium ,zhang starch soil extract agar,etc .(36).

Selective inhibition

Use of antibiotics in media to get selective inhibition of unwanted microorganisms helps to get desired species of actinomycetes (30). the use of antifungal antibiotics to improve the efficiency of media for isolating the . Fungi have ability to grow with actinomycetes and hence antibiotics which fungi have been found .recommended Nystatin, Primaricin as a potent antifungal agent .(36) Nalidixic acid and Cycloheximide inhibit the most of gram negative bacteria and fungi and can applicable for isolation of various genera of actinomycetes (39).

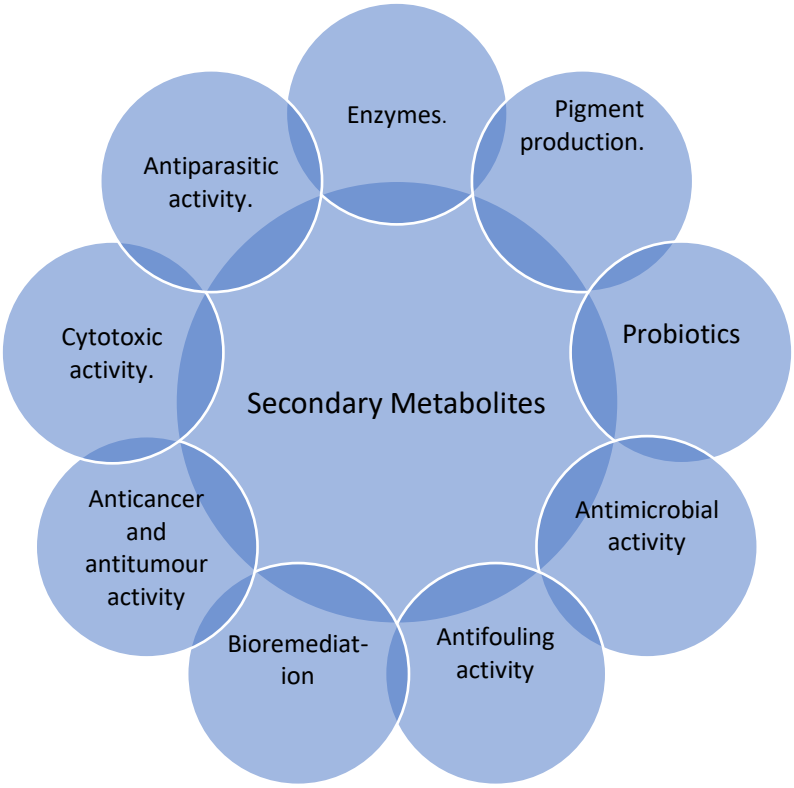
Activities in nature

Actinomycetes plays both beneficial and harmful roles in nature. Among their negative attributes is their pathogenic nature in disease of animals ,humans, forestry ,and plants .the ability of their spores can pollute the environment inside and outside home ,on the farm and industrial settings , as result of disease such as farmers lung ,and hypersensitivity pneumonities can occur . Also it pollute the water and cause the seware problems in sewage treatment plant such as bulking ,and the formation of scums and foams . It is an extremely active in the bio-deterioration and also in the bio-degradation .they have ability to destroy use apparatus and can cause spoilage of hay, cereal grains ,seeds ,bagasse, plant fibre ,wood ,pulp, straw ,paper ,wool, hydrocarbons ,rubber ,plastics. Bio degradation by these organisms plays an extremely beneficial role in waste removal and as it is useful part of recycling of materials in the environment . Mesophillic and thermophillic bacterial species produce cellulase ,xylanase,amylase ,protease and ligninase . whereas thermophillic species degrade plant polymers and form heat . decomposition of lignocellulose are species of the thermophillic *Thermomonospora* and *Microbiospora and the* mesophillic *Streptomyces* . By the Streptomyces the breakdown of the lignocellulose to a reactive polymer is known as precipitable polymeric lignin (APPL). may economic potential and other interesting thing oxidative liquefaction of of lignite coals by *Streptomyces spp* . the degrade lignin /cellulose could potentially be very useful in in the production of liquid fuel and chemicals from lignocellulose .

other useful activities in agriculture and forestry consist biological control agents in the control of fungal disease .great ability to produce antibiotics ,also increases the plant growth by unknown mechanism . agriculturally important secondary metabolites ;these are of following :-coccidiostats ,growth permittants ,anthelminitics, insecticide ,fungicide ,and herbicides . In nature ,*frankia* is extremely useful for symbiotic nitrogen fixation (48)

Applications of an actinomycetes

Secondary Metabolites and Bio activity by Actinomycetes.



