



**CALIFORNIA STATE SCIENCE FAIR  
2017 PROJECT SUMMARY**

<b>Name(s)</b> <b>Aarzu Gupta; Maya Shukla</b>	<b>Project Number</b> <b>S1609</b>
<b>Project Title</b> <b>Efficacy of Combinations of Plant-Based Antimicrobial Agents in Inhibiting the Growth of Antibiotic Resistant Bacteria</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> According to the US Centers for Disease Control and Prevention, if antibiotic-resistant bacteria continue to impact the human population, by 2050, 10 million people will start dying each year from the impact of superbugs. We hypothesized that combinations of goldenseal and garlic with plant extracts will be more effective than individual agents in inhibiting the growth of bacteria, in the fight against antibiotic-resistance.</p> <p><b>Methods/Materials</b> We applied combinations of the pure extracts of five natural antimicrobial agents (Turmeric, Ginger, Cinnamon, Goldenseal, and Garlic) on four different bacteria (Escherichia coli, Citrobacter freundii, Staphylococcus epidermidis, and Bacillus coagulans), two gram- and two gram+ to determine the efficacy. We used the Kirby-Bauer disk-diffusion method to find out if certain bacteria can colonize when tested with combinations of these extracts. We measured the diameter of the zone of inhibition around each of the disks to determine whether the antimicrobial agent was effective in killing the bacteria.</p> <p><b>Results</b> Statistical analysis of the data revealed that while not all combinations of garlic and goldenseal were more effective than the individual substances, many did have increased efficacy. On both gram-positive and gram-negative bacteria, garlic in combination with ginger or turmeric, as well as goldenseal and turmeric, had significant improvements in inhibiting bacterial growth when compared to individual efficacy levels.</p> <p><b>Conclusions/Discussion</b> Many combinations of plant-based antimicrobial agents are more effective than single agents in inhibiting bacterial growth, particularly combinations of those that have limited individual antimicrobial properties. Turmeric and ginger are the most promising agents to pursue for further research against antibiotic-resistant bacteria. Understanding that not all chemical combinations have synergistic effects is also crucial to selecting and designing future combination therapy experiments.</p>	
<b>Summary Statement</b> Combinations of certain plant-based agents are effective treatments against bacterial antibiotic-resistance.	
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