



## Evaluation of Morphological Changes of *Aeromonas caviae* Sch3 Biofilm Formation under Optimal Conditions

PDF (Size: 1223KB) PP. 552-560 DOI: 10.4236/aim.2012.24071

### Author(s)

Erika Beatriz Angeles-Morales, Ricardo Mondragón-Flores, Juan Pedro Luna-Arias, Cinthia Teresa Enríquez-Nieto, Berenice Parra-Ortega, Graciela Castro-Escarpulli

### ABSTRACT

*Aeromonas* is a Gram-negative bacterium that lives in aquatic habitats. It can be infective in humans. One of its remarkable attributes is the ability of biofilm formation. Many factors are involved in the construction of biofilms as has been described for *Pseudomonas*, *Klebsiella*, and *Vibrio*, among others. The aim of this work was to study the bacterial morphology during the establishment of biofilm through scanning electron microscopy (SEM) and transmission electron microscopy (TEM) with a modified microtiter plate assay and to determine the best conditions for the establishment of *Aeromonas caviae* Sch3 biofilm *in vitro*. We observed several phenotypic changes, including surface appearance, size, presence of extracellular vesicles from 100 to 250 nm in diameter, and flagella. The best conditions for biofilm formation were to grow cultures at 28°C at pH 6, as determined by the crystal violet assay. This is, to the best of our knowledge, the first study that describes the cell's biological events involved in the establishment of biofilm formation of *Aeromonas caviae* Sch3 *in vitro*.

### KEYWORDS

Biofilm; *Aeromonas Caviae*; Scanning Electron Microscopy; Transmission Electron Microscopy; Physical and Chemical Factors

### Cite this paper

E. Beatriz Angeles-Morales, R. Mondragón-Flores, J. Pedro Luna-Arias, C. Teresa Enríquez-Nieto, B. Parra-Ortega and G. Castro-Escarpulli, "Evaluation of Morphological Changes of *Aeromonas caviae* Sch3 Biofilm Formation under Optimal Conditions," *Advances in Microbiology*, Vol. 2 No. 4, 2012, pp. 552-560. doi: 10.4236/aim.2012.24071.

### References

- [1] J. L. Parker and J. G. Shaw, "Aeromonas spp. Clinical Microbiology and Disease," *Journal of Infection*, Vol. 62, 2011, pp. 109-118. doi:10.1016/j.jinf.2010.12.003
- [2] J. M. Janda and S. L. Abbott, "The Genus *Aeromonas*: Taxonomy, Pathogenicity, and Infection," *Clinical Microbiology Reviews*, Vol. 23, No. 1, 2010, pp. 35-73. doi:10.1128/CMR.00039-09
- [3] A. K. Chopra and C. W. Houston, "Enterotoxins in *Aeromonas*-Associated Gastroenteritis," *Microbes and Infection*, Vol. 1, 1999, pp. 1129-1137. doi:10.1016/S1286-4579(99)00202-6
- [4] R. Gavín, S. Merino, M. Altarriba, R. Canals, J. G. Shaw and J. M. Tomás, "Lateral Flagella Are Required for Increased Cell Adherence, Invasion and Biofilm Formation by *Aeromonas* spp.," *FEMS Microbiology Letters*, Vol. 224, 2003, pp. 77-83. doi:10.1016/S0882-4010(03)00047-0
- [5] L. Chen and Y. M. Wen, "The Role of Bacterial Biofilm in Persistent Infections and Control Strategies," *International Journal of Oral Science*, Vol. 3, 2011, pp. 66-73. doi:10.4248/IJOS11022
- [6] J. W. Costerton, P. S. Stewart and E. P. Greenberg, "Bacterial Biofilms: A Common Cause of Persistent Infections," *Science*, Vol. 284, 1999, pp. 1318-1322. doi:10.1126/science.284.5418.1318

[AiM Subscription](#)[Most popular papers in AiM](#)[About AiM News](#)[Frequently Asked Questions](#)[Recommend to Peers](#)[Recommend to Library](#)[Contact Us](#)

Downloads:	23,279
------------	--------

Visits:	124,494
---------	---------

[Sponsors, Associates, and Links >>](#)

