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ABSTRACTS

PREDICTING FEED CONVERSION RATIO AT COMMERCIAL SIZE FROM JUVENILE PERFORMANCE IN INDIVIDUALLY REARED *Oreochromis niloticus*

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Introduction

Using breeding programs to reduce feed conversion ratio (FCR), namely the ratio between feed intake (FI) and body weight gain (BWG), could highly strengthen aquaculture sustainability. However, selective breeding programs require phenotyping individual FCR, and thus FI, on a large number of fish, which is particularly challenging. A solution is to rear fish in individual aquaria and collect uneaten pellets (Besson et al., 2019). In literature, this method is exclusively used on juvenile fish for practical reasons. Estimating individual FCR beyond juvenile stage is, however, critical since much more feed is consumed during the later stages of growth than during the younger stages. Determining whether FCR estimated at a young age accurately predicts FCR at commercial size has major implications for the design of selective breeding program. In particular, when individual rearing is used, labour costs and space needed would be much lower to individually phenotype juvenile fish rather than fish at commercial size. Selecting male Nile tilapia on their FCR estimated over only two weeks might permit to improve the whole production cycle FCR by about 1% per generation with a 50% selection intensity (Rodde et al, 2020). However, these results were established on only 30 male tilapia and needed to be confirmed on more individuals, including females. In the present study, 60 fish (30 females and 30 males) were reared over 30 weeks and we assessed whether phenotyping individual FCR over only two weeks could accurately predict individual FCR over the 30 weeks.

Material and methods

Animals were originating from the 18th generation of GIFT (Genetically Improved Farmed Tilapia) produced from the 4th March to the 4th April 2019 at the WorldFish Research Station in Jitra (Kedah State, Malaysia). On the 22nd of July 2019, fish were isolated in 10 L aquaria part of a same water recirulating system. Over the whole experiment, fish were fed a commercial diet (Cargill®) to 90% of the optimal feeding rate to reduce feed wastage, as explained in Rodde et al (2020). After two weeks of acclimation, the experiment started on the 5th of August 2019 (35.3 g and 35.5 g for females and males BW, respectively). On the 14th of October (around 90 g), fish were transferred to individual 60 L aquaria to provide them extra space to grow. The experiment ended after 30 weeks, on the 2nd of March 2020, once fish at commercial size (342.7 g and 288.4 g for females and males BW, respectively). Each fish was anaesthetized with clove oil once a week and weighed to adjust feed ration. Every day, uneaten pellets were removed from the aquaria at least two hours after the last meal and counted to estimate the total amount of feed wasted by each fish. Body weight gain, FI and FCR were calculated over 15 two-week periods. The FCR was also estimated over the 30 weeks of the experiment (global FCR named "FCRg"). Individual FCR measured over the two-week time steps and FCRg were normalized using log-transformation (lnFCR and lnFCRg) and Pearson's correlation between each two-week period lnFCR and lnFCRg was estimated. Then, the potential genetic gain on FCRg was compared when fish were selected for i) FCRg directly and ii) FCR estimated over a two-week period as an indirect selection criterion. To perform this simulation, selection intensity was set to 50% (the 15 best females and males were selected) and heritability was set to 0.32 as estimated for juvenile FCR in GIFT Nile tilapia by de Verdal et al. (2018).

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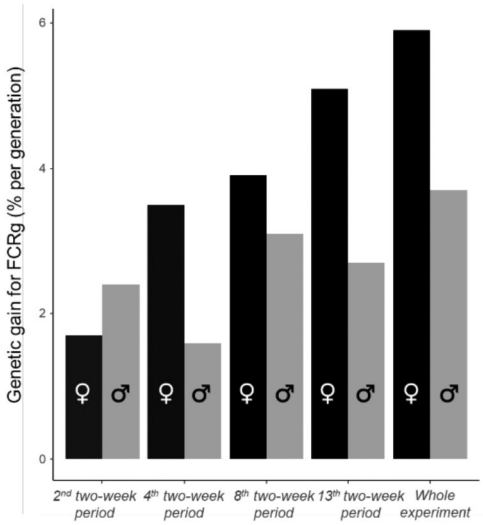

Figure 1 Genetic gain for FCRg depending on various selection periods

Results

In total, 30 females and 29 males were successfully phenotyped. FCRg was 1.87 ± 0.44 (CV = 23.4%) and 1.94 ± 0.33 (CV = 16.7%) for females and males, respectively. When including both females and males in the analyses (n = 59), lnFCR appeared to be significantly correlated with lnFCRg over 14 two-week periods out of 15 (r = 0.26-0.75 for significant correlations). For females and males separately, lnFCR and lnFCRg were significantly correlated over 11 and seven periods, respectively (r = 0.48-0.88 and r = 0.39-0.82, respectively). Projections revealed that direct selection on FCRg would improve FCRg by 5.9 and 3.7% per generation for females and males, respectively (Fig. 1). In comparison, selection on FCR on the 4th two-week period (worst correlation, r = 0.26) would improve FCRg by 3.5 and 1.6% for females and males, respectively, whereas selection on FCR on the 13th period (best correlation, r = 0.75) would improve FCRg by 5.1 and 2.7% for females and males, respectively (Fig. 1). Two other simulations were made selecting on the 2nd and the 8th periods to balance correlations of respectively r = 0.40 and 0.65 with time to wait before performing selection. An improvement of FCRg by 1.7 and 2.4% was projected for females and males, respectively, for the 2nd period, and by 3.9 and 3.1% for females and males, respectively, for the 8th period (Fig. 1).

Discussion and conclusions

These results suggest that estimating the FCR of juvenile tilapia over two-week periods could be relevant to perform a selective breeding program for FCRg at lower costs in both female and male tilapia. Genetic gains projected here were higher than the 1% per generation estimated in Rodde et al. (2020), this being explained by both stronger correlations between lnFCR and lnFCRg and higher variability of FCRg (the CV of FCRg was only 10.8% in Rodde et al., 2020). The impact of individual rearing on fish performance remains, however, debatable. Moreover, the heritability of 0.32 used here and published by de Verdal et al. (2018) was estimated over only one week at juvenile stage with fish reared in small groups, which differs greatly from experimental conditions presented here.

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