Antimicrobial and Biochemical Characterization of Actinomycetes Antagonists of Phytopathogenic Microorganisms Isolated from Soils of Michoacán

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Pepper (*Capsicum annuum* L.) is an important crop in Mexico and pepper wilt caused by *Phytophthora capsici* (PC) *Fusarium oxysporum* (FO) and *Rhizoctonia solani* (RS) is one of the diseases that affect it. The disease control is performed mainly by applying large amounts of agrochemical compounds and the search for alternatives with less environmental impact is required, so the finding and use of biological control agents could contribute to reducing the environmental impact that the application of pesticides cause and meet the demand for organic products. Actinomycetes may be employed as biological control agents due to their ability to produce bioactive compounds as antibiotics. These microorganisms are present in soil and interact with phytopathogenic microorganisms. Therefore the aim of this study was to characterize soil actinomycetes isolated from Michoacán with antimicrobial activity against PC, FO and RS, to further determine the biochemical mechanism by which the inhibition of microbial pathogens occurs. To evaluate the *in vitro* antagonism between actinomycetes and plant pathogens, three experiments were established, each test was placed in a completely randomized experimental design with 87 treatments (85 Michoacán actinomycetes, *Streptomyces lydicus* of Actinovate^{AG} and PC, FO, RS as controls). The response variable evaluated was the area of inhibition (%) of plant pathogenic microorganism growth (AIMF-PC, FO, RS) due to actinomycetes. Subsequently, the production of cellulase, pectinase, chitinase and phosphatases for the 10 strains of actinomycetes with the highest antimicrobial activity was determined. For RS, there were significant differences between strains (Tukey, $p \leq 0.05$) for AIMF-RS, being the best strains MABV07, MABV45, MABV37 and MABV47 AIMF-RS with greater than 50%. in the case of PC, there were statistical differences (Tukey, $p \leq 0.05$) among the 85 strains of actinomycetes for AIMF-PC, 32 strains inhibited the growth of PC over 60% and 14 inhibited the growth of PC completely (MABV01, MABV09, MABV24, MABV30, MABV37, MABV38, MABV39, MABV40, MABV42, MABV45, MABV47, MABV48, MABV49, MABV65 and MABV74). Finally, to FO, the results also indicate statistical differences between treatments (Tukey, $p \leq 0.05$) and of the 85 strains tested, 12 showed a AIMF-FO than 60%. To confirm the inhibitory activity of the strains tested, a second experiment was established in dual confrontation culture. The results showed that 12 strains AIMF-FO showed a greater than 40%, the strain MABV63, it presented an AIMF-FO greater than 50%. Finally a positive correlation between the production of cellulase, pectinase, chitinase and phosphatases with the inhibitory capacity of 10 strains of actinomycetes to RS, PC, FO, found result suggesting that the mechanism by which the actinomycetes are acting is by producing of enzymes involved in the formation of the cell walls of the phytopathogenic microorganisms.

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