Farmed fish as a functional food: fortification strategies with health valuable compounds

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Summary

The current trend in the aquaculture industry of replacing fish meal and fish oil by alternative ingredients is reducing the levels of n-3 LCPUFA and microelements such as iodine and vitamin D3, of which fish is the main natural food source. Exogenous feeding in aquaculture unlocks the possibility to tailor fish composition with healthy beneficial nutrients improving quality and nutritional value of edible fish. An on-line survey to inquire about the concept of fish fortification **(chapter 2)** showed that half of respondents agreed with it and were willing to consume fortified fish. Respondents less interested on fish origin (wild vs aquaculture) were more receptive to fortification. Subsequently, several experimental trials were undertaken targeting the muscle fortification of gilthead seabream and rainbow trout with health beneficial compounds. Seabream and trout were able to accumulate iodine and selenium in muscle as response to a dietary fortification of these trace minerals, supplied from distinct sources **(chapter 3)**. At similar supplementation levels, the maximum fillet iodine content found in seabream was higher than that found in trout which is probably associated with the physiological needs for homeostasis of freshwater and marine fish. Efficacy of dietary fortifications aiming to raise iodine concentration in fish muscle may be more dependent on the targeted fish species than on the iodine source used. In trout, an effective muscle fortification with selenium was achieved with a selenised yeast supplemented diet. Fortification of fish muscle with vitamin D_3 via dietary supplementation is apparently a more complex process, showing variable results (chapter 4). Raising dietary vitamin D_3 from a basal level to the maximum permitted level did not significantly enhance fillet vitamin D_3 contents. In chapter 5, a study was undertaken to assess the potential of microalgae biomass, from the diatom *Phaeodactylum tricornutum*, as a functional ingredient in seabream feeds. Results showed that algae-fed seabream positively improved external appearance, originating a more vivid yellow pigmentation of the operculum and a

lighter colouration of ventral skin. Moreover, an untrained consumer panel showed a clear preference for algae-fed fish when compared with those fed a commercial diet. Marine-derived raw materials traditionally used in aquafeeds are scarce resources, mainly fish oil rich in n-3 LCPUFA. To tackle the low retention of dietary EPA and DHA in fish, our work focused on a nutritional strategy to foster the metabolic sparing of n-3 LCPUFA in gilthead seabream fillets (Chapter 6). The fatty acid composition of tissues is not solely dependent on the quantitative fatty composition of feeds but is also affected by their relative ratios. The initial fatty acid composition of fish seems to play a significant role on the EPA and DHA sparing efficiency. A higher MUFA intake led to a significant increase on EPA and DHA retention in fish with a vegetable nutritional background. Retention of combined EPA and DHA in seabream fillets was relatively low, with DHA retention generally more than double of EPA.

The use of natural/organic compound sources in fortification trials were equally or more efficacious than the synthetic ones and should be considered adequate alternatives. In the various fortification trials, the nutritional contribution of trout and seabream fillets (160 g serving) to the daily adequate intake of combined EPA and DHA was well above the recommended levels. The serving amount of trout fillets could contribute to 98% of selenium, over 100% of vitamin D_3 and 13% of iodine Daily Recommended Intakes, respectively. In turn, the consumption of 160g of seabream fillets would cover 60% of vitamin D_3 and 84% of iodine Daily Recommended Intake levels. The fortification strategies enhanced the nutritional contribution of seabream and trout fillets in health beneficial compounds resulting in novel products, and thus resulting in potential candidates to the functional foods market. Throughout our work we contributed towards the generation of new data on the efficacy of feed fortification strategies as tools to modulate several traits of farmed fish.

Keywords: *Fish nutrition; Feed fortification; Fish quality; Nutritional contribution; Consumers' perception; Functional foods*