SHORT-TERM EFFECT OF A LOW PROTEIN HIGH CARBOHYDRATE DIET ON GLUCOSE AND LIPID METABOLISM IN THE LIVER OF MATURE FEMALE AND MALE, AND NEOMALE RAINBOW TROUT

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Introduction

Aquaculture and more specifically carnivorous fish farming, such as trout production, are highly dependent on fish derived products such as fish meal (FM) and fish oil (FO) as sources of proteins and lipids, respectively, in the aquafeed formula. However, FM and FO rely on fishing from wild stocks, which can be seen as a hindrance to the sustainable development of salmonid farming, the first aquacole production in Europe [1]. This applies in particular to broodstocks, which are large animals that consume large amounts of feed generally containing high proportion of FM and FO. Three sex are used in aquaculture as broodstocks, female, male and neomale that are for the latter masculinized females used to produce all-female lines. Carbohydrates represent good candidates for the replacement of FM [2]. However, rainbow trout juvenile are considered as poor users of digestible carbohydrates [3]. This is linked to several hypothesis such as the non-inhibition of the production of endogenous glucose through gluconeogenesis or the poor induction of *de novo* lipogenesis [4,5]. In this context, this study aimed to evaluate the consequences of feeding rainbow trout broodstocks with a high carbohydrate diet for two days on glucose and lipid metabolism.

Materials and methods

Mature female and male, and neomale rainbow trout were fed for two days with a low protein high carbohydrate diet (32% carbohydrates, 42% proteins - HC) or a diet containing no carbohydrates (0%CHO, 66% proteins, NC).. Six hours after the last meal, we analysed plasma metabolites, mRNA levels and enzymatic activities of glucose and lipid metabolism-related actors. All these parameters were studied in the liver that is the key organ for the regulation of intermediary metabolism.

Results

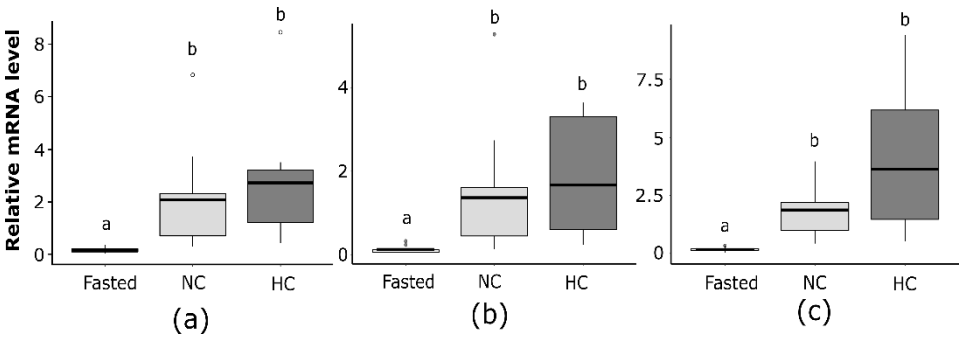

Figure 1 : Illustration of the up-regulation of the *de novo* lipogenesis with *aca alpha a* mRNA levels in (a) mature female, (b) mature male and (c) neomale 15 days fasted (Fasted, white) and then refed with either the NC (non-carbohydrate diet, grey) orthe HC diet (High-carbohydrate diet, dark grey).

Data (n=9 fish per condition) were analysed with a Kruskal Wallis test, followed by a post hoc Tukey test in case of significant difference ($p<0,05$, indicated with different letters).

Results demonstrated that the glucose metabolism was regulated at the molecular level by the nutritional status in all sex irrespective of the diet composition. Glycolysis was up-regulated in fed neomales and females with an increase of mRNA levels of glucokinase and phosphofructokinase encoding genes as well as an increase in the enzymatic activity of the pyruvate kinase. Concerning gluconeogenesis only glucose-6-phosphatase coding genes were regulated by the nutritional status irrespective of diet composition with the repression of *g6pcb1b* and the induction of *g6pcb2a*. However, no differences in enzymatic activities was highlighted for this pathway. Finally, concerning the lipid metabolism, our results clearly demonstrated for neomales and males the up-regulation of the *de novo* lipogenesis and the down-regulation (example of *aca alpha-a*, figure 1) of the beta oxidation,while only an up-regulation of the *de novo* lipogenesis occurred in female .

Discussion and conclusion

The present study investigated the glucose and lipid metabolism at the molecular level in mature female and male, and neomale rainbow trout fed for two days with a NC diet or a HC diet. The results obtained for the glucose metabolism highlighted an activation of the glycolysis pathway and a repression of the gluconeogenesis (except for g6pcb2 genes) by the nutritional status in all sex irrespectively of the diet. The up-regulation of the *de novo* lipogenesis was also demonstrated in fed animals. These data points out that carbohydrate intake during a short period (5 meals) does not induce specific metabolic changes after two days of feeding in mature female and male, and neomale.. Moreover, we demonstrated for the first time sex differences regarding the effects of two days feeding on metabolism, especially with neomales displaying more differences in the regulation of the glucose and lipid metabolism than male and female broodstock, which could be explained by the fact that they are still immature. In conclusion, there is no negative effects of feeding mature female and male, and neomale rainbow trout with a high carbohydrate diet for a short period of time. However, more studies will be needed focusing on the long term consequences of such diet on neomales.

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