

Use of flavourings to improve aquafeed palatability in aquaculture: a multidisciplinary approach to better understand teleost physiological responses

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Introduction

In the modern aquaculture, the use of vegetable ingredients (e.g., soybean or corn meals) for aquafeed production often results in lower diet palatability affecting fish growth, the environment, and the farm economics. In this regard, it is estimated that a considerable part of the provided feed is not ingested by fish, ending in wastewater outflow. Nowadays, feed attractants, mostly represented by natural-derived ingredients, are regularly included in aquafeeds to elicit an optimal feeding response, in terms of time and feed intake, but posing some unsustainability issues. In addition, these ingredients also present fluctuations in availability and their attractive effect is highly variable depending on raw material composition, freshness, and processing methods. Mixture of free amino acids are the current alternative solution although the limitations and disadvantages of their use as feed attractants are well known. Therefore, a novel, standardized and sustainable alternative to natural feed attractants is represented by synthetic feed attractants obtained through standardized processes. The aim of this study was to identify different synthetic feed attractants, testing them in the rearing of zebrafish (*Danio rerio*) from the larval to the juvenile stage. A multidisciplinary laboratory approach was used to have a comprehensive overview of fish physiological responses and feed intake.

Materials and Methods

Sampling: 5 dpf → larva – 21 dpf → juvenile – 60 dpf

dpf – days post-fertilization

Experimental groups:

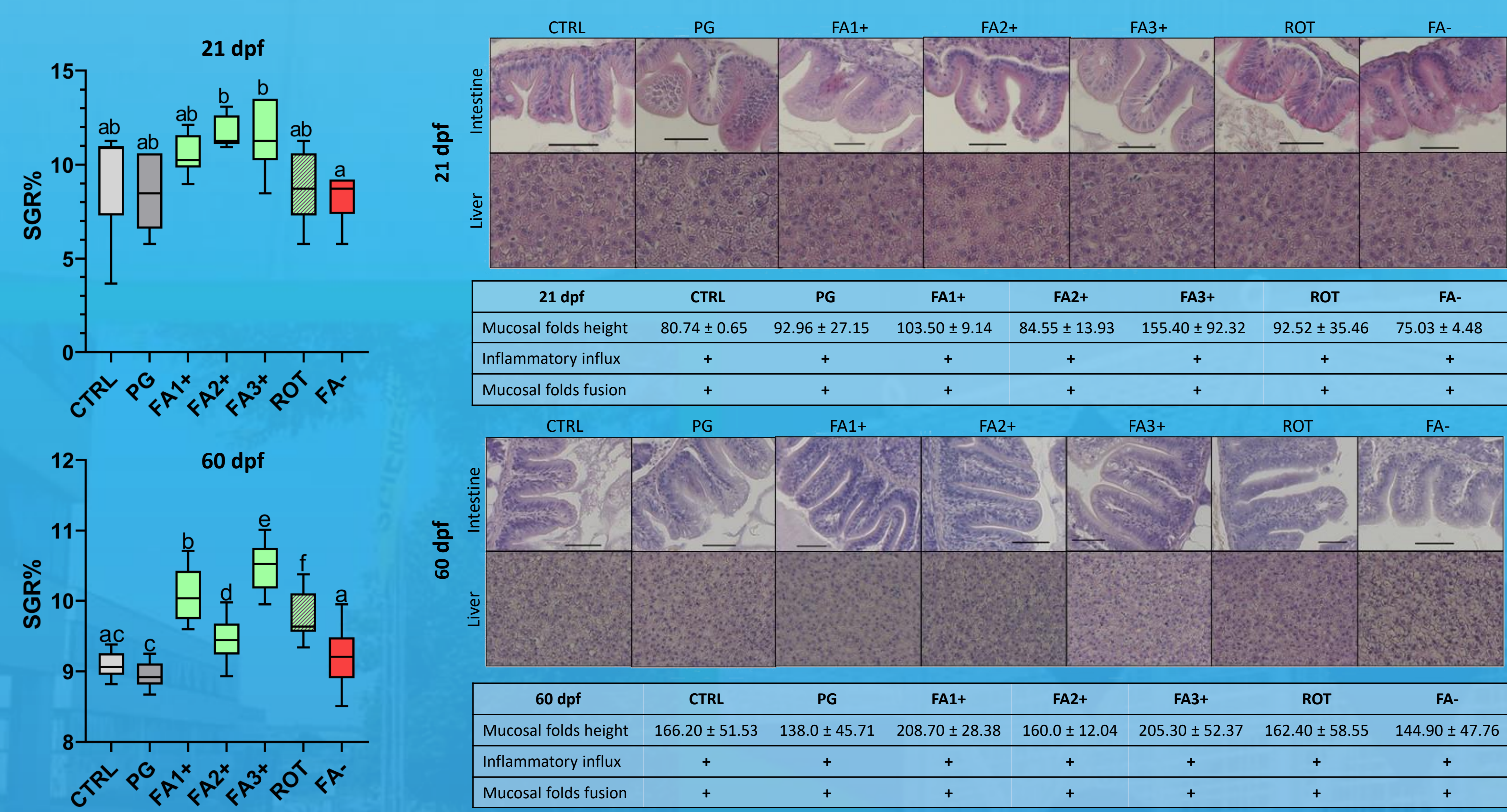
- CTRL – fish fed the control diet;
- PG – fish fed control diet with 1% of Propylene Glycol;
- FA1+, FA2+, and FA3+ – fish fed control diet with 1% of attractive feed attractants;
- FA- – fish fed control diet with 1% of a repulsive feed attractant;
- ROT – fish fed the three attractive diets (FA1+, FA2+, and FA3+) each administered singularly in a weekly rotation scheme.

