PERSPECTIVE

Strategies for salinity acclimation in nitrifying bioreactors

Arthur Barnes

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ABSTRACT

Aquaculture is one of many businesses that produces effluents with high or changing salt concentrations. Due to the sensitivity of the bacteria involved in the biological nitrification process to salinity, treating such effluents might be difficult. It is crucial to maintain high nitrification efficiency during salinity fluctuations in some circumstances, such as in Recirculating Aquaculture Systems (RAS), to avoid ammonia and nitrite toxicity. As a result, appropriate techniques are needed to make nitrifying bioreactors resistant to changes in salinity. It has been demonstrated that nitrifying bioreactors can adapt to salinity variations over a number of days, despite the fact that salinity changes can have an impact on nitrification performance. The physiological adaptation of the existing microorganisms or the selection of microorganisms adapted to that salinity regime may be the cause of this acclimation. Salinity acclimation may be influenced by a variety of other variables, including the biofilm matrix. Recent research has demonstrated that microbial management techniques can be used to increase the salinity tolerance and shorten the recovery period of nitrifying bioreactors. Here, we go over the current understanding of salinity acclimation in nitrifying systems as well as recent developments in methods for increasing the salinity tolerance of nitrifying biofilms. We also suggest areas for future study to enhance our comprehension of the mechanisms nitrifying systems use to adapt to salinity.

Key Words: *Adaptation; Salinity; Aquaculture; Biofilms; Acclimation*

INTRODUCTION

Over 5% of effluents worldwide are saline or hypersaline. Future freshwater shortages may necessitate the use of seawater, which will result in a rise in this. Several industries, including petroleum refineries, the leather industry, the food industry, and aquaculture, emit saline effluents. Coastal communities' wastewater treatment facilities might also get saline water from seawater flushing. Instead of an incremental rise in salinity, substantial swings in salinity are frequently caused by process oscillations in many systems. Salinity can also alter over time. The biological water treatment process of nitrification can be affected by high or fluctuating salinity because osmotic stress can prevent the activity of the microorganisms. The microbiological process of nitrification involves the oxidation of ammonia (NH_3) to nitrite (NO_2-) and then to nitrate in two steps (NO_3). The two processes are normally carried out by two microbial guilds: Nitrite Oxidising Bacteria (NOB), and Ammonia Oxidising Microorganisms (AOM), which comprise Ammonia Oxidising Bacteria (AOB) and archaea (AOA). Within the genus Nitrospira, bacteria that can completely oxidise ammonia to nitrate (comammox) have just been identified. Despite the benefits of more recently discovered techniques like anammox, nitrification is still frequently used in water treatment facilities to convert ammonia. This is probably because nitrifying microorganisms can function well in a wider range of environmental conditions and multiply more quickly than anammox. Particularly crucial to Recirculating Aquaculture Systems is nitrification (RAS). RAS are fish farms on land that have water reusing systems. In RAS, nitrification is necessary to keep the levels of ammonia and nitrite from rising to fish-toxic levels. Maintaining high nitrification efficiency during salinity changes is crucial. We are not aware of any reviews that outline strategies for salinity acclimation in nitrification processes, despite the fact that

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Correspondence:, Arthur Barnes, Editorial Office, Journal of Environmental Microbiology UK, Email: arthurbarnes@gmail.com

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several literature reviews briefly examine the influence of salinity on nitrification. Thus, we examine recent developments in salinity acclimation strategies for nitrifying systems and present current understanding regarding the effect of salinity on nitrification in this article.

The osmotic equilibrium can be upset by changes in the salinity of a microbe's surroundings. This immediate outflow or influx of water and/or a cell response to control the cellular osmolarity are both brought on by the variation in osmotic pressure. Whether the salinity shock is hyper- (salinity rise) or hypoosmotic determines the nature of these events (salinity decrease). The robust bacterial cell walls can sustain a little rise in pressure brought on by water input, making hypoosmotic shock less severe. Contrarily, hyperosmotic shock results in cell shrinkage and dehydration, which might impede the intake of nutrients and growth.

The cells can adjust to the greater salinity by raising the internal osmolarity if the hyperosmotic shock is not severe. The cells use either I the salt-in-cytoplasm method or the organic osmolyte (compatible solute) strategy to achieve this without losing water. Only obligate halophiles use the salt-in tactic since it calls for significant structural modifications. A rise in K+ is followed by an increase in osmolytes in the cytoplasm in the osmolyte strategy. Most halotolerant microorganisms adopt the osmolyte strategy because it offers a higher degree of flexibility to deal with variations in the external osmolarity, despite being more energy-intensive than the salt-in strategy.