Impact of microalgae meal on rainbow trout quality

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Introduction

The aquaculture sector is of paramount importance for achieving the Zero Hunger goal of Agenda 2030, and it is estimated that in the next decades, more than 60% of the world's seafood demand will be provided by aquaculture. However, the forecasted rise in aquaculture production volumes necessarily will result in an increase in aquafeed consumption, whose golden ingredients (namely fishmeal, fish oil, and soybean meal and oil) are not considered sustainable anymore. For these reasons, innovative ingredients for aquafeed formulation (i.e., insect meal, animal, and vegetable by-product meal) have been investigated to limit the negative impact of aquaculture on the environment and the natural resources, but maintaining, in the meantime, similar nutritional properties. Among the others, microalgae seemed to be promising substitutes for conventional protein sources, given their nutritional properties (sources of macro- and micronutrients), their influence on skin and fillets' colour, and their beneficial role in animal physiology (antibacterial and antiviral function, improved immune response, stimulation of intestinal function and subsequent colonization by probiotic bacteria).

Aim

The present study aimed at evaluating if and to what extent growth, physical characteristics, nutritional value and antioxidant capacity of fillet muscle of rainbow trout (*Oncorhynchus mykiss*) are improved when fish are fed fish meal-free diets, including whole cell dry biomass of *Tetraselmis suecica* (12%) alone, or in association with that of *Tisochrysis lutea* (11%) to substitute 10% crude protein from conventional vegetable feedstuffs. The diets also had a low fishmeal content (5%).

Materials and methods

Based on the assumptions listed above, this trial compared the effects of 4 grossly isoproteic, isolipidic, and isoenergetic diets on the quality of rainbow trout (RT): a diet based on vegetable protein sources (negative control, VEG), a diet based on VEG but containing *T. suecica* meal singly (12%, TETRA) or combined with *T. lutea* (11%, MAMIX), and a commercial diet (COMM), were compared. Thus, a total of 600 RT individuals, all females, (initial mean weight 79.7±3.0 g) were randomly assigned to experimental tanks (n = 50 per tank), for a total of 12 tanks (4 diets, 3 replicates per experimental diet), of 1600 L volume. Diets (pellets, 4 mm diameter) were administered for 15 weeks (104 days - 76 meals, in total). The daily ration was initially 2% w/w for the first 5 weeks, then gradually decreasing to 1.1% during the last 5 weeks. The daily ration was distributed manually for 6 days per week for the first 6 weeks and then reduced to 5 days per week. The quantity of feed daily administered was adjusted weekly, based on the estimated gain in biomass, measured at regular intervals, *i.e.*, at 0, 7, and 14 weeks. After the 15-week rearing period, 3 fish were taken from each tank resulting in a total of 36 trout, which were fasted for 24 hours and euthanised with a lethal dose of tricaine methanesulfonate (ms-222) to perform the analyses hereunder described. First, both morphometric (fish length, weight) and marketable traits (condition factor - K, fillet yield - FY, hepato-somatic index - HSI) were recorded. Then, both physical (pH, colour, WHC, texture) and chemical (moisture, ashes, crude protein, total lipids, fatty acid profile, total carotenoid content, antioxidant capacity, DPPH, TBARS) characteristics were also analyzed. Data were subjected to one-way ANOVA, using the GLM procedure of SAS. The level of significance considered was 95% ($p \leq 0.05$).

Results

Looking at morphological and marketable traits, all the experimental groups showed an overall homogenous growth. The group fed with MAMIX showed the greatest length (25.59 cm), while the lowest was recorded for the group fed with TETRA (23.86 cm) ($p < 0.05$). Fish-fed microalgae had an intermediate FY between the VEG group (64.14%), which showed the highest values, and the COMM group (60.77%), showing the lowest ones ($p < 0.05$). In contrast, significantly different HSI ($p < 0.05$) were observed between the group fed with MAMIX (1.02%, lowest value) and the group fed with TETRA (1.38%, highest value, together with the fish fed the COMM diet). A similar trend was observed for the percentage of perivisceral fat, with the MAMIX group showing the lowest fat content (0.39%) ($p < 0.05$). A pinkish colour was evident for fillets of the VEG group, in contrast to that of the microalgae-fed groups ($p < 0.05$), which were characterized by yellowish colour. Probably, the xanthophylls in the macroalgae could have led to a colour change. In addition to this, the amount of lipids did not discriminate the samples of the different groups ($p > 0.05$). Regarding the fatty acid profile, a similar content of SFA, n-3PUFA and n-6PUFA was observed for VEG and microalgae-fed groups. Consistent with this, microalgae-fed and control-fed fish presented similar values in the n-3PUFA/n-6PUFA ratio. The lowest value of the n-3PUFA/n-6PUFA ratio (0.50) was, however, observed in the group fed the COMM diet, characterized by the highest n-6PUFA content (26.38 g/ 100 g total fatty acids) ($p < 0.05$). Finally, the microalgae-fed groups were characterized by an intermediate antioxidant capacity between the VEG group (lower capacity) and the COMM group (higher capacity) ($p < 0.05$).

Conclusions

In conclusion, microalgae turned out to be possible alternative ingredients for rainbow trout diet formulation while considering fish growth and marketable characteristics. Noticeably, microalgae had a significant effect on reducing perivisceral fat content and increasing both the n-3PUFA/n-6PUFA ratio and the antioxidant capacity of fish fillets when compared to the VEG group. However, a detrimental effect on fish colour turning into a yellowish pigmentation should suggest focusing further studies on the possible use of microalgae as additives in aquafeeds or as functional ingredients in species different from salmonids, for which red-pink colour is of paramount importance for fish quality.