

Research Article

Antibiotic Resistance of Diverse Bacteria from Aquaculture in Borneo

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The administration of antimicrobials in aquaculture provides a selective pressure creating a reservoir of multiple resistant bacteria in the cultured fish and shrimps as well as the aquaculture environment. The objective of this study was to determine the extent of antibiotic resistance in aquaculture products and aquaculture's surrounding environment in Sarawak, Malaysian Borneo. Ninety-four identified bacterial isolates constituted of 17 genera were isolated from sediment, water, and cultured organisms (fish and shrimp) in selected aquaculture farms. These isolates were tested for their antibiotic resistance against 22 antibiotics from several groups using the disk diffusion method. The results show that the highest resistance was observed towards streptomycin (85%, $n = 20$), while the lowest resistance was towards gentamicin (1.1%, $n = 90$). The multiple antibiotic resistant (MAR) index of the isolates tested ranged between 0 and 0.63. It was suggested that isolates with MAR index > 0.2 were recovered from sources with high risk of antibiotic resistant contamination. This study revealed low level of antibiotic resistance in the aquaculture bacterial isolates except for streptomycin and ampicillin ($> 50\%$ resistance, $n = 94$) which have been used in the aquaculture industry for several decades. Antibiotic resistant patterns should be continuously monitored to predict the emergence and widespread of MAR. Effective action is needed to keep the new resistance from further developing and spreading.

1. Introduction

Since the discovery of penicillin in 1928 by a Scottish scientist Alexander Fleming followed by the release of many other earlier drugs onto the market to treat infection, the development of drug resistance in various sectors including aquaculture has been reported [1–3]. The misuse and abuse of the antimicrobial drugs are among the important factors that have contributed to the rise of resistant microbes around the world. Antibiotics, which have saved millions of lives and were also known as miracle drug in the past, are no longer the ultimate way for the treatment of infections because bacteria have continued to develop multiple resistance towards many different types or classes of the drugs [4].

Antimicrobial agents have been widely used in fish farming for either therapeutic, prophylactic, or other purposes [5]. The antibiotics are normally used to increase growth as well as feed efficiency in the animals [6]. However, some of the

antibiotics have been frequently used in both veterinary and human medicine such as sulfonamides, chloramphenicol, tetracycline, nitrofurans [5], oxytetracycline [7], neomycin, erythromycin, streptomycin, prefuran, and enrofloxacin [8]. The evolution of bacteria towards antibiotic resistance has been accelerated distinctly by selective pressure due to inappropriate and overuse of the antibiotics [3, 9]. In the efforts to cope with this problem, scientists have accelerated the search for alternative antimicrobial agents by screening many potential sources including medicinal plants [10, 11] and microbes [12, 13].

Aquaculture is an important sector in the agriculture industry and is rapidly growing to meet the world's demands for protein source. This sector is challenged with the diverse type of diseases and bacterial infections; and antibiotics are an excellent tool to circumvent the problem [14, 15]. The presence of bacteria with multiple antibiotic resistance found in food products has become a threat to public health as