



Abstract

Integrated System of Red Seaweed *Kappaphycus alvarezii* (Rhodophyta, Solieriaceae) and Clownfish *Amphiprion ocellaris* (Perciformes, Pomacentridae): An Experimental Study [†]

Alejandra Filippo Gonzalez Neves dos Santos ^{*,†} , Nathalia da Silva Lucarevski, Eshefison Rodrigues Batista and Simone Gomes Ferreira

Laboratory of Applied Ecology, Department of Zootechny and Sustainable Socioenvironmental Development, Fluminense Federal University (UFF), Rua Vital Brazil Filho, 64, Niterói CEP 24230-340, Brazil; nathalia.lucarevski@id.uff.br (N.d.S.L.); esthefison2015@gmail.com (E.R.B.); simonegomes@id.uff.br (S.G.F.)

* Correspondence: afileppo@gmail.com; Tel.: +55-21-2629-9518

[†] Presented at the IX Iberian Congress of Ichthyology, Porto, Portugal, 20–23 June 2022.

[‡] Presenting author (Poster presentation).

Abstract: This study aimed to analyse the integrated system of red seaweed *Kappaphycus alvarezii* and clownfish *Amphiprion ocellaris*. Experiments were performed in a 45 L aquarium under the following controlled conditions: temperature 22 °C, dissolved oxygen 5 mg/L, salinity 30, and photoperiod 12 h light. There were 10 fish per aquarium, fed with commercial food. Four treatments were tested (three replicates per treatment): (1) only fish (control); (2) fish with 250 g seaweed; (3) fish with 500 g seaweed; and (4) fish with 750 g seaweed. Weekly seaweed and fish were weighed and measured, and ammonia (NH₃), nitrite (NO₂), nitrate (NO₃[−]), phosphate (PO₄^{3−}), and phosphorus (P) were analyzed. The total weight (g) (TW) of fish differed over time ($F = 0.00$) and between treatments ($F = 2.84$; $p = 0.03$). Higher TW (± 0.75 g) occurred in treatment 3 and after 14 days did not significantly differ from the end of the experiment ($p < 0.01$). The total length of fish (cm) did not differ significantly over time ($F = 0.64$; $p = 0.66$) or between treatments ($F = 0.34$; $p = 0.79$). The relative growth rate of seaweed (RGR) did not differ over time ($p > 0.12$). There was a significant interaction between the nutrients present in the water by treatment and time ($F = 3.59$; $p = 0.00$). The nutrient removal efficiency (NRE) of NH₃ and NO₂ was higher in treatments 3 and 1, respectively, reaching $\pm 30\%$ at 14 days ($p < 0.001$), and from the 21st day of the experiment, the values were close to zero, with no significant difference between treatments up to 35 days ($p > 0.90$ for both). The NRE of NO₃[−] increased by 2% at 28 days of the experiment, with no significant difference between treatments ($p > 0.07$). The NRE of P was $\pm 25\%$ at 14 days and was not different between treatments 1 and 2. The NRE of PO₄^{3−} reached 14% at 21 days for treatments 1, 2 and 3 ($p < 0.001$). The control showed lower values for the NRE of NH₃, NO₃[−], P, and PO₄^{3−} compared to the treatments, but the NRE of NO₂ increased in 14 days. It is concluded that a greater abundance of *K. alvarezii* helps in water quality and contributes to the total weight of clownfish between 14 and 21 days.

Keywords: water quality; sustainability; coral reef fish



Citation: Santos, A.F.G.N.d.; Lucarevski, N.d.S.; Batista, E.R.; Ferreira, S.G. Integrated System of Red Seaweed *Kappaphycus alvarezii* (Rhodophyta, Solieriaceae) and Clownfish *Amphiprion ocellaris* (Perciformes, Pomacentridae): An Experimental Study. *Biol. Life Sci. Forum* **2022**, *13*, 130. <https://doi.org/10.3390/blsf2022013130>

Academic Editor: Alberto Teodorico Correia

Published: 20 June 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Author Contributions: Methodology, A.F.G.N.d.S.; N.d.S.L.; E.R.B.; and S.G.F.; Formal analyses, A.F.G.N.d.S.; Writing—original draft preparation, A.F.G.N.d.S. and N.d.S.L.; and Writing—review and editing, A.F.G.N.d.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by FAPERJ, grant number E26/202826/2019.

Institutional Review Board Statement: CEUA—UFF n.115416092.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.