



# Bacteriophages as Preservation Agents to Promote Minimally Processed Food Safety



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## Abstract

Foodborne disease related to ready to eat products contaminated by foodborne pathogens is a global concern due to its impact on human health and economy worldwide. Minimally processed food like ready to eat fruits and vegetables are not subjected to common preservation processes, additionally, the use of antibiotics and chemicals for pathogens eradication may affect consumers health. Bacteriophages or viruses that infect bacteria have been suggested as bio-control tools and advantageous bio-preservation agents to promote minimally processed food safety. Recent studies show a reduction of pathogens after application of phages cocktails on fresh produce. Usefulness of broad-host range bacteriophages as bio-preservation agents needs more investigation.

**Keywords:** Ready to eat products; Bacteriophages; Bio-preservation; Broad-host range; Food process

## Introduction

Bacteriophages or viruses that infect bacteria are extremely abundant in nature with a high diversity. There are more than  $10^{31}$  phage particles in the biosphere. They outnumber bacteria in most studied habitats including human and animal associated microbial communities. Phages are considered non-pathogenic to humans and obligate intracellular parasites without intrinsic metabolism, they replicate in metabolizing host bacteria. After adsorption, phages inject their genomes into the bacterial cytoplasm and replicate by means of one or two main life cycles: the lytic cycle or the lysogenic (or temperate) cycle. During the lytic cycle they induce the bacterial mortality by disrupting host cell and releasing the phage progeny. Phages bind to specific targets on the cell wall, this specificity determinate its host range. Since their discovery by Frederick Twort (1915) and Felix d'Herelle (1917), bacteriophages were used for many applications in clinical and veterinary medicine (phage therapy), in microbial source tracking for water assessment (viral indicators of fecal contamination) and in agro-food industry (sanitation, biocontrol and food preservation) through food chain.

Aside their use in food safety for therapy by the reduction of pathogens in living animal during primary production and for the disinfection of surfaces and equipment in contact with processed food, bacteriophages could be used as a bio-preservation tool, as well.

Phages used for ready to eat food preservation can have a broad host range. Broad host range phages or polyvalent phages are capable of infecting many strains of the target, species or targets bacteriophages host range is not a fixed characteristic of each species of bacteriophage as it evolves over time and can show unexpected plasticity cross species, genera, families and even classes boundaries.

In fact, fresh-cut vegetables and ready to eat products constitute a favorable medium for foodborne bacteria transmission to human causing foodborne illnesses and even death. Numerous pathogenic bacteria may contaminate ready to eat fruits and vegetables like *Salmonella enterica*, *E. coli* O157: H7, *Listeria monocytogenes*, and *Shigella*. Furthermore, food industries are facing challenges related to the susceptibility of consumers to foodborne pathogens infections due to the high number of immune-compromised individuals and the special processing requirements for ready to eat food and fresh cut fruits and vegetables prior to commercialization. Moreover, ready to eat food is highly perishable and can't be preserved with common processing methods including heat, pasteurization and dehydration, that may alter its organoleptic properties and reduce its nutritious value. Hence, bacteriophages seem to be appropriate for controlling bacterial pathogens in food processing environments especially ready to eat food industries as they can be used as natural antimicrobials

without affecting food organoleptic properties or nutritious value. Only strictly lytic phages are used for food bio-preservation and must be well known and genetically mapped to avoid the risk of bacterial mutation and the emergence of new resistant phenotype.

Regarding application for the preservation of minimally processed food, phages are used during minimal process (slicing, washing...), storage and marketing of the final product (packaging...). Despite the controversial efficiency of phages application for pathogens eradication on animal products using different strategies (oral delivery, injection...) [1-3], it seems that phages application on fresh produce and ready to eat food is very promising and effective regarding pathogens reduction and even pathogens total eradication. Knowing that the most used strategy in ready to eat food preservation reported in literature is spray of phage cocktail containing different phages against specific bacteria [4-6], it's important to highlight that there is insufficient data concerning the use of broad-host phages to eradicate pathogens from ready to eat food. Hence, further studies are needed to be performed on this topic.

### Conclusion

As an outcome of the latest studies on the usefulness of bacteriophages as agents for ready to eat food preservation prior to consumption, it may be concluded that the emergence of pathogenic bacteria resistant to phage infection and the choice of the most adequate strategy for phage delivery process

are challenging issues that need further studies to set a strong scientific evidence required for regulations and standards authorities for a commercialized and a common use of phages as bio-preservation tools in agro-food industry. Meanwhile, the perception of "phage-treated food products" by the general public and consumer attitude should be addressed.

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