

Comparing the effects of grain- versus fish meal-based diets on water quality and waste production within low exchange water reuse aquaculture systems culturing rainbow trout, *Oncorhynchus mykiss*

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The effects of grain-based versus fish meal-based feed on water quality criteria and rainbow trout performance were evaluated and compared within water recirculating aquaculture systems (RAS) operated at low exchange (0.26% of the total recycle flow). Six identical 9.5 m³ RAS, containing a single 5.3 m³ dual drain culture were used for the study. Each RAS was stocked with approximately 1400 juvenile rainbow trout (213 ± 3 g) to begin. Three RAS were fed a grain-based diet and three RAS were fed a fish meal diet. Fish were fed every other hour around the clock using a 24-h photoperiod. Daily feed amounts were equal amongst RAS for the duration of the experiment. Water quality was evaluated weekly and also when RAS were operated at maximum feed loading.

Mean water quality data is reported in Table 1. Total ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen were generally greater within RAS fed the plant based diet. However, total nitrogen concentration provided a more meaningful comparison. Total nitrogen was greater (but not significantly) within RAS fed the grain based diet, i.e. 74 ± 13 vs. 62 ± 10 mg/L. Additionally, the grain-based feed resulted in significantly greater TSS and BOD. Mean TSS for the grain-based and fish meal diets at maximum feed loading was 15.2 ± 1.0 and 8.0 ± 1.5 mg/L, respectively. Mean BOD at maximum feed loading for the grain-based and fish meal feed was 6.6 ± 1.1 and 4.4 ± 0.8 mg/L, respectively. Despite the differences in TSS and BOD, the water clarity was better for the grain-based feed as reflected by color and UV transmittance values. True color within RAS fed grain-based and fish meal diets was 19 ± 2 and 36 ± 4 Pt-Co units, respectively; and UV transmittance was 77 ± 3 and 69 ± 3%, respectively. Schuster (1994) found that fish meal contributed to the brown or colored water typically observed in RAS, while plant meal did not stain the water. Phosphorous was significantly greater in RAS fed the fish meal diet. Phosphorous concentrations for RAS fed grain-based and fish meal diets was 0.75 ± 0.09 and 2.11 ± 0.31 mg/L, respectively, over the study duration.

Rainbow trout growth was similar between RAS fed the grain-based and fish meal-based diets. Rainbow trout fed the grain-based and fish meal based diets were 726 ± 37 and 704 ± 27 grams, respectively, at the conclusion of the study (Fig. 1). Feed conversion ratios, condition factor, and other growth parameter data will be reported at the conference. Survival was near 100% for all tanks during the study and was equal between treatments.

In conclusion, water quality within low exchange RAS fed a grain-based feed was within safe limits for all tested parameters, thus grain-based feeds appear to be a viable feed option within

these systems. The slight increases in TSS and BOD resulting with the grain-based feed could be eliminated with the use of ozone. Overall, the results indicate significant progress toward a more sustainable grain-based diet as reflected by the water quality and rainbow trout growth rates.

Table 1. Mean tank water quality concentrations for low exchange RAS fed grain-based and fish meal-based diets over the study duration as well as a period of maximum feed loading.

Treatment	Duration of Study		High Feed Loading	
	Grain Based Feed	Fish Meal Feed	Grain Based Feed	Fish Meal Feed
Total Ammonia Nitrogen	0.51 ± 0.04	0.39 ± 0.02	0.79 ± 0.02	0.61 ± 0.05
Nitrite Nitrogen	0.21 ± 0.12	0.10 ± 0.05	0.29 ± 0.17	0.08 ± 0.01
Nitrate Nitrogen	77 ± 13	57 ± 7	100 ± 9	71 ± 15
Total Nitrogen	74 ± 13	62 ± 10	-	-
Alkalinity	203 ± 2	207 ± 1	181 ± 3	195 ± 2
pH	7.71 ± 0.01	7.73 ± 0.02	-	-
CO ₂	9 ± 0	10 ± 0	15 ± 0	16 ± 0
cBOD ₅	4.9 ± 0.8	2.9 ± 0.3	6.6 ± 1.1	4.4 ± 0.8
True Color	19 ± 2	36 ± 4	-	-
UV Transmitt. (%)	77 ± 3	69 ± 3	-	-
Phosphorous	0.75 ± 0.09	2.11 ± 0.31	-	-
TSS	8.9 ± 1.2	6.2 ± 1.1	15.2 ± 1.0	8.0 ± 1.5
Heterotrophic Bacteria	9.5 x 10 ⁴	7.2 x 10 ³	-	-
Temperature (°C)	13.1 ± 0.1	13.1 ± 0.1	13.6 ± 0.1	13.6 ± 0.0
DO	10.4 ± 0.0	10.4 ± 0.0	10.3 ± 0.1	9.9 ± 0.2

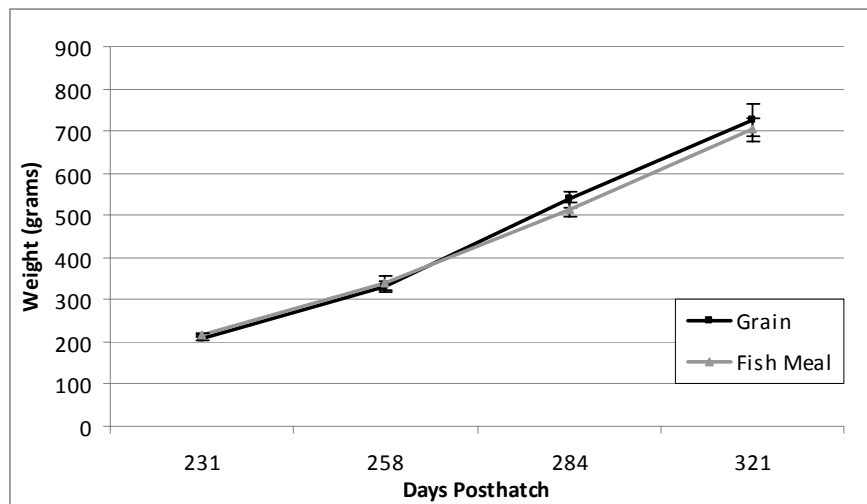


Figure 1. Mean rainbow trout weights within RAS fed grain-based and fish-meal based diets within low exchange RAS.

Schuster, C. 1994. The effect of fish meal content in trout food on water color in a closed recirculating aquaculture system. *Aquaculture International* 2, 266-269.