EC MICROBIOLOGY
Editorial

# Exploring the Potential of *Actinobacteria* in Agriculture

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*Actinobacteria* has the potential to produce a wide variety and great number of bioactive compounds. It has estimated that over 10,000 are synthetized by this phylum, and 70% of them attributed to the genus *Streptomyces.* Although this great potential, evidences suggest that novel molecules from this group are still waiting to be discovered. Recently, novel *Actinobacteria* species have been described from different ecosystems, including the extreme ones, representing a unique source of new molecules. Likewise, *Actinobacteria* inhabiting the inner tissues of plants, the endophytes, have attracted attention of the scientific community as potential sources of novel natural compounds. *Actinobacteria*, particularly members of *Streptomyces*, have been tested for their ability to control a range of plant pathogens and also as fruitful source of agroactive compounds. Activities as antibiosis, mycoparasitism and competitive inhibition have been described in the biological control of plant diseases as well as lytic enzymes are involved in reducing the incidence of plant pathogens. However, nearly the totality of these *Actinobacteria*-derived compounds is used to treat human diseases as antibiotics, enzymes, immunosuppressive agents and antitumor agents compared to those applied in agriculture for biological control of plant diseases. In agriculture, some *Actinobacteria* species have been using to control plant diseases [1]. For instance, *Streptomyces* spp. 5406 has been applying for decades to protect cotton crops against soil borne plant pathogens in China [2]. As agrochemical sources, natural fungicides (kasugamycin) manufactured by *S. kasugamis* has been used to control the rice blast caused by *Pyricularia oryzae*. Validamycin, another natural fungicide synthetized by *S. hygroscopicus,* has been used to control rice sheath blight caused by *Rhizoctonia solani.* Aureofungin, produced by *Streptoverticillium cinnamomum*, causes the disruption of fungal cell and is used against citrus gummosis, powdery mildew of apple, apple scab and anthracnose of grapevine [3]. Rustmicin, isolated from *Micromonospora chalcea* has been used against the wheat stem rust fungus *Puccinia graminis*. In regard to antibacterial antibiotics, *Streptomyces griseus* produces streptomycin that prevents the electron transport and protein synthesis and is available to control Gram-positive and Gram-negative bacterial plant pathogens. It is mostly used as foliar spray to control fire blight of apple and pear (*Erwinia amylovora*), citrus canker (*Xanthomonas vesicatoria*) and soft rot of vegetables (*Erwinia carotovora*). The massive use of synthetic pesticides coupled with their adverse environmental effects and the benefits achieved in medical treatments with *Actinobacteria*-derived compounds have stimulated the use of this group of bacteria as a source of novel bioactive compounds. In this direction, our group has successfully been conducted isolation of new *Actinobacteria* species from terrestrial and marine habitats for biological control of agronomical important plant pathogens. In these last five years, we have described a number of novel *Actinobacteria* species and some of them have presented functional activity against plant pathogens. In our continuing search for biocontrol agents, we have exploited suppressive soils and endophytic *Actinobacteria*. Endophytic *Streptomyces* strains isolated from healthy maize plants were able to inhibit the development of some phytopathogenic fungi [4]. One *Streptomyces* strain (16R3B) reduced up to 71% damping-off incidence in cucumber caused by *Pythium aphanidermatum,* a cosmopolitan pathogen that infect a huge variety of hosts (Figure 1).

It is noteworthy considering that the control of damping-off is difficult due to the lack of registered and commercially available fungicides. Likewise, the strain 16R3B inhibited *Rhizoctonia solani* (Figure 2) and completely reduced the root rot of common beans.


***Figure 1:*** *Effect of Streptomyces sp. 16R3B on Pythium aphanidermatum damping-off of cucumber. Infested soil with the pathogen (pot on the left) was treated with the biocontrol agent. Untreated seedlings on the right.*