- [7] B. Lee, J. A. Haagensen, O. Ciofu, J. B. Andersen, N. H?ibyand S. Molin, "Heterogeneity of Biofilms Formed by Nonmucoid *Pseudomonas aeruginosa* Isolates from Patients with Cystic Fibrosis," *Journal of Clinical Microbiology*, Vol. 43, 2005, pp. 5247-5255. doi:10.1128/JCM.43.10.5247-5255.2005
- [8] H. Kobayashi, H. Watanabe, N. Ohgaki and H. Takeda, "Bacterial Adhesion and Biofilm," *Nihon Rinsho*, Vol. 52, No. 2, 1994, pp. 332-338.
- [9] H. Mikkelsen, Z. Duck, K. S. Lilley and M. Welch, "Interrelationships between Colonies, Biofilms, and Planktonic Cells of *Pseudomonas aeruginosa*," *Journal of Bacteriology*, Vol. 189, 2007, pp. 2411-2416. doi: 10.1128/JB.01687-06
- [10] K. Harjai, R. K. Khandwaha, R. Mittal, V. Yadav, V. Gupta and S. Sharma, "Effect of pH on Production of Virulence Factors by biofilm Cells of *Pseudomonas aeruginosa*," *Folia Microbiologica*, Vol. 50, 2005, pp. 99-102. doi:10.1007/BF02931455
- [11] C. C. Goller and T. Romeo, "Environmental Influences on Biofilm Development," *Current Topics in Microbiology and Immunology*, Vol. 322, 2008, pp. 37-66.
- [12] A. Hostacká, I. Ciznár and M. Stefkovicová, "Temperature and pH Affect the Production of Bacterial Biofilm," *Folia Microbiologica*, Vol.55, 2010, pp. 75-78.
- [13] S. M. Kirov, "Bacteria That Express Lateral Flagella Enable Dissection of the Multifunctional Roles of Flagella in Pathogenesis," *FEMS Microbiology Letters*, Vol. 224, 2003, pp. 151-159. doi: 10.1016/S0378-1097(03)00445-2
- [14] S. M. Kirov, B. C. Tassell, A. B. Semmler, L. A. O' Donovan, A. A. Rabaan and J. G. Shaw, "Lateral Flagella and Swarming Motility in *Aeromonas* Species," *Journal of Bacteriology*, Vol. 184, No. 2, 2002, pp. 547-555. doi:10.1128/JB.184.2.547-555.2002
- [15] G. O' Toole, H. B. Kaplan and R. Kolter, "Biofilm Formation as Microbial Development," *Annual Review of Microbiology*, Vol. 54, 2000, pp. 49-79.
- [16] S. Merino, X. Rubires, A. Aguilar and J. M. Tomás, "The Role of Flagella and Motility in the Adherence and Invasion to Fish Cell Lines by *Aeromonas hydrophila* Serogroup O: 34 Strains," *Microbiology Letters*, Vol. 151, 1997, pp. 213-217. doi:10.1111/j.1574-6968.1997.tb12572.x
- [17] C. Van Delden and B. H. Iglewski, "Cell-to-Cell Signaling and *Pseudomonas aeruginosa* Infections," *Emerging Infectious*, Vol. 4, 1998, pp. 551-560. doi:10.3201/eid0404.980405
- [18] E. P. Greenberg, "Bacterial Communication and Group Behavior," *Journal of clinical investigation*, Vol. 112, 2003, pp. 1288-1290. doi:10.1172/JC1200320099
- [19] J. Y. Hu, Y. Fan, Y. H. Lin, H. B. Zhang, S. L. Ong, N. Dong, J. L. Xu, W. J. Ng and L. H. Zhang, "Microbial Diversity and Prevalence of Virulent Pathogens in Biofilms Developed in a Water Reclamation System," *Research in Microbiology*, Vol. 154, 2003, pp. 623-629. doi:10.1016/j.resmic.2003.09.004
- [20] J. W. Costerton, Z. Lewandowski, D. Caldwell, D. R. Korber and H. M. Lappin-Scott, "Microbial Biofilms," *Annual Review of Microbiology*, Vol. 49, 1995, pp. 711-745. doi:10.1017/CBO9780511525353.005
- [21] J. C. Davies, "Pseudomonas aeruginosa in Cystic Fibrosis: Pathogenesis and Persistence," *Paediatric Respiratory Reviews*, Vol. 3, 2002, pp. 128-134. doi:10.1016/S1526-0550(02)00003-3
- [22] C. Ryder, M. Byrd and D. J. Wozniak, "Role of Polysaccharides in *Pseudomonas aeruginosa* Biofilm Development," *Curr Opin Microbiol*, Vol. 10, 2007, pp. 644-648. doi:10.1016/j.mib.2007.09.010
- [23] E. E. Mann and D. J. Wozniak, "Pseudomonas Biofilm Matrix Composition and Niche Biology," *FEMS Microbiology Reviews*, 2012, in press. doi:10.1111/j.1574-6976.2011.00322.x
- [24] M. Whiteley, M. G. Banger, R. E. Bumgarner, M. R. Parsek, G. M. Teitzel, S. Lory and E. P. Greenberg, "Gene Expression in *Pseudomonas aeruginosa* Biofilms," *Nature*, Vol. 413, 2001, pp. 860-864. doi:10.1038/35101627
- [25] A. P. Stapper, G. Narasimhan, D. E. Ohman, J. Barakat, M. Hentzer, S. Molin, A. Kharazmi, N. H?iby and K. Mathee, "Alginate Production Affects *Pseudomonas aeruginosa* Biofilm Development and Architecture, but Is Not Essential for Biofilm Formation," *Journal of Medical Microbiology*, Vol. 53, 2004, pp. 679-690. doi:10.1099/jmm.0.45539-0

