Dual Antimicrobial and Prebiotic Activities of Lamiaceae Honeys: Implications for Food Safety and Healthy Aging

Filomena Nazzaro[1], Maria Neve Ombra[1], Francesca Coppola[1,2], Beatrice De Giulio[1], Antonio d'Acierno[1], Raffaele Coppola[1,3], and Florinda Fratianni[1]

[1] Institute of Food Science, National Research Council, Via Roma 64, 83100, Avellino, Italy

[2] Department of Agricultural Sciences, University of Naples Federico II, Piazza Carlo di Borbone 1, 80055 Portici, Italy

[3] Department of Agriculture, Environment and Food (DiAAA), University of Molise, Via de Sanctis, 86100 Campobasso, Italy

Background

The growing prevalence of microbial resistance and age-related health issues highlights the need for natural products with multifunctional properties. Honey from Lamiaceae plants—basil, mint, oregano, rosemary, savory, and thyme—contains bioactive compounds with antimicrobial and prebiotic potential. This study aimed to investigate the dual effects of the honey against pathogenic bacteria and beneficial probiotics, with particular consideration of their potential applications for elderly populations, who are more vulnerable to infections, gut dysbiosis, and chronic inflammation.

Methods

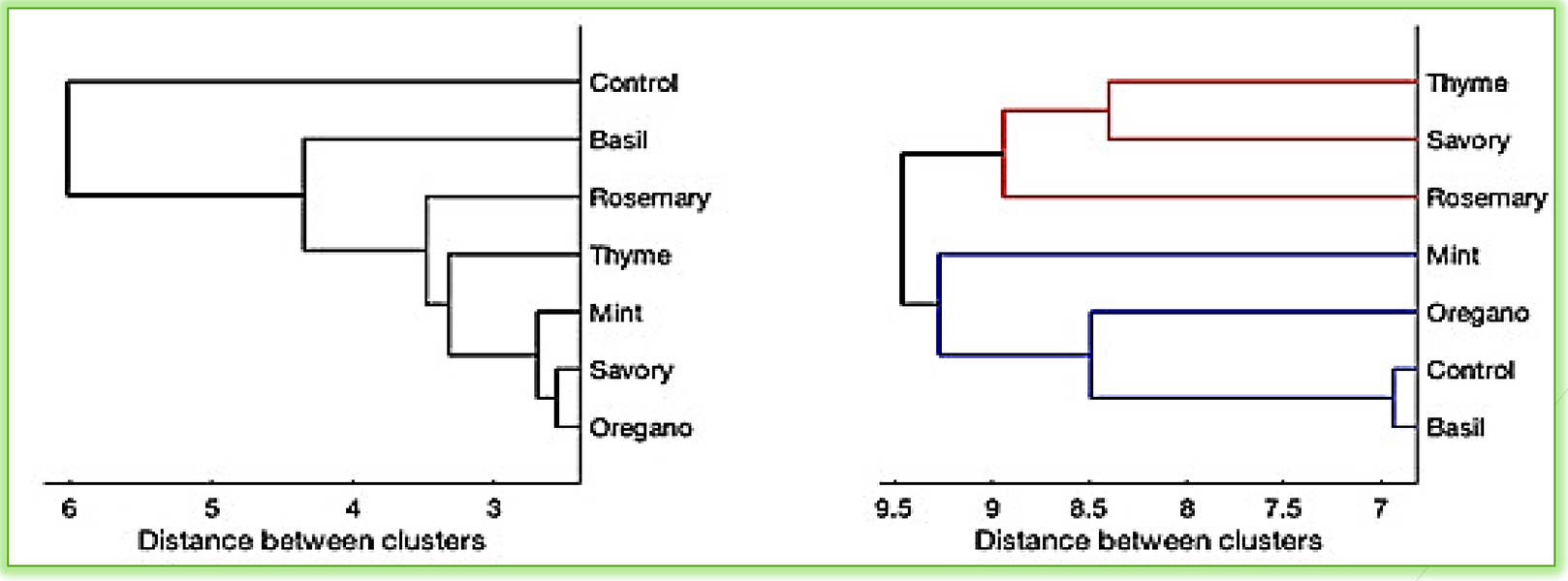
Antimicrobial activity of the honey was tested against *Acinetobacter baumannii, Escherichia coli, Listeria monocytogenes, Pseudomonas aeruginosa*, and *Staphylococcus aureus*. Assays evaluated hydrophobicity, hemolytic activity, and biofilm inhibition at immature and mature stages. Spectrophotometric detection of nucleic acids and proteins provided insight into membrane damage and impairment of the biofilm scaffold. Prebiotic potential was assessed on *Lacticaseibacillus casei* Shirota, *Lactobacillus gasseri*, *Lacticaseibacillus paracasei* subsp. *paracasei*, and *Lacticaseibacillus rhamnosus*, analyzing growth, adhesion, antioxidant, and cytotoxic properties. Probiotic supernatants were further examined for their ability to inhibit pathogen biofilms.

Results

All honeys inhibited pathogen biofilms, with the most potent effects observed against mature forms. Mint honey reduced *L. monocytogenes* biofilms by 81.62%, while *S. aureus* biofilms were highly susceptible, showing up to 67.38% inhibition in immature biofilms (basil honey) and 80.32% in mature biofilms (mint honey). Release of nucleic acids and proteins indicated possible membrane disruption or defective scaffold formation. All honeys also enhanced probiotic growth and adhesion, supporting functional properties. Supernatants from *L. casei* Shirota, *L. gasseri*, and *L. paracasei* significantly inhibited the growth of immature pathogen biofilms. The study assessed also whether combining probiotics with honey enhances anticancer effects compared to glucose or honey alone. Supernatants from probiotics grown in Lamiaceae honeys—especially mint honey—significantly reduced the viability of MCF-7 and Caco-2 cells, while honey alone had minimal impact. *L. casei* Shirota and *L. gasseri* cultured with mint, oregano, or rosemary honey showed the most potent antiproliferative activity. Overall, probiotics grown in Lamiaceae honeys exhibited greater cytotoxicity than those grown on glucose or honey alone, suggesting synergistic interactions that may enhance anticancer potential.

			Antimicrobial Activity			
	Hydrophobicity	Hemolytic activity	CV0	MTT0	CV24	MTT24
Basil	++++	+++	++	++	++++	–
Mint	++++	++++	++	++	+++++	–
Oregano	+++	+++++	++	++	++++	–
Rosemary	+++++	++++	++++	++	+++++	–
Savory	++++	++++	+++	++	++	–
Thyme	+++++	+++	++	++	+++++	–

Summary of the effectiveness of basil mint, oregano, rosemary, savory, and thyme honey as antimicrobial agents. The number of "+" is commensurated with the behavior of the honey and indicates the major or minor effectiveness of the kinds of honey, depending on the tests performed. The "—" sign indicates no efficacy.



Dendrogram of the Lamiaceae kinds of honey obtained using a UPGMA clustering algorithm, taking into account the results obtained from the hydrophobicity and hemolytic tests (on the left) and antibiofilm assays (on the right).

Conclusions

Lamiaceae honeys exert dual antimicrobial and prebiotic activities, making them promising natural agents for food safety and health promotion. Their ability to counteract biofilms while supporting probiotic growth suggests potential benefits for aging populations, where maintaining gut health and reducing infection risk are critical. Further clinical validation is required to explore their role in functional diets for the elderly.