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Physicochemical point of view in the evaluation of PR772 bacteriophage as a surrogate for human adenovirus

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► **To cite this version:**

Maryse Iris Sedji, Laurence Mathieu, Khalid Ferji, Christophe Gantzer, Isabelle Bertrand. Physicochemical point of view in the evaluation of PR772 bacteriophage as a surrogate for human adenovirus. 20th International Symposium on Health Related Water Microbiology., Sep 2019, Vienna, Austria. hal-02369373

HAL Id: hal-02369373

<https://hal.univ-lorraine.fr/hal-02369373v1>

Submitted on 18 Nov 2019

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Introduction

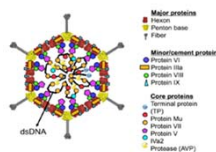
Among pathogenic enteric viruses, human adenovirus (HAdV) are noteworthy by their genome (double stranded DNA) and capsid (projecting fibre at each vertex and diameter ~110nm). These particularities rise the question of their behaviour in the environment. Bacteriophages of the *Tectiviridae* family, especially phage PR772, have been proposed as surrogate for HAdV during water disinfection [1]. This bacteriophage could also be envisaged as a potential surrogate for HAdV to study the mechanisms involved in their adhesion to surfaces; this phenomenon is known to be governed by the physicochemical characteristics of virus particles and surfaces.

Objective

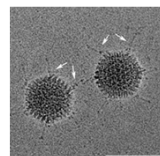
Evaluation of bacteriophage PR772 as a surrogate for HAdV in adhesion experiments by comparison of their physicochemical characteristics.

Materials and Methods

Human adenovirus

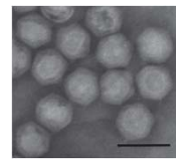


Structural model of adenovirus [2]

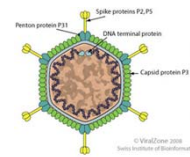


Cryo-electron micrograph of adenovirus [3]
Scale bar: 100 nm, white arrows: fibres

Bacteriophage PR772



Electron micrograph of bacteriophage PR772 [4]
Scale bar: 100 nm



Structural model of *Tectiviridae* (ViralZone)

Virus strain:

HAdV-2 (HPACC, NCPV # 213)

Bacteriophage PR772 (Centre Félix d'Herelle, Québec, HER # 221)

Cell host:

Cell line 293A (Thermo Fisher Scientific, R705-07)

Escherichia coli K12 J53-1 (R15) (HER # 1221)

Purification of HAdV-2 and PR772 particles: caesium chloride density gradient followed by dialysis (100 kDa MWCO) against NaNO₃.

Hydrodynamic diameter and electrophoretic mobility measurements: compact goniometer ALV/CGS-3 and Zetasizer Nano ZS instrument.

Relative hydrophobicity: Adhesion on hydrophobic beads made of polystyrene (Polysciences, 07307-15).

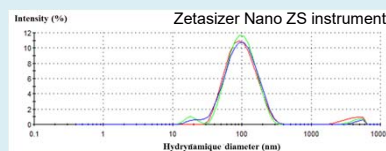
Virus quantification: Genome quantification using qPCR [1, 5]

Results

Hydrodynamic diameter

Size distribution of the viral suspensions was determined using Dynamic Light Scattering (DLS)

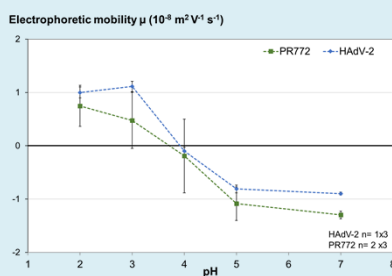
Size distribution of PR772 particles in NaNO₃ 1 mM



HAdV-2: 152 ± 4 nm > PR772: 94 ± 4 nm

Electrostatic charge

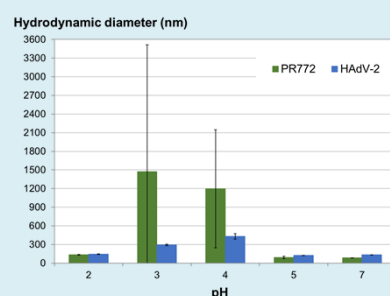
Electrophoretic mobility as a function of pH



Similar electrophoretic profile
 $\mu=0$ between pH 3 and 4

- Isoelectric point (IEP) between 3 and 4 for both viruses
- HAdV-2 and PR772 are negatively charged at pH 7

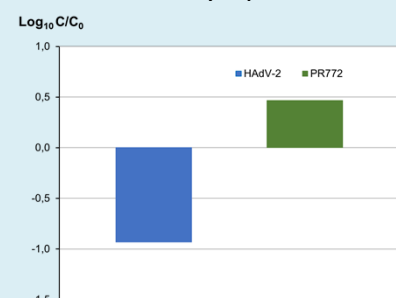
Hydrodynamic diameter as a function of pH



Aggregation at pH 3 and 4 for both viruses

Relative hydrophobicity

Adhesion on hydrophobic beads



Log C/C₀ : Quantification of virus in suspension before and after binding assay

Hydrophobicity of HAdV-2 >> PR772

CONCLUSION: Hydrophobicity appeared as the main difference between HAdV-2 and phage PR772. The role of hydrophobicity on adhesion of virus particles has been previously shown. Moreover, this parameter might influence the localisation of viruses in case of biofilm colonization and then exposure to oxidant such as chlorine [6]. Overall, the implication of hydrophobicity in the accumulation and persistence of viruses on surfaces might limit the use of bacteriophage PR772 as surrogate for HAdV in such a context.

Acknowledgments: The present work was supported by Zone Atelier Moselle (ZAM) and EPHE, PSL Research University.

References

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- [6] Pelletieux et al. (2016) The effect of chlorination and hydrodynamic shear stress on the persistence of bacteriophages associated with drinking water biofilms. *J Appl Microbiol.* 121(4):1189-97.