Medical Application

More than 80% of all antibiotics used in the medical field are derived from actinomycetes, and 50% of clinically relevant antibiotics are derived from actinomycetes (93). Each actinomycete strain may produce 10–20 secondary metabolites (94). The major drug classes of clinical antibiotics are aminoglycosides, β-lactams, glycopeptides, macrolides, and tetracyclines (64). Specific antibiotics derived from actinomycetes and used in clinics today are neomycin, streptomycin, kanamycin, cephamycin, vancomycin, erythromycin, and tylosin (1).

Antibiotics

The development of antibiotics will help treat microbial infections in humans (1) anti-tuberculosis drugs to treat Mycobacterium tuberculosis:- Rifampicin, Cycloserine (8)

Respiratory infections such as Legionellosis:- Erythromycin (isolated from Saccharopolyspora erythraeae), tetracycline (isolated from Streptomyces aureofaciens) and daptomycin (isolated from Streptomyces roseosporus) are used to treat vancomycin-resistant MRSA infections (44). Chloramphenicol (from Streptomyces venezuelae) inhibits bacterial protein synthesis (42). Gentamicin (from Micromonospora purpurea) treats a variety of infections caused by Gram-positive and Gram-negative bacteria (41). In a study of 20 actinomycetes strains from the mangrove ecosystems of the Andaman Islands, 13 strains of Streptomyces sp. It showed broad-spectrum activity against positive

bacteria. negative bacteria (40) . An interesting topic is whether antibiotics produced by actinomycetes affect unique microorganisms at subinhibitory concentrations compared to antimicrobial compounds produced by other organisms. For example, subinhibitory concentrations of antibiotics mediate nutrient utilization and competition between different Streptomyces strains remaining in terrestrial habitats (16).

Anti-tumour activity.

Adriamycin remoted from Streptomyces peucetius (55) inhibits DNA replication and is an anticancer drug . Other powerful merchandise for most cancers chemotherapeutic are as following :- Actinomycin D, Bleomycin, Anthracyclines (Daunorubicin), Mitosan (Mitomycin C). Important secondary metabolites from marine actinomycetes with antitumor activity include streptoprolidine, cyclo-(L Pro -L-Met), streptochlorin, linamycin, marizomib, and thiocoraline (59).

Anthelmintic activity

Avermectins discovered from Streptomyces avermitilis (77), avermectins are potent anthelmintics used to target nematodes, arachnids, and insects (9). Ivermectin is used in both veterinary and human medicine (12). Used to treat heartworm infections in dogs (11). Human onchocerciasis (43), mosquito-borne malaria infection (60). Abamectin and emamectin benzoate (both avermectins) are common pine wilt nematodes (61).

Biofouling

Biofouling, caused by the formation of undesirable biofilms, is an industrial waste found on medical devices and implants (10), membrane systems (65), ship hulls, pipelines (80), and a variety of other environmental surfaces. Corrosion and natural efficiency issues. Biofilms are found in human dental plaque, intestinal tract, implants, tubes, and stents (40). Such biofilms are responsible for urinary tract infections, cystic fibrosis, chronic obstructive pulmonary disease, and chronic wounds (23). Marine biofouling deposits damage hulls and increase towing by up to 60%, resulting in up to 40% higher fuel consumption and increased CO2 and SO2 pollution (45). These environmental concerns require new research to improve biofouling prevention and removal, and recently, antibiotic film agents discovered from marine actinomycetes were used to improve biofouling properties. has been noted to improve (63)

Actinobacteria as a source of antifungal drugs

In 1965, Isono et al. (28) isolated the first members of a new class of natural fungicides, polyoxins B and D, from the metabolites of Streptomyces cacaoi var. asoensis. These substances work by interfering with fungal cell wall synthesis by inhibiting chitin synthetase (29). Polyoxin B is used against a variety of fungal pathogens on fruits, vegetables and ornamental plants, while polyoxin D is used for the control of the rice pod rot pathogen Rhizoctonia hissolani (86).

Antiviral activity:

Antiviral compounds have been extracted from actinomycetes, and there are various reports on antiviral agents derived from marine actinomycetes. AJ8 isolated from Streptomyces covalum salt can effectively inhibit shrimp white spot syndrome virus by 85% [5].

Environmental application

Production of pesticides

Pesticides are chemicals used to kill pests, including the most common insects and fungi in nature, caused by pollution, human disease, high production costs, and ecosystem degradation (47). plant diseases (49) Antifungal metabolites from actinomycetes, including kasugamycin (84), mildiomycin (55).polyoxin B, polyoxin D (18), and validamycin A (1), are harmful to animals. It is a powerful antifungal agent that does not affect Another effective form of pathogen regulation is inhibition of fungal cell wall synthesis by inhibiting chitin synthase using polyoxin B and D (18).

