

Analysis of a Purina Aquamax and a Purina Experimental Diet for Rainbow Trout based on Protein Content

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Abstract

From July 12th 2010 through August 16th 2010 Rainbow Trout fingerlings were grown at Northern Aquaculture Demonstration Facility. Two Purina diets were tested: Purina Aquamax Grower 500 (41% crude protein, 4% crude fiber) and Purina Experimental High Protein feed (56.5% crude protein, 2.5% crude fiber, 4.0% starch). The two feeds were distributed to the trout in separate raceways, each with three 80 ft³ compartments. All compartments were fed twice daily at 1.2% total body weight. Both feeds had high survival rates of greater than 99.5%. After the five week growth study, the growths were compared using percent gain in weight and length, food conversion ratios, and condition factors in order to determine whether the higher protein content affected the growth of Rainbow Trout fingerlings.

Introduction

Since the 1930's and 40's, biologists have relied on Surber's idea of the daily meal, Bajhov's method for estimating the daily meal of a fish population, and Ricker's definition of the daily ration to create a comprehensive fish feed that includes the maximum amounts of nutrients and minimum amounts of excess ingredients (Windell 1978). In the 1970's, great headway was made in understanding the diets of various fish, especially rainbow trout (*Oncorhynchus mykiss*). Numerous feed studies have been conducted evaluating different amounts of ingredients primarily crude protein, fiber, carbohydrates, and lipids. It has become clear from these studies that "in the area of fish nutrition an understanding of protein utilization is of special significance" (Cho and Kaushik. 1990).

This five week study at the UWSP-Northern Aquaculture Demonstration Facility in conjunction with Purina Feeds focused on two feeds: Purina Aquamax Grower 500 with a crude protein level of 41%, and the experimental Purina feed with crude protein 56.5%. While Purina Aquamax Grower 500 has been used in commercial settings for years with much success, the experimental feed was created to see if the protein levels of the feed would increase the rainbow trout's ability to grow, thereby decreasing production time at aquaculture facilities.

Methods

The five week study took place at the UWSP-Northern Aquaculture Demonstration Facility (NADF) in Bayfield, Wisconsin, USA. The 240 female rainbow trout fingerlings were obtained from Star Prairie Trout Farm one week prior to the beginning of the study. On day one of the study, the fingerlings were separated into six compartments of 2.26 m³ (1.2m x

0.68m x 2.8m) in two separate 18.3 m x 1.2m x 1.0m, concrete, covered, outdoor raceways. Each compartment was separated by a wire mesh grate (0.33cm). All 6 compartments had 40 fingerlings and each had an average total body weight of 3007g (\pm 3.5%) at the commencement of the study. Density of the compartments was calculated using the Density Index, $D = \frac{W}{(V \times L)}$ where V is volume of raceway (ft³), W is permissible weight of fish, D is density index, and L is fish length (in) (Piper et al. 1982). Using the equation, the density of the compartments was determined to be 0.014, much below the 0.5 recommended maximum density for rainbow trout.

Both raceways were fed by flow-through 48° F groundwater pumped from wells through degassing and aeration columns into the main head tank, then by HDPVC pipes into the south end of the raceways at 10 gallons per minute (37.9 L/min). This flow rate was determined using the Flow Index, $F = \frac{W}{(L \times I)}$ where F is flow index, W is known permissible weight of fish, L is length of fish (in), and I is water inflow (gallons/minute) (Piper et al. 1982). Water out-flowed through a 15 cm diameter PVC standpipe at the north end of the raceways.

As stated in Fish Hatchery Management, “there is a relationship between the amount of feed that can be metabolized in a given rearing situation and the pounds of fish that can be carried in that rearing unit” (Piper et al. 1982). Since the density index was low, and the flow index was more than adequate, the carrying capacity of the raceways was not a variable in affecting the growth of the rainbow trout fingerlings.



Water quality in the form of temperature, dissolved oxygen, and pH were tested weekly in the center of each compartment and in the center of the water column using a handheld YSI meter (Model 550A) and a handheld pH meter (pH Testr 10 Double Junction). In addition to testing water quality of the compartments, the temperature, dissolved oxygen, and pH were also tested near the input valve and drainage standpipe.

Fish in each raceway were fed a separate feed. Fish in Raceway 1 (R1) were fed the control Purina Aquamax Grower 500 and fish in Raceway 2 (R2) were fed the experimental Purina feed. Fish in all compartments were fed at 1.2% of their total body weight daily. The daily rations were split between two feedings, one at 9 a.m. and the second at 2 p.m. The fish were not fed on the day they were measured. A synopsis of the two types of feed is included in Table 1.

Once a week the trout were collected with a 0.33 cm mesh screen crowding grate, transported to 5 gallon (18.9 L) buckets with two grams MS-222 (fish anesthetic), and measured for length and wet weight. All 40 fish from each compartment were measured (sample counted) every week for 6 weeks. After sample counts, the total body weight for each compartment was recalculated and the resulting feed amounts adjusted.



