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Unravelling the fatty acid profiles of different polychaete species cultured under integrated multi-trophic aquaculture (IMTA)

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Polychaetes can be successfully employed to recover otherwise wasted nutrients present in particulate organic matter (POM) of aquaculture effluents. The present study describes the fatty acid (FA) profile of four different polychaete species cultured in sand filters supplied with effluent water from a marine fish farm. The FA profile of cultured and wild *Hediste diversicolor* was compared and revealed a ≈ 24.2% dissimilarity, with cultured biomass displaying a higher content in two essential *n*-3 highly unsaturated FA (HUFA) (EPA [20:5 *n*-3] and DHA [22:6 *n*-3]—eicosapentaenoic and docosahexaenoic acid, respectively). The comparison of the FA profile of cultured *H. diversicolor* with that of other polychaete species whose larvae successfully settled on the sand filters (*Diopatra neapolitana*, *Sabella* cf. *pavonina* and *Terebella lapidaria*) revealed that their FA profile, which is here described for the first time, displayed high levels of EPA and DHA (≈ 1.5–4.8 and 1.0–1.1 µg mg^{-1} DW, respectively). The highest concentration of total FA per biomass of polychaete was recorded in *H. diversicolor* and *T. lapidaria*, with both species being the ones whose FA profiles revealed a lowest level of dissimilarity and more closely resembled that of the aquafeed used in the fish farm. In the present work it was demonstrated that it is possible to produce polychaetes biomass with high nutritional value through an eco-design concept such as integrated multi-trophic aquaculture (IMTA). Indeed, this framework promotes a cleaner production and, in this specific case, allowed to recover essential fatty acids that are commonly wasted in aquaculture effluents.

Aquaculture has grown globally 5.8% per year during the period 2001–2016 and continues to grow faster than any other food production sector[1]. In 2016, this industry produced 110.1 million tonnes of food fish and aquatic plants with an estimated value of USD 243.3 billion[1]. It is through the growth and development of this industry that can be possible to supplement human needs in *n*-3 highly unsaturated fatty acids (HUFA). A dose of 500 mg/day of eicosapentaenoic (20:5 *n*-3 [EPA]) and docosahexaenoic (22:6 *n*-3 [DHA]), *n*-3 HUFA, is recommended to reduce the risk of cardiovascular disease[2–5]. Based on this recommended dose to maintain a good cardiac wellness, there is a global requirement of approximately 0.4 million metric tonnes of *n*-3 HUFA per year[5]. Our needs in these essential fatty acids (EFA) are due to limitations that vertebrate species exhibit in the de novo synthesis of these molecules due to the lack of desaturases (Δ12 and Δ15) responsible to produce polyunsaturated fatty acids (PUFA) from oleic acid (18:1 *n*-9), thereby making their inclusion in the aquafeeds essential[5–7]. Marine fish for example incorporate in their tissues with little or no modification the fatty acids (FA) from lower trophic levels and, as such, some species may present well-defined FA signatures depending on their diet[6]. These EFA are included in formulated aquafeeds to satisfy the needs of cultured species, but especially so that these at the end of a productive cycle exhibit an optimal profile for human nutrition[5]. Presently, balanced aquafeeds are formulated using fish meal and fish oil (mainly for marine finfish and shrimp), two increasingly scarcer and costly marine based resources[1]. Their inclusion has been optimized over time and today´s formulas contain less than 10%

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