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Commercialization of phage products: An aperture to new opportunities

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Statement of Problem: In recent years, the prevalence of antibiotic-resistant bacteria became a major issue in medicine. Therefore, alternative therapeutics like lytic bacteriophages have been commenced to tackle this trouble.

Research Purpose: This study has been focused on overviewing the commercialization status of single phage formula *versus* phage cocktails and phage encapsulation in medicine and industry.

Data Collection: Google Scholar, PubMed, and Google patent have been overviewed and FDA-approved encapsulated phage cocktails discussed here.

Results and Conclusion: In spite of single phage, phage cocktails destroy a wide range of pathogens, improve therapy, reduce the probability of emerging phage-resistant mutant bacteria, and increase the success in phage therapy. Technically, the encapsulation of bacteriophages in the pharmaceutical industry provides optimal posology, protects bacteriophages against the gastric acidic pH, and improves their stabilization and long-term storage. In this line, the accrual production of commercial products around the world made the Food and Drug Administration (FDA), and United States Environmental Protection Agency (USEPA), provide a regulatory pathway for the production of products containing phage cocktails and the use of lytic bacteriophage encapsulation techniques. In this context, a cocktail phage (SalmoFresh[®], American company Intralytix) approved against pathogenic *Salmonella* serotypes in food products. Phagex company in Ukraine has offered products containing phage cocktails (Pyofag[®] and Intestifag[®]) to treat enteric diseases. In addition, an encapsulated



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bacteriophage (Mediphage[®], Aziya Immuno-preparat Co. Uzbekistan) against *Shigella* has been marketed. Accordingly, phage encapsulation in the pharmaceutical industry and edible solid products maximizes the oral potency of grafting high-performance phages in patients and leads to bioconservation of gut microbiota in health and diseases.

Keywords: Bacteriophage, phage cocktail, encapsulation, commercialization