At the end of the study, the food conversion ratios (FCR), and percent gains for both length and weight were calculated as follows:

$$FCR = \frac{\text{weight of feed}}{\text{wet weight gain} + \text{weight of mortalities}}$$

$$\% \text{ gain} = \frac{\text{final} - \text{initial}}{\text{initial}} \times 100$$

At both the beginning and end of the study the condition factor (K) was calculated using, $K = \frac{W \cdot 10^3}{L^3}$, W is weight (g), and L is the length (mm) (Carlander 1950). At end of study a weekly t-test was conducted on both length and weight.

Results

Over the course of the five-week study, water temperatures averaged 9.5°C, dissolved oxygen was above 9.91 mg/l, and pH ranged 7.60 to 8.70.

During the study there was only one mortality, this occurred due to the fish jumping out of the raceway. With survival rates of 99.6% it is apparent that both feeds gave the fish adequate nutrition for survival.

Percent gains of weight and length are illustrated in Graphs 1 and 2, respectively. Growth figures, food conversion ratios, and condition factors are recorded on Table 2.

According to the t-test only weight was proven to be statistically significant. The percent change (graph 1) between weeks 2 to 3 and 3 to 4 were statistically different (p-value \leq 0.05). All lengths (weeks 1 through 6) and weights from weeks 1 to 2, 4 to 5, and 5 to 6 were not found to be statistically different (p-values $>$ 0.05).

Discussion

With all other components being equal between the two raceways, the only experimental component that was different between the two treatments was the content of the two feeds. Companies that produce commercial fish feeds are constantly searching for something that will enhance the growth of the fish at a more rapid rate. "Both the quantity and quality of the diet influence the metabolic partition of the components" (Cho & Kaushik, 1990)

but as very few companies release the ingredient lists of their experimental feeds, the quantities of protein, lipid, fats, and carbohydrates are difficult to assess.

Protein is of crucial importance to carnivorous fish such as rainbow trout so it has rightly been the ingredient of interest. Past studies (Lawson 1996, Okumus and Mazlum 2002, and Heinen et al. and Hankins 1993) have shown no growth differences in rainbow trout fed diets with protein contents of 38% to 65.5%. This was also seen in this study where rainbow trout were fed two diets with protein contents of 41% and 56.5%.

These results indicate that the limit to which rainbow trout can metabolize protein to increase growth may have already been reached, and that any future increases in protein in commercial feeds may not affect the growth rates. According to Cho and Kaushik, “the most efficient combination being a diet containing 36% digestible protein and 16% lipid” (Cho & Kaushik, 1990). Also, Watanabe et al. (1979) showed in studies that the sparing effect of lipids on dietary protein in rainbow trout was seen when optimum protein retention occurred where the protein to lipid ratio was 35% to 15-20%.

In this study, the Purina Aquamax and Purina experimental feeds showed that the greater amounts of protein in the experimental feed did not elicit the desired enhanced growth differences in rainbow trout. This same feed may be more effective for other fish species or in rainbow trout grown over a longer time period.

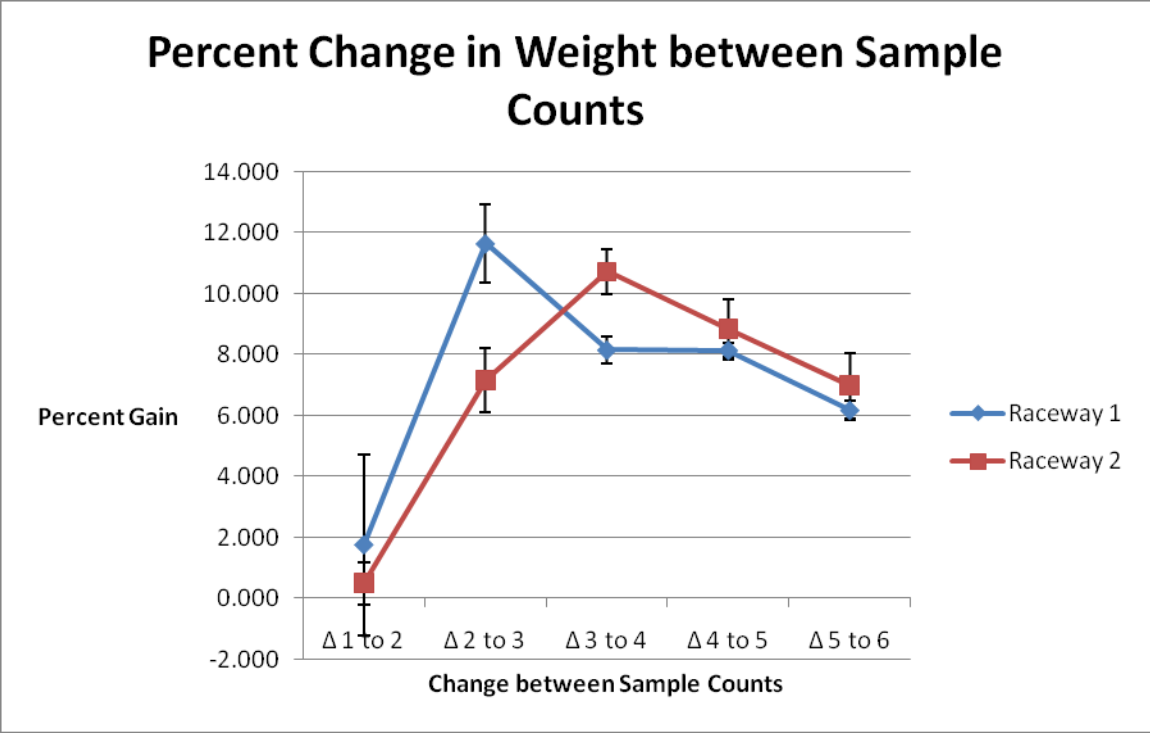
Table 1: Percent protein, fat, fiber, size and type for control and experimental feed (courtesy of Purina)

