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Research Article

Metabarcoding Analysis of Bacterial Communities Associated with Media Grow Bed Zones in an Aquaponic System

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The development of environmentally sustainable plant and fish production in aquaponic systems requires a complete understanding of the systems' biological components. In order to better understand the role of microorganisms in this association, we studied the bacterial communities in the dry, root, and mineralized zones of a flood-and-drain media bed aquaponic system. Bacterial communities were characterized using metabarcoding of the V3-V4 16S rRNA regions obtained from paired-end Illumina MiSeq reads. Proteobacteria, Actinobacteria, and Bacteroidetes accounted for more than 90% of the total community in the dry zone and the effluent water. These phyla also accounted for more than 68% of the total community in the root and mineralized zones. The genera *Massilia*, *Mucilaginibacter*, *Mizugakiibacter*, and *Rhodoluna* were most dominant in the dry, root, and mineralized zones and in the effluent water, respectively. The number of shared operational taxonomic units (OTUs) for the three zones was 241, representing 7.45% of the total observed OTUs. The number of unique OTUs in samples from dry zone, root zone, mineralized zone, and effluent water was 485, 638, 445, and 383, respectively. The samples from the root zone harbored more diverse communities than either the dry or mineralized zones. This study is the first to report on the bacterial community within the zones of a flood-and-drain media bed. Thus, this information will potentially accelerate studies on other microbial communities involved in the bioconversion of nitrogen compounds and mineralization within these types of aquaponic systems.

1. Introduction

Aquaponics is an integrated farming concept that combines the production of fish and hydroponic plants in systems that rely on microbial activity to improve water quality and provide nutrients to plants, in either single process loop (coupled) or two-loop systems (decoupled) [1, 2]. The accumulation of uneaten food, fish feces, and organic and inorganic nitrogenous compounds in the system provides an ecosystem for microbial activity and development resulting in their conversion to plant nutrients [3]. During nitrification, ammonia, the main form of inorganic nitrogen excreted by fish, is oxidized either directly to nitrate [4] or via nitrite to nitrate, the latter being less toxic to fish, while plants can utilize it for growth [5, 6]. An important feature of aquaponics is the reliance on microbial activity. Both autotrophic and heterotrophic bacteria occur in aquaponic systems [6, 7]. They play a role in rhizosphere remediation, the control of abiotic stressors, and the protection of plants from pathogens [8].

Media-based growth systems are frequently used because of their simplicity and reliability [3, 9]. Media beds are designed to flood and drain or to operate as constant-flow systems [10]. Flood-and-drain cycles enable the hydroponic media bed to acquire atmospheric air which can lead to aerobic conditions in parts of the media bed [10]. Consequently, there are distinct vertically differentiated zones in media bed of flood-and-drain systems [3]. The media bed provides stability for root growth, and plants with extensive root systems typically adapt well to this environment [11].