



TRANSFORMING FOOD ANALYSIS AND CONTROL:

NON-DESTRUCTIVE TECHNOLOGIES AND INNOVATIONS

K. Prasad, S. Shekhar, M. K. Paswan and R. Ahuja



Advancing Food Quality, Safety and Sustainability with
Smart, Innovative and Non-Destructive Technologies



Sant Longowal Institute of Engineering
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Bacteriophage: Against Bacterial Infections and Improving Overall Gut Health

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Abstract. Bacterial infections, mainly caused by enterobacteria in livestock, poultry, and humans, are the leading cause of illness and mortality worldwide. Bacteriophages are bacterial-infecting viruses that interact dynamically with bacteria and mammalian cells, thereby greatly influencing human health. Despite the vast reservoirs of bacteriophages in the human body, their potential to treat bacterial diseases has been undermined by the widespread use of antibiotics for many years. Despite the rise in antibiotic-resistant bacteria and our growing understanding of the gut microbiota's significance for health, the exploitation of bacteriophages is making a comeback. Considering the recent trend, the article comprehensively summarizes bacteriophages, their classification, mechanisms of action, comparisons with antibiotics, and some important studies related to phage therapy. Their applications against bacterial infections (e.g., Tuberculosis) and for improving gut health (e.g., Inflammatory Bowel Disease) are also discussed. Also, some novel applications of bacteriophages, such as gene and vaccine delivery, bacterial detection (phage typing), immunomodulation, and use in the food industry, are covered. With the expanding scope of phage therapy, the present review underscores the need to exploit it further and overcome its limitations, thereby improving human health.

Keywords: Antibiotic resistance; Gene regulation; Immunomodulation; Opsonization; Phage typing; Tuberculosis.

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1. Introduction

The vast diversity of microorganisms, including viruses, archaea, eukaryotes, and bacteria, present in the gastrointestinal (GI) tract is commonly referred to as the “gut microbiota”. This microbiota plays an essential role in maintaining digestion, enabling the absorption of various important nutrients, and supporting the immune response. Any alteration in the gut microbiota, also called dysbiosis, leads to various GI disorders, metabolic diseases, and other diseases such as Alzheimer’s disease (Morais et al., 2021), diabetes (Komaroff, 2017), and various types of tumours (Guglielmi, 2018). Bacterial infections, which pose major public health concerns, also result from dysbiosis and lead to sexually transmitted diseases, food poisoning, skin infections, and most urinary tract infections. Human organs or cells are susceptible to various bacterial infections; for example, *Mycobacterium tuberculosis* causes tuberculosis (TB), which primarily infects the lungs, and *Neisseria meningitidis* infects the central nervous system. These bacterial infections can also spread easily through the air, water, and other vectors to healthy individuals. Antibiotics are drugs used to treat bacterial infections either by destroying bacterial cells or preventing their growth, ultimately aiding the body’s immune system in fighting off the infection (Galarza et al., 2021). In recent years, the high death rate from bacterial infections and the limited effectiveness of even strong antibiotics prescribed for bacterial diseases due to multidrug resistance (MDR) have drawn increased attention to alternative, effective treatment methods (Pang et al., 2019). The rising crisis of MDR has revitalized the scope of bacteriophages (phages) against MDR bacterial strains (Azam et al., 2021). The therapeutic application of bacteriophages to treat bacterial infections and improve gut microbiota is also reemerging (Gordillo Altamirano and Barr, 2019; Kaur et al., 2024; Qv et al., 2021). The potential of bacteriophages is not being fully utilized. It needs to be accelerated, as more and more bacteria are becoming resistant to most antibiotics, resulting in infections that are difficult to cure.

2. Bacteriophages (bacteria-eating viruses)

Viruses are acellular, intracellular parasites that act as a connecting link between living and non-living and require specific host cells for their growth.

and further explore the scope of phage therapy. Considering their potential, bacteriophages are natural antibiotics that can be used as powerful weapons not only against bacterial diseases but also to treat non-bacterial disorders, including metabolic, genetic, and autoimmune disorders. There are various reports on the successful use of phage therapy for TB and GI disorders. The use of phages to precisely modify the gut microbiota and their therapeutic potential for many GI disorders is astonishing. Thus, there is an urgent need to further explore the potential of phage therapy for other diseases and to enable its widespread use. In the future, phages as immunomodulators, phage-based vaccines, and phage-mediated gene editing could be key areas for discovery and research. The potential of artificial phages to target specific cells and enzymes to control metabolic diseases is also a great area of interest.

Conflict of Interest

The authors have disclosed that there are no conflicts of interest to declare

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