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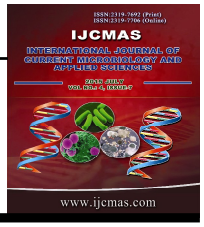

Review Article

Oral *Streptococci* Bacteriophages as a Potential Agent for Dental Caries Therapy

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A B S T R A C T

Bacteriophage (phage) therapy involves using phages or their products as bioagents for the treatment or prophylaxis of bacterial infectious diseases. The most important species that play key role in dental plaque and caries formation are oral Streptococci. Out of the 12 species of oral Streptococci, *Streptococcus sobrinus* and *Streptococcus mutans* are more dealt with dental diseases. There are few reports indicating the role of bacteriophages as therapeutic agents for phage therapy of oral *Streptococci*. However, the isolation and identification of specific bacteriophages of oral Streptococci can be used as potential agent for phage therapy of dental caries.

Introduction

Extracellular polysaccharide formation plays a key role in the pathogenesis of infections in the oral cavity. Bacteria implicated in the accumulation of dental plaque, the precursor of gingivitis and periodontitis, are embedded in a matrix of bacterially derived exopolysaccharide that largely determines the structural integrity and diffusion properties of plaque biofilm (Palmer *et al.,* 2003). However, the most important species that play key role in dental plaque formation are oral *Streptococci* (Tanzer *et al.,* 2001).

According to Bergey's manual of systematic bacteriology, oral *Streptococci* are formed from 12 species including *Streptococcus salivarius, Streptococcus anginosus, Streptococcus constellates, Streptococcus cristatus, Streptococcus gordonii, Streptococcus mitis, Streptococcus mutans, Streptococcus mutans, Streptococcus oralis, Streptococcus parasanguis, Streptococcus pneumonia, Streptococcus sanguis and Streptococcus sobrinus* (Holt *et al.,* 1994; Schaeter, 2004). These species are the first to attach to salivary glycoproteins on tooth surfaces through their specific surface capsular polymers such as glucan and fructan (Freedman and Tanzer, 1974; Tanzer *et al.,* 2001). *S. salivarius* as well as mutans *Streptococci* and non mutans *Streptococci* or sanguis *Streptococci* are present at high levels in tooth and mucosal surfaces some of which are highly acidogenic and a few are acid tolerant (Tanzer *et al.,* 2001). *Streptococcus mutans*, the causative agent of

dental caries, typically produces a highly adhesive dextran that enables it to colonize tooth surfaces (Schilling and Bowen, 1992). *S. salivarius* along with *S. sanguis*, *S. oralis* and *S. gordonii* are the first tooth colonizers. However *S. sobrinus* and *S. mutans* are more dealt with dental diseases (Van der Ploeg, 2008).

Bacteriophage therapy for the oral microflora

The bacteriophages, are viruses that attack their specific bacterial hosts, have a great impact on controlling bacterial population throughout the world as well as microenvironmental niches in human body (Marks and Sharp, 2000; Chanishvili *et al.*, 2001). In recent decades bacteriophages have been studied as biotechnological tools for treatment and eradication of bacterial pathogens such as *E. coli* in gastrointestinal infections (Marks and Sharp, 2000; Smith *et al.*, 1993; Drozdova *et al.*, 1998), *Pseudomonas aeruginosa* and *Acinetobacter baumanii* in skin burns and grafts (Soothill, 1994). Interest in this approach is increasing as a result of the continuing rise in the incidence of multiple antibiotic –resistant pathogenic bacteria. Bacteriophages have the potential to regulate the oral microflora by lysing sensitive cells, selecting mutants that may have altered properties and by releasing bacterial components with pro-inflammatory activity (Delisle and Rostkowski, 1993); the complex nature of infections of the oral cavity suggest that bacteriophages could be considered as potential therapeutic tools for elimination of infectious foci. As bacteriophages that infect exopolysaccharide producing bacteria frequently carry specific polysaccharide depolymerases that aid viral penetration, bacteriophage may constitute a source of enzymes that can disrupt pathogenic process associated with biofilm and exopolysaccharide production (Hanlon *et al.*, 2001) in the oral cavity.

Isolation of *Streptococci* bacteriophages from the oral cavity

Several aspects of oral *Streptococci* and their influences on dental disorders and dentistry have been studied (Tanzer *et al.*, 2001; Okada *et al.*, 2002; Franco e Franco, 2007) but there are few reports indicating the role of bacteriophages in ecology of oral cavity as a microenvironment or the attitude toward phages as strong biotechnological and natural therapeutic agents for phage therapy of oral *Streptococci* (Bachrach *et al.*, 2003; Hitch *et al.*, 2004). Some reports have indicated the isolation and identification of lytic bacteriophages of *S. mutans* from human saliva (Delisle and Rostkowski, 1993; Armau *et al.*, 1988) and recently the complete genome sequence of one of them *S. mutans* lytic bacteriophage M102 has been revealed (Van Der Ploeg, 2007). The characterization of prophage PH 15 of *Streptococcus gordonii* (an oral Streptococcus) has been reported the complete genome sequence of this lysogenic phage has been analysed (Van der Ploeg, 2008).

A lysogenic bacteriophage of *S. mutans* PK1 has been identified as bacteriophage PK1. It has been revealed that most PK1 phage particles had 95 nm hexagonal heads and 150nm tails (Higuchi *et al.*, 1982). Recently a lytic bacteriophage of oral *Streptococcus salivarius*, a member of dental caries producing *Streptococci* has been isolated from the Persian Gulf located at the south of Iran (Keivan Beheshti *et al.*, 2010).

