



Seaweed aquaculture: a preliminary assessment of biosecurity measures for controlling the ice-ice syndrome and pest outbreaks of a *Kappaphycus* farm

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Received: 23 February 2021 / Revised and accepted: 6 June 2021 / Published online: 2 August 2021
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Abstract

The application of biosecurity in seaweed aquaculture plays an important role in reducing the impact of disease and pest outbreaks. The continuous occurrence of seaweed pests including the macroalgal epiphytes, epi-endophytic filamentous algae and biofilms on *Kappaphycus* farms may also potentially induce further incidences of the ice-ice syndrome. In this study, on-farm biosecurity management measures were tested on the commercially grown seaweeds *Kappaphycus malesianus* and *Kappaphycus alvarezii* during peak ice-ice season at Gallam-Gallam Village, Sabah, Malaysia. The investigation was focused on preventative control measures including the early detection of the ice-ice syndrome and pests through propagule health checks, regular cleaning of the crop thallus and associated long-line ropes and monitoring of the environment. Farm procedures and practices were also assessed in terms of their biosecurity ‘risk’ using the hazard analysis and critical control point (HCCAP) approach. Observations were replicated in two different farm management systems; one system adopted routine biosecurity measures and the other had no biosecurity measures. The results showed that the ice-ice syndrome and pest outbreak was significantly decreased by 60–75% for *K. malesianus* and 29–71% for *K. alvarezii* at the farm which adopted the routine biosecurity measures compared with the no biosecurity treatment. The biosecurity measures also significantly improved growth rate and seaweed quality. The infection levels of the epi-endophyte *Melanothamnus* sp. contributed to the ice-ice syndrome in *K. malesianus*, whilst the epiphyte coverage was correlated to the ice-ice incidence in *K. alvarezii*. This study provides the first evidence of biosecurity management measures significantly decreasing the incidence of the ice-ice syndrome and pests on a commercial seaweed farm.

Keywords Biosecurity · Farm practices · Ice-ice syndrome · *Kappaphycus* farm · Rhodophyta · Seaweed aquaculture

Introduction

Seaweed is highly nutritious and has been consumed by humans for centuries. In 2018, the total production of world seaweed aquaculture reached 32 million tonnes fresh weight (FW), increasing by 200% within eight years (FAO 2020). The red seaweed *Kappaphycus/Eucheuma* has been reported to be the most rapidly expanding sector of the seaweed market and recently contributed to 34% of the world’s seaweed production (FAO 2020). South-East Asia is a major global producer of *Kappaphycus/Eucheuma* and the industry has supported national economic growth and significantly improved the livelihood of millions of farmers (Valderrama et al. 2015; Cottier-Cook et al. 2016; FAO 2020).

Changes in the aquatic environment, however, as a consequence of global climate change have had led to significant

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