- [26] S. A. Palumbo, M. M. Bencivengo, F. Del Corral, A. C. Williams and R. L. Buchanan, "Characterization of the *Aeromonas hydrophila* Group Isolated from Retail Foods of Animal Origin," *Journal of Clinical Microbiology*, Vol. 27, 1989, pp. 854-859.
- [27] H. Namdari and V. J. Cabelli, "The Suicide Phenomenon in Motile *Aeromonads*," *Applied and Environmental Microbiology*, Vol. 55, 1990, pp. 543-547.
- [28] S. M. September, F. A. Els, S. N. Venter and V. S. Br?zel, "Prevalence of Bacterial Pathogens in Biofilms of Drinking Water Distribution Systems," *Journal of Water and Health*, Vol. 5, 2007, pp. 219-227.
- [29] G. Di Bonaventura, R. Piccolomini, D. Paludi, V. D' Orio, A. Vergara, M. Conter and A. Ianieri, "Influence of Temperature on Biofilm Formation by *Listeria monocytogenes* on Various Food-Contact Surfaces: Relationship with Motility and Cell Surface Hydrophobicity," *Journal of Applied Microbiology*, Vol. 104, 2008, pp. 1552-1561. doi:10.1111/j.1365-2672.2007.03688.x
- [30] S. Nakamura, Y. Higashiyama, K. Izumikawa, M. H. Seki, Kakeya, Y. Yamamoto, K. Yanagihara, Y. Miyazaki, Y. Mizuta and S. Kohno, "The Roles of the Quorum-Sensing System in the Release of Extracellular DNA, Lipopolysaccharide, and Membrane Vesicles from *Pseudomonas aeruginosa*," *Japanese Journal of Infectious Diseases*, Vol. 61, 2008, pp. 375-378.
- [31] A. Kulp and M. J. Kuehn, "Biogenesis of Secreted Bacterial Outer Membrane Vesicles," *Annual Review of Microbiology*, Vol. 64, 2010, pp. 163-184. doi:10.1146/annurev.micro.091208.073413
- [32] S. R. Schooling, A. Hubley and T. J. Beveridge, "Interactions of DNA with Biofilm-Derived Membrane Vesicles," *Journal of Bacteriology*, Vol. 191, 2009, pp. 4097-4102. doi:10.1128/JB.00717-08
- [33] L. Mashburn-Warren, R. J. McLean and M. Whiteley, "Gram-Negative Outer Membrane Vesicles: Beyond the Cell Surface," *Geobiology*, Vol. 6, 2008, pp. 214-219. doi:10.1111/j.1472-4669.2008.00157.x
- [34] M. E. Shirliff, J. T. Mader and A. K. Camper, "Molecular Interactions in Biofilms," *Chemistry & Biology*, Vol. 9, 2002, pp. 859-871. doi:10.1016/S1074-5521(02)00198-9
- [35] P. Stoodley, K. Sauer, D. G. Davies and J. W. Costerton, "Biofilms as Complex Differentiated Communities," *Annual Review of Microbiology*, Vol. 56, 2002, pp. 187-209. doi:10.1146/annurev.micro.56.012302.160705
- [36] P. S. Stewart and M. J. Franklin, "Physiological Heterogeneity in Biofilms," *Nature Reviews Microbiology*, Vol. 6, 2008, pp. 199-210. doi:10.1038/nrmicro1838
- [37] M. Alhede, K. N. Kragh, K. Qvortrup, M. Allesen-Holm, M. Van Gennip, L. D. Christensen, P. ? Jensen, A. K. Nielsen, M. Parsek, D. Wozniak, S. Molin, T. Tolker-Nielsen, N. H?iby, M. Givskov and T. Bjarnsholt, "Phenotypes of Non-Attached *Pseudomonas aeruginosa* Aggregates Resemble Surface Attached Biofilm," *PLoS One*, Vol. 6, 2011, pp 927-943. doi:10.1371/journal.pone.0027943
- [38] R. Canals, S. Vilches, M. Wilhelms, J. G. Shaw, S. Merino and J. M. Tomas, "Non-Structural Flagella Genes Affecting Both Polar and Lateral Flagella-Mediated Motility in *Aeromonas hydrophila*," *Microbiology*, Vol. 153, 2007, pp. 1165-1175. doi:10.1099/mic.0.2006/000687-0