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Editorial on Bacteriophage Therapy

Muhsin Jamal*

Department of Microbiology, Abdul Wali Khan University, Mardan, Pakistan

Bacteriophages or "phages" are viruses that parasitize host bacterial cells. There are two categories of phages i.e. lytic and lysogenic. The lytic phages have deleterious effect on host bacterial cells causing their disruption/destruction and are used for phage therapy whereas the lysogenic phages do not cause direct lyses and are not suitable for phage therapy. So phage therapy is the uses of bacteriophages to control pathogenic bacterial infections. There are two kind of phage therapy i.e. mono phage therapy (using single specific phage) and poly phage therapy (using combination/cocktail of two or more phages). Phages have multiple applications.

We are interested in isolation of bacteriophages from various sources (such as e.g. soil, river, springs, waste water, animal and animal waste) against various multi-drug resistant bacteria (such *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Salmonella* species, *Listeria monocytogenes*, *Campylobacter*, *Shigella dysenteriae*, *Klebsiella pneumoniae*, *Enterobacter cloacae*) and studying various characteristics of such phages having a key role in phage therapy.

These phages are characterized for its various characteristics such as host range, one step growth (burst size and latent time), heat stability, and pH stability, calcium/magnesium on effect on phage adsorption to host, Phage morphology by transmission electron microscopy, phage genome isolation/sequencing and proteins analysis.

Formulation of different potencies (in the form of MOI=Multiplicity of infections) of phages and studying their deleterious effect on their respective host bacterial strains in planktonic forms (suspension culture) at specific temperature and pH and finally formation of phage cocktail (combination of different phages) to avoid bacterial resistance and studying their deleterious effect on targeted bacterial strains at specific temperature and pH.

Biofilm control using bacteriophages - Aggregate of micro-organisms in which microbial cells are frequently embedded within an extracellular polymeric substance (EPS) produced by microbial cells and are adhere to each other and/or to a living or inert surface. In humans biofilms are responsible for much pathology. Biofilm are found everywhere and cause many chronic infections. The antibiotics are unable to control the infections that are caused by biofilms.

We use bacteriophages to control biofilms and associated bacteria. Phages have the capability to target the common form of bacterial growth. Approximately 75% to 80% infections are caused by biofilms, According to national institutes of health (NIH) 65% all microbial infections caused by biofilm, in which the most common infections are nosocomial infections. About 99% of microorganisms have the capability to form biofilms on a wide range of surfaces. As we know that bacteriophages are natural killer of the bacteria, therefore phages can offer better potential to treat bacterial biofilm infections. Besides the destruction of bacterial cells by these phages, some of them encode a lytic protein endolysin. This enzyme degrades the extracellular matrix and can be applied to control biofilm. A biofilm is a thin usually resistant layer of microorganisms (as bacteria) that form on and coat various surfaces. A very serious problem of biofilm is the resistant nature bacteria in biofilm matrix. The resistant nature of biofilm to antibiotics is a very big issue and scientists are trying to solve this problem by using phages in different ways.

We are also interested in studying various bacterial strains tendency for biofilm formation on various material surfaces (such as 96-well plates, petriplates, plastics, rubbers, stainless steel plates and test tubes) and also to treat/control such types of biofilms using host specific bacteriophages and phage cocktails (combination of phages).

Food bio-safety - Everyday people worldwide use a variety of foods. They eat different foods, but the foods which they eat are not free from pathogens and cause serious diseases in humans. Due to these contaminated food millions of people are ill, many serious infections are caused by food borne pathogens due to which many people die per year. The consumption of contaminated food is the best way for the pathogens to enter into the body. According to the center for disease control (CDC) round about 76 million illness and 5000 deaths occur each year in USA due to the food borne pathogens. There are a lot of pathogens that cause serious infections in the human body. There are some pathogenic bacteria that produce toxin in foods and change the texture and appearance of food, and cause serious infections. *E. coli* is a gram negative bacteria that can cause acute diarrhea, pathogenic strain of *E. coli* is (*E. coli* O157:H7), these bacteria spread from fecal oral route, and have long incubation period of 1-3 days. Another pathogenic bacteria is *Listeria monocytogenes* caused listeriosis, *Campylobacter jejuni* caused complyobacteriosis, this is a disease of acute gastritis, it is transmitted from partially cooked food, long incubation period of 2-10 days, cytotoxin of *C. jejuni* are heat sensitive. The last one is Salmonella and their species (*S. typhorium, S. enteritidis*) caused salmonellosis. It is a disease of gastroenteritis, transmitted from meat, eggs, etc. Incubation period is form 4-48 hours. As phages are natural killer of bacteria. Therefore these infections caused by different bacteria can be controlled or treated by using bacteriophages.

We are also involved in isolation of bacteriophages against bacteria causing food spoilage and food born infections. In this concern we are focusing on *Listeria, Salmonella, Escherichia coli* (*E. coli* O157:H7, in particular) and *Campylobacter jejunii.*

Bacterial antibiotic resistance - Aggregate of micro-organisms in which microbial cells are frequently embedded within an extracellular polymeric substance (EPS) produced themselves by microbial cells and are adhered to each other and/or to a living or inert surface. In humans biofilms causes many chronic infections. Biofilms have been detected

***Corresponding author:** Muhsin Jamal, Assistant Professor, Department of Microbiology, Abdul Wali Khan University, Mardan, Pakistan, Tel: +92-346-9398028; E-mail: muhsinkhan08@gmail.com

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be involved in a large number of microbial infections/diseases in the human body. Biofilms have been considered to be responsible for about 80 % of all infections. Emergence of antibiotic resistance in bacteria is also the biggest problem worldwide in health care unit. For example, the bacterium such as *Staphylococcus epidermidis* is one of the leading causes of nosocomial sepsis. According to national institutes of health (NIH) about 65% of all microbial infections/disease are caused by biofilms, in which one of the most common infections are nosocomial infections.

About 99.9% of micro-organisms have the ability to form biofilms on a wide range of surfaces. Some bacteriophages endolytic proteins endolysin and have been assessed as a antimicrobial agents against bacteria, where as some phages encode proteins with polysaccharide depolymerize activity and can be used as anti-biofilm agents. Upon the contact to a surface, replicating adherent bacteria can secret mostly insoluble gelatinous exopolymers forming a three dimensional polymer structure known as a biofilm. The resistant nature of biofilm to antibiotics is a major concern worldwide in the health care unit, whereas the resistance nature of bacteria is associated with a number of diseases/infections.

We are also interested in studying various bacterial strains tendency for biofilm formation on various material surfaces (such as 96-well plates, petriplates, plastics, rubbers, stainless steel plates and test tubes) and also to treat/control such types of biofilms using host specific bacteriophages and phage cocktails. In case of phage cocktail a combination of two or more phages are used to avoid resistance and treat bacterial infections or to control biofilms.