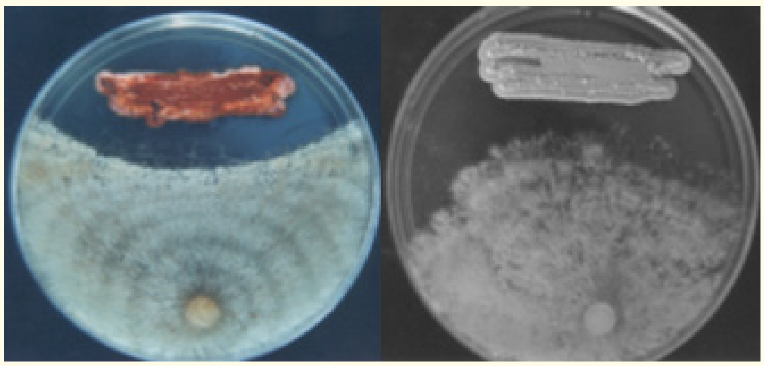

***Figure 2:*** *Inhibition of Rhizoctonia solani by Streptomyces sp. 16R3B.*

We found out that an endophytic *Streptomyces* sp. strain ASBV-1 isolated from potato tubercle successfully controlled *Aspergillus parasiticus* with consequent decrease in aflatoxin contamination of peanut grains [5]. This strain reduced the levels of both aflatoxins B1 and G1 when applied 24 hours after the pathogen [5]. Since mycotoxins are found in almost 25% of the world's agricultural commodities, efforts should be made to develop efficient control methods to avoid mycotoxin contamination in food. Later, we described *Streptomyces araujoniae* as a novel species [6] which inhibits *Botrytis cinerea* in strawberry pseudofruit (Figure 3), and produces a multiantibiotic complex with ionophoric property [7]. This complex contains members of the macrotetralides class, including monactin, dinactin, trinactin, and tetranactin, and the cyclodepsipeptide valinomycin, all of which with activity against *B. cinerea* [7] (Figure 4).

***Figure 3:*** *Treatments: Tr 1: A -Pseudofruit without disinfection; Tr 2: B - Control of disinfection; Tr3: C – Positive control (Botrytis cinerea); Tr 4: D – Application of the fungicide Cercobin 500; Tr 5: E – Application of culture medium filtrate of S. araujoniae; Tr 6: F - Application of 104/mL cells of S. araujoniae; Tr 7: G – Application of crude extract of S. araujoniae (1 mg/mL); Tr 8: H – Application of crude extract of S. araujoniae (0,1 mg/mL);Tr 9: I – Application crude extract of S. araujoniae (0,01 mg/mL). The application of 1mg/ mL of the extract of S. araujoniae completely reduced the symptoms of gray mold.*

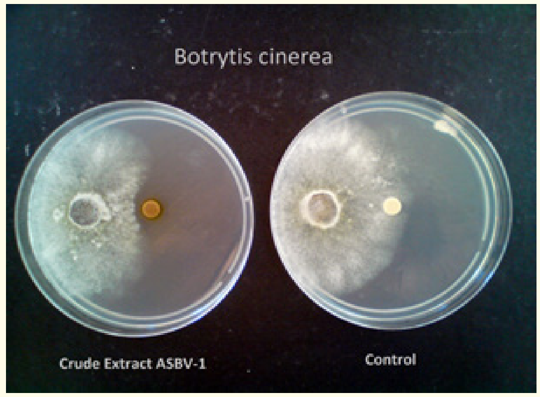


***Figure 4:*** *Bioactive metabolite of Streptomyces araujoniae against Botrytis cinerea, causal agent of gray mold in strawberry.*

From the sea, we have investigated *Actinobacteria* associated with marine sponges with herbicide activity. One novel species, *Streptomyces atlanticus* isolated from *Aplysina fulva* [8] demonstrated to produce butenolide, a lactone compound that showed a potent herbicide property, inhibiting the growth of monocotyledonous annuals (Figure 5).

***Figure 5:*** *Streptomyces atlanticus sp. nov. pure fraction (pot on the right) inhibiting the seed germination of the bentgrass Agrostis sp. Pot on the left received only distilled water.*

We also have employed a rapid primary screening method using the oomycete *Pythium aphanidermatum* as model for high throughput screening antifungal activity with positive correlation with herbicidal activity, following the same approach developed for antitumor activity [9]. In conclusion, the future of biopesticides is surely bright, and the use of *Actinobacteria* and their products for management of plant diseases should be a feasible substitute to the synthetic pesticides. Future use of *Actinobacteria* may also include the application for plant growth promotion, however, some studies still have be done with regard root colonization, and safety and stability under field conditions.

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