Biometry

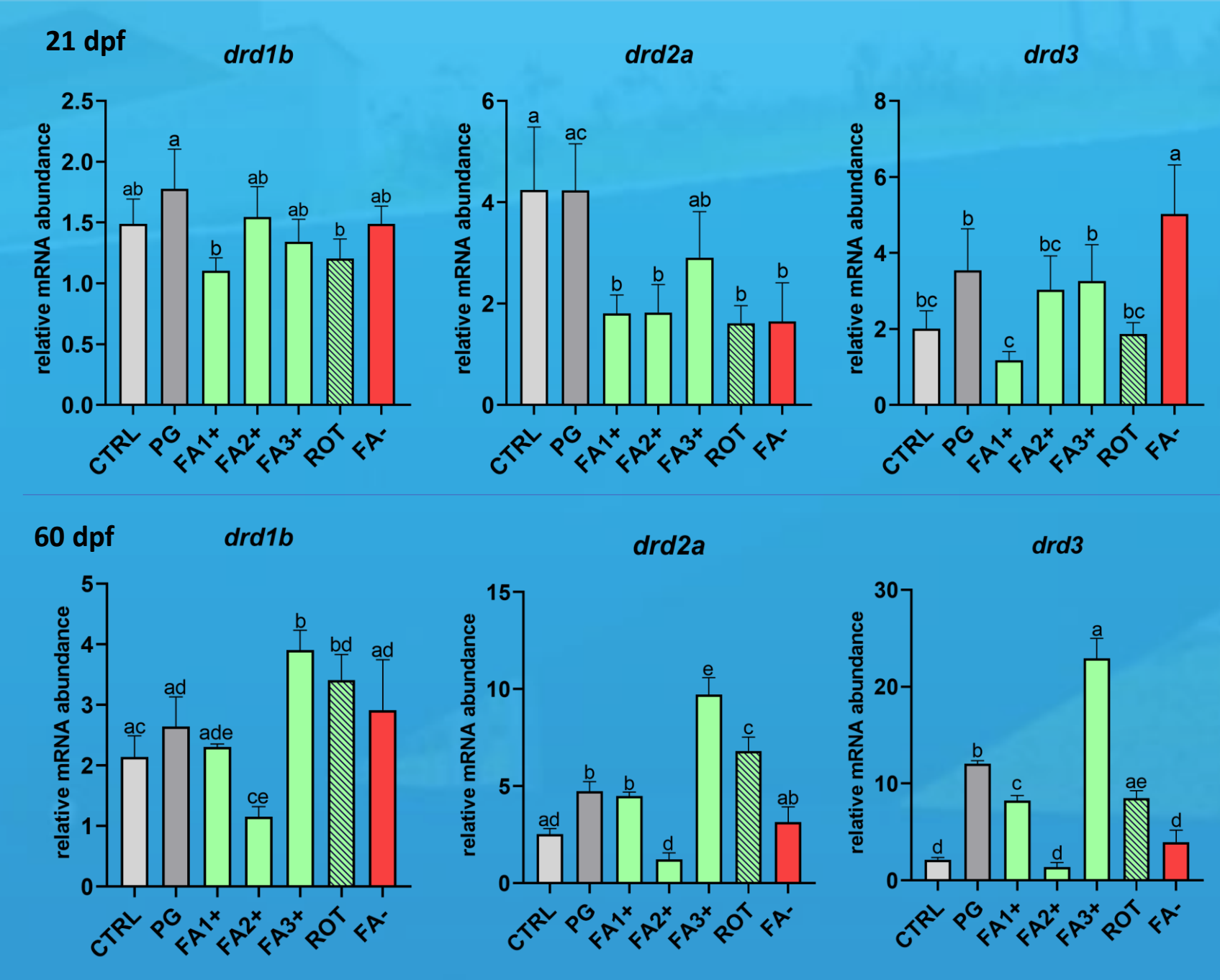
Histology

Molecular Analysis

Results and Discussion



Molecular analysis: as regards the analysis of gene expression involved in brain's reward system (*drd1b*, *drd2a*, and *drd3*), as dopamine is the main neurotransmitter involved in the pleasure sensation, results evidenced a different dopamine receptors activity among groups, suggesting a pivotal role of the tested feed attractants in their activation/inactivation.



Biometry: significant variations in SGR were detected in both the larval and juvenile stages among groups. The highest values in SGR for FA+ groups are related to a greater feed assimilation, compared to CTRL and PG groups. As regards ROT group, a significant increase in SGR is evident only on at 60 dpf. Finally, FA- group showed no significant differences as probably the feed reduce the repulsive effect of the feed attractant.

Histology: as regards intestinal tract, no alterations in tissue's architecture or signs of inflammations were evident in all experimental groups. Considering liver, no negative effects or structural differences in hepatic parenchyma were evident, confirming the absence of negative effects due to the feed attractants administration. Scores: Inflammatory influx + = scarce lymphocytes infiltration, ++ = moderated infiltration, +++ = diffused infiltration; mucosal folds fusion + = 0-5 observations per section, ++ = 6-15, +++ = >15; scale bar 50µm.

Conclusion: the administration of positive feed attractants promoted higher feed intake by the fish, acting on the fish brain reward system without impairing welfare and represents a very promising result for the aquaculture industry since a faster and complete feed intake by the fish has both ecological and economic benefits for the sector. A more palatable feed, promoting adequate feed intake, not only positively affects the animal welfare, and thus the quality of the final product, but also allows for shorter production times, improving farm economics.