	Purina Aquamax Grower 500	Purina High Protein Experimental
Size	4.0 mm	3.2 mm
Type	Extruded Slow Sink	Extruded Slow Sink
Crude Protein	41.0%	56.5%
Crude Fat	12.0%	12.0%
Crude Fiber	4.0%	2.5%

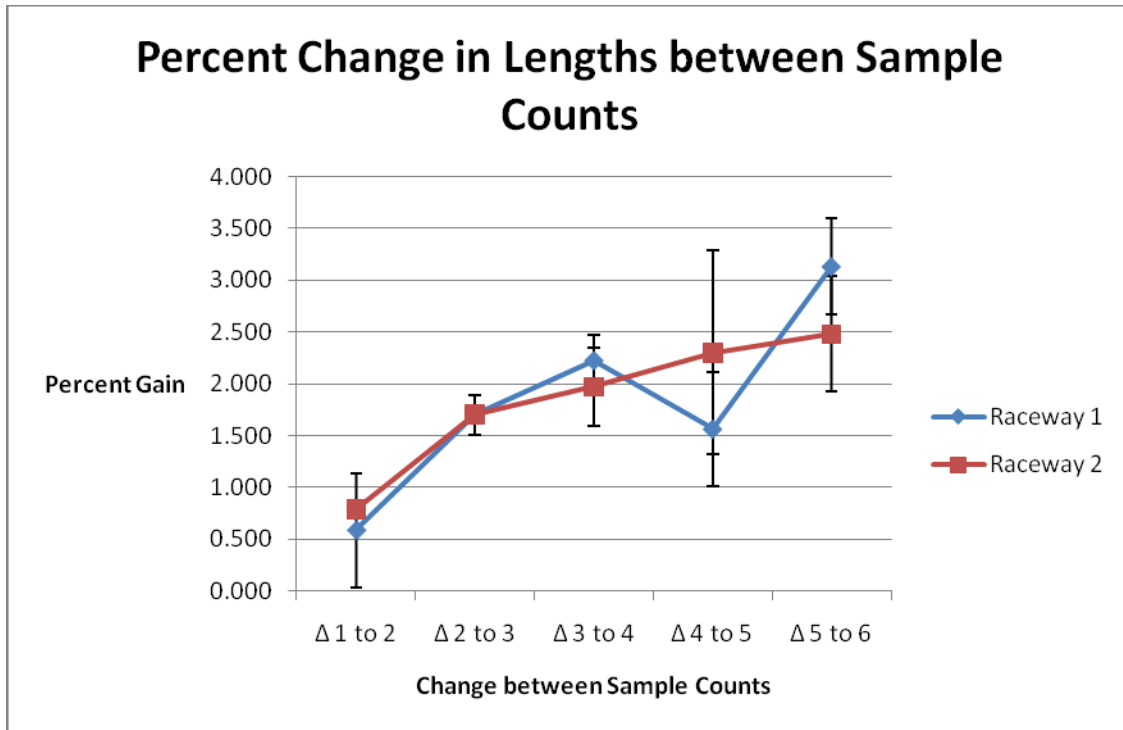
Table 2: Growth variables percent total wet weight and length gain, food conversion ratios, and condition factors for start and end of study for control and experimental feed.

Variable	R1: Purina Aquamax Control	R2: Purina Experimental
Percent total wet weight gain	40.88%	38.74%
Percent total length gain	9.53%	9.57%
FCR	1.03	1.04
Condition Factor: start of study	1.15	1.15
Condition Factor: end of study	1.23	1.22

Graph 1:



Graph 2:



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