Role in bioremediation

Better systems are needed to decontaminate pesticides, metals and mixed soils. There are now methods to remove pesticides and other toxic chemicals from soil and water, especially for inorganic substances and compounds. While chemical compounds can be fully degraded into safe products, inorganic compounds are often only partially degraded, producing intermediate products that are more toxic than the original pesticide. Actinobacteria are suitable for this purpose because they are ubiquitous in soil and water and already perform functions to maintain ecological balance by degrading both organic and inorganic compounds in the environment. (62).

Role in biodegradation

Role in bio degradation Many research have proven that crop straw as an crucial fraction of agricultural wastes typically includes a big share of polymeric lignocellulose, that's slowly decomposed throughout composting and can result in low composting cap potential and undesirable compost quality (92) for this reason , it's far useful to look at the variations of lignocellulose degradation among one-of-a-kind crop straw composts and the way to enhance the cap potential of straw composting. Microbes play an important thing function in composting, which can be the using pressure in the back of the transformation and stabilization of natural rely throughout composting. And sell the pastime of practical microbes with the aid of using regulating the environmental elements that accelerating bio degradation (75) Inoculants are specifically micro organism and fungi ,inoculation with inside the degradation of lignocellulose polymers (I.e. cellulose ,hemicellulose and Lignin) throughout composting .actinomycetes produce spore beneathneath excessive temperature to face up to harsh environmental in composting (75) higher know-how of the jobs of actinomycetes inoculants able to degrading lignocellulose throughout diverse crop straws composting may also assist to offer greater green suggestions for crop straw management .Lignin with macro molecular homes and structural traits is difficult to be degraded with the aid of using microbes (57)

Pigment manufacturing

Various industries, such as textiles, food, cosmetics and pharmaceuticals, use synthetic pigments for coloring as they are economically feasible. However, various studies have demonstrated that increased use of such man-made products can result in carcinogenic, genotoxic, and neurotoxic effects. For this reason, the use of these types of synthetic colors are minimized instead of these natural pigments from different herbal and microbial sources are used .Melanin was prepared by Streptomyces Sp. F1, F2, and F3 were isolated from a marine sediment sample. The pigment was also found to have an inhibitory activity against pathogen strains(20).

industrial applications

Probiotics

One way to circumvent this problem is to use probiotic microorganisms introduced into another organism to compete with pathogens for resources, improve the internal or external environment of the organism, (50) Species currently used as macrobiotics include Lactobacillus, Bacillus, Bifidobacterium, Lactobacillus species, and yeasts such as Saccharomyces cerevisiae. However, actinomycete species, particularly members of his Streptomyces genus, have recently been highlighted as potential new sources of probiotics (72). It is a strong candidate for Streptomyces genus Streptomyces spp. It is a strong candidate for probiotic use, mainly because of its ability to produce antibiotics that are active against common and MDR Vibrio species (34).

Biofuels

The method used to eliminate actinomycete contamination is to prevent the formation of these contaminants in the first place (33) . In particular, the use of actinomycetes as potential producers of biofuels is being investigated as a promising new research area. This decomposition allows the formation of compounds such as bioethanol and biodiesel that can convert current ethanol- and diesel-based fuels derived from non-renewable resources [32].

Streptomyces are used for biofuel production, and most studies support their ability to degrade cellulose and other plant biomass (32).

Chemical Additives

In one study, S. lividans was modified with a phenolic acid decarboxylase from another species and used to produce the plastic additive 4-vinylphenol from cellulose [22]. In another study, Streptomyces maritimus increased benzoic acid production, enabling a new pathway to synthesize benzoic acid directly from cellulose [17]. Benzoic acid is used in cosmetics, food preservatives, hygiene products and pharmaceuticals. Common enzymes used in medical applications today also act as detergents and are also used in food and textile manufacturing [4].

Conclusions

This review provided a comprehensive overview of the current state of knowledge on the biology of actinomycetes and their members' applications in medicine, agriculture, the natural environment, and industry. Actinomycetes are distributed in both aquatic and terrestrial ecosystems, and their members play important roles in biomaterial recycling. The diversity of this phylum is large and includes many useful as well as several pathogenic species. It is also used as other secondary metabolites used in medicine and improving plant growth and disease resistance.

We also need to focus on the selective isolation of actinomycetes using appropriate enrichment methods and media. Various generalized and advanced methods have been introduced to isolate actinomycetes from soil, sea and plants. Various strategies have been used to isolate antibiotic-producing actinomycetes from sources mentioned in reviews.

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