The Effects of Jasmonate Derivatives on *Escherichia coli* Growth

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Abstract

Small cyclic plant signaling molecules called jasmonates serve as activators of wound response pathways and growth regulators in many types of plants; however, new connections are being made between these molecules and microbial life. This project focuses on how different jasmonate molecules can alter growth patterns in *E. coli* K-12 W3110 derived strains’ growth were measured by growth curve analysis in several jasmonate solutions. Five jasmonates were synthesized from methyl jasmonate, the most common naturally occurring jasmonate. Results indicate that methyl jasmonate and ethyl jasmonate caused a small dip in growth at about 6 hours, whereas jasmonic and jasmonolic acid had little to no effect on growth. Methyl jasmon impeded growth as well, but did not show the same pattern as methyl jasmonate. Our ethanol control showed no major difference in growth. These results indicate that the presence of certain jasmonates directly affect bacterial growth rather than by some side pathway. Further research into the genetic changes that may shed light on mechanisms through which bacteria interact with plant hormones.

Introduction

- Jasmonates are a class of lipid signaling hormones generated by many biochemical response pathways in plants. Jasmonates are oxylipins, as they are derived via oxygenated polysaturated fatty acids, and are found in nearly all plant life.
- Jasmonates such as methyl jasmonate and jasmonic acid are used in complex biochemical pathways involved in wound response (Farmer & Ryan, 1990). Jasmonates interact with different kinase proteins to inhibit general plant growth and activate plant senescence (Reinbothe et al., 2009).
- Previous research shows that MeJ treatment of Arabidopsis thaliana caused a significant change in the rhizobial microbe composition (Carvalhais et al., 2013). This suggests that the activation of jasmonate signaling pathways may modulate bacterial growth.

Methods

- Preparation of Jasmonate Analogs: Five jasmonate analogs were prepared: methyl jasmonate (MeJ), jasmonic acid (JA), ethyl jasmonate (EU), methyl jasmonol (MeJOH), and jasmonolic acid (JAOH). 500 mg MeJ was used as starting material for each step of synthesis. See reaction scheme for synthesis details.
- Analysis of Chemical Purity: All products were analyzed using 1H NMR, 13C-NMR, IR, GC-MS, and the OSU CCIC provided HRMS analysis.
- Strain Reference / Media Preparation: *E. coli* K-12 W3110 was used as the ancestral strain for the wild type and mutant strains used. LBK was prepared, and buffered to a pH of 7.0 using a 100 mM piperazine buffer. Any pH adjustments were made via either 5 M HCl or 5 M KOH (Creamer et al., 2019). padaica stain for the wild type and mutant strains used. LBK was prepared, and buffered to a pH of 7.0 using a 100 mM piperazine buffer. Any pH adjustments were made via either 5 M HCl or 5 M KOH (Creamer et al., 2019).

![Figure 1](attachment://1H-NMR_of_Methyl_Jasmonate.png)

**Figure 1:** 1H-NMR of Methyl Jasmonate

**Figure 2:** Both MeJ and EtJ show a small “dip” in growth around 300 - 500 min. MeJOH caused a large decrease in growth, but no dip.

**Figure 3:** Both JA and JAOH showed very little effect on growth in all strains tested. Ethanol control shows no difference from standard growth, indicating that the ethanol used to dissolve all products is inconsequential in overall growth.

**Figure 4:** mdlep and marA knockout strains exhibit standard growth. Jasmonate resistance does not rely on the multidrug efflux pump or the mar regulon.

Conclusions

- Methyl jasmonate and ethyl jasmonate inhibit bacterial growth
- Dip in growth at about 5 hours
- Methyl jasmonate stress causes a large decrease in growth
- No dip observed
- Ketone group may be responsible for dip in growth
- Jasmonic acid and jasmonolic acid do not affect growth
- Ester-hydrolyzed jasmonate analogs likely not involved in mechanism that plants use to regulate bacterial growth
- Benzoate-evolved A5-1 strain has increased jasmonate tolerance
- mdlep, mdlef, marA, and marR knockouts grow similar to background strain
- mdlep pump and mar regulon not involved in jasmonate tolerance

References


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