

Lichens as a promising natural antibacterial agent against fish pathogens

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Abstract

Lichens are symbiotic organisms composed of fungi and algae. They have been used as a treatment of various diseases through the ages. This study was carried out to investigate the potential antibacterial effects of 13 lichen species (*Anaptychia ciliaris*, *Bryoria capillaris*, *Cetraria islandica*, *Evernia divaricata*, *Evernia prunastri*, *Letharia vulpina*, *Lobaria pulmonaria*, *Platismatia glauca*, *Pseudoevernia furfuracea*, *Ramalina farinacea*, *Ramalina fastigiata*, *Ramalina fraxinea*, and *Usnea florida*) against six common fish bacterial pathogens (*Aeromonas hydrophila*, *Aeromonas salmonicida*, *Enterococcus faecalis*, *Lactococcus garvieae*, *Streptococcus agalactiae*, and *Yersinia ruckeri*). Acetone, methanol and water extracts of lichen species were evaluated by using disc diffusion method. The majority of the lichen species exhibited antibacterial activity against *A. hydrophila*, *S. agalactiae*, *E. faecalis* and *L. garvieae* by the inhibition zones between $7.0 \pm 0.0 - 28.5 \pm 0.5$ (mm \pm SE). However, none of the lichens produced an inhibitory effect against *A. salmonicida* and *Y. ruckeri*. In general, acetone extractions were found to be more effective than methanol and water extractions. This is the first report related to the bioactivity of lichens that especially focuses on fish pathogens. The study suggested that lichens may be a possible source of natural antibacterial agents in the fishery and aquaculture industries.

Introduction

The Food and Agriculture Organisation of the United Nations (FAO) (2016) reported that the world fish supply reached a record high 20 kg/capita in 2014 and claimed that fisheries and aquaculture are still important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world. The main goal of this organisation is to achieve food security for all and ensure that people have access to enough high-quality food.

Although fish farming has developed more rapidly than all the food production sectors of alternative animals, due to diseases and stocking densities, it is obstructed by unpredictable mortality (Turker and Yildirim, 2015). It is clear that one of the main issues for high quality fish production is health management (Thanigaivel et al., 2015).

The fishery and aquaculture industries clearly prefer the administration of antibiotics, vaccines, chemotherapeutics or probiotics to protect

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