The transmission electron microscopy (TEM) of this phage particle showed that it is 83.33 nm in diameter and could be most probably related to Cystoviridae family of bacteriophages. There are few reports of the

isolation of *S. mutans* lytic bacteriophages from salivary samples (Delisle and Rostkowski, 1993). There is no report of isolation and identification of lytic bacteriophages of other eleven oral *Streptococci* species.

The lytic effects of bacteriophages on the oral *Streptococci* could be applied as a potential for phage therapy of dental caries and other dental and periodontal disorders.

References

Armau, E., Bousque, J.L., Boue, D., Tiraby, G. 1988. Isolation of lytic bacteriophages for *Streptococcus mutans* and *Streptococcus sobrinus*. *J. Den. Res.,* 67: 121.

Bachrach, G., Lecizrovici-Zigmond, M., Zlotkin, A., Naor, R., Steinberg, D. 2003. Bacteriophage isolation from human saliva. *Lett. Appl. Microbiol.,* 36: 50–53.

Chanishvili, N., Chanishvili, T., Tediashvili, M., Barrow, P.A. 2001. Review: Phages and their application against drug resistant bacteria. *J. Chem. Technol. Biotechol.,* 76: 689–699.

Delisle, A.L., Rostkowski, C.A. 1993. Lytic bacteriophages of *Streptococcus mutans. Curr. Microbiol.,* 27: 163–167.

Drozdova, O.M., An, R.N., Chanishvilli, T.G., Livshits, M.L. 1998. Experimental study of the interaction of phages and bacteria in the environment. *Zhurmal. Microbiol. Epidemiol. Immunobiol.,* 7: 25–39.

Franco e Franco, T.C.C. 2007. Detection of *Streptococcus mutans* and *Streptococcus sobrinus* in dental plaque samples from Brazilian pre-school children by polymerase chain reaction. *Braz. Dent. J.,* 18: 329–333.

Freedman, M.L., Tanzer, J.M. 1974. Disassociation of plaque formation from glucan- induced agglutination in mutants of *Streptococcus mutans*. *Infect. Immun.,* 10: 189–196.

Hanlon, G.W., Denyer, S.P., Olliff, C.J., Ibrahim, L.J. 2001. Reduction in exopolysaccharide viscosity as an aid to bacteriophage penetration through *Pseudomonas aeruginosa* biofilms. *Appl. Environ. Microbiol.,* 67: 2746–2753.

Higuchi, M., Higuchi, M., Katayose, A. 1982. Identification of PK1 bacteriophage DNA in *Streptococcus mutans*. *J. Dent. Res.,* 61: 439–441.

Hitch, G., Pralten, J., Taylor, D.W. 2004. Isolation of bacteriophages from the oral cavity. *Lett. Appl. Microbiol.,* 39: 215–219.

Holt, J.G., Krieg, N.R., Sneath, P.H.A., Staly, J.T., Williams, S.T. 1994. Bergeys manual of determinative bacteriology, Williams and Wilkins, USA. Pp. 456–468.

Keivan Beheshti, M., Majid, B., Farahaz Arbab, Z., Zadeh, Zavareh, 2010. Identification of *Streptococcus salivarius* bacteriophage isolated from Persian Gulf as a potential agent for dental caries phage therapy. *Afr. J. Microbiol. Res.,* 4(20): 2127–2132.

Marks, T., Sharp, R. 2000. Bacteriophages and biotechnology: a review. *J. Chem. Technol. Biotechnol.,* 75: 6–17.

Okada, M., Soda, Y., Hayashi, F., Doi, T., Suzuki, J., Miura, K., Kozai, K. 2002. PCR detection of *Streptococcus mutans* and *Streptococcus sobrinus* in dental plaque samples from Japanese pre – school children. *J. Med. Microbiol.,* 51: 443–447.

Palmer, R.J., Gordon, S.M., Cisar, J.O., Kolenbrander, P.E. 2003. Coaggregation –mediated interactions of *Streptococci* and actinomycetes detected in initial human dental plaque. *J. Bacteriol.,* 185: 3500–3409.

Schaeter, M. 2004. The desk encyclopedia of microbiology. Elsevier Academic Press, Netherlands. Pp. 156–174.

Schilling, K.M., Bowen, W.H. 1992. Glucans synthesized in situ in experimental salivary pellicle function as specific binding sites for *Streptococcus mutans*. *Infect. Immun.,* 60: 284–295.

Smith, D.J., Anderson, J.H., King, W.F., Van Herete, J., Teubman, M.A. 1993. Oral Streptococcal colonization of infants. Oral *Microbiol. Immunol.,* 8: 1–4.

Soothill, J.S. 1994. Bacteriophage prevents destruction of skin grafts by *Pseudomonas aeruginosa*. *Burns,* 20: 209–211.

Tanzer, J.M., Livingston, J., Thompson, A.M. 2001. The microbiology of primary dental caries in humans. *J. Dent. Edu.,* 65: 1028–1037.

Van Der Ploeg, J.R. 2007. Genome sequence of *Streptococcus mutans* bacteriophage M102. *FEMS Microbiol. Lett.,* 275: 130–138.

Van der Ploeg, J.R. 2008. Characterization of *Streptococcus gordonii* prophage PH15: complete genome sequence and functional analysis of phage-encoded integrase and endolysin. *Microbiology*, 154: 2970–2978.