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Review

The role of probiotics in aquaculture

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Abstract

The increase of productivity in aquaculture has been accompanied by ecological impacts including emergence of a large variety of pathogens and bacterial resistance. These impacts are in part due to the indiscriminate use of chemotherapeutic agents as a result of management practices in production cycles. This review provides a summary of the use of probiotics for prevention of bacterial diseases in aquaculture, with a critical evaluation of results obtained to date.

Keywords: Probiotics; Bacteria; Disease control; Aquaculture

Contents

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1. Introduction

Aquaculture has become an important economic activity in many countries. In large-scale production facilities, where aquatic animals are exposed to stressful conditions, problems related to diseases and deterioration of environmental conditions often occur and result in serious economic losses. Prevention and control of diseases have led during recent decades to a substantial increase in the use of veterinary medicines. However, the utility of antimicrobial agents as a preventive measure has been questioned, given extensive documentation of the evolution of antimicrobial resistance among pathogenic bacteria. Globally, tonnes of antibiotics have been distributed in the biosphere during an antibiotic era of only about 60 years duration. In the United States, 18,000 t of antibiotics produced each year for medical and agricultural purposes, 12,600 t are used for the non-therapeutic treatments of livestock in order to promote growth (SCAN, 2003). In the European Union and Switzerland, 1600 t of antibiotics, representing about 30% of the total use of antibiotics in farm animals, were similarly used for growth promotion purposes in 1997 (SCAN, 2003). These amounts of antibiotics have exerted a very strong selection pressure towards resistance among bacteria, which have adapted to this situation, mainly by a horizontal and promiscuous flow of resistance genes (SCAN, 2003).

Resistance mechanisms can arise one of two ways: chromosomal mutation or acquisition of plasmids. Chromosomal mutations cannot be transferred to other bacteria but plasmids can transfer resistance rapidly (Lewin, 1992). Several bacterial pathogens can develop plasmid-mediated resistance. Plasmids carrying genes for resistance to antibiotics have been found in marine *Vibrio* species and they could be laterally exchanged. At the high population densities of bacteria found in aquaculture ponds, transfer via plasmids, transduction via viruses and even direct transformation from DNA absorbed to the particles in the water or on the sediment surfaces could all be likely mechanisms for genetic exchange (Moriarty, 1997). For example, transference of multidrug resistance occurred in Ecuador during the cholera epidemic (1991–1994) in Latin America and this began among persons who were working on shrimp farms. Although the original epidemic strain of *Vibrio cholerae* 01 was susceptible to the 12 antimicrobial agents tested, in coastal Ecuador it became multidrug resistant by the transference of resistance genes of non-cholera vibrios that are pathogenic to the shrimp (Weber et al., 1994). In addition, other evidence of the transmission of resistance between aquaculture ecosystems and human has been demonstrate, when a novel florofenicol resistance gene *floR*, in *Salmonella typhimurium* DT104, which also confers resistance to chloramphenicol, is almost identical by molecular sequence to the florofenicol resistance gene first described in *Photobacterium damsela*, bacterium found in fish (Angulo, 2000).

The use of probiotics or beneficial bacteria, which control pathogens through a variety of mechanisms, is increasingly viewed as an alternative to antibiotic treatment. The use of probiotics in human and animal nutrition is well documented (see Fuller, 1992; Mulder et al., 1997 reviews; Rinkinen et al., 2003) and recently, they have begun to be applied in aquaculture (Gatesoupe, 1999; Gomez-Gil et al., 2000; Verschuere et al., 2000; Irianto and Austin, 2002; Bachère, 2003). The purposes of this review are to describe the principles, mechanisms of action and criteria for selection of probiotics, and to summarize their applications in aquaculture.