Suitability of Three Commercial Feeds for *Clarias fuscus* Growout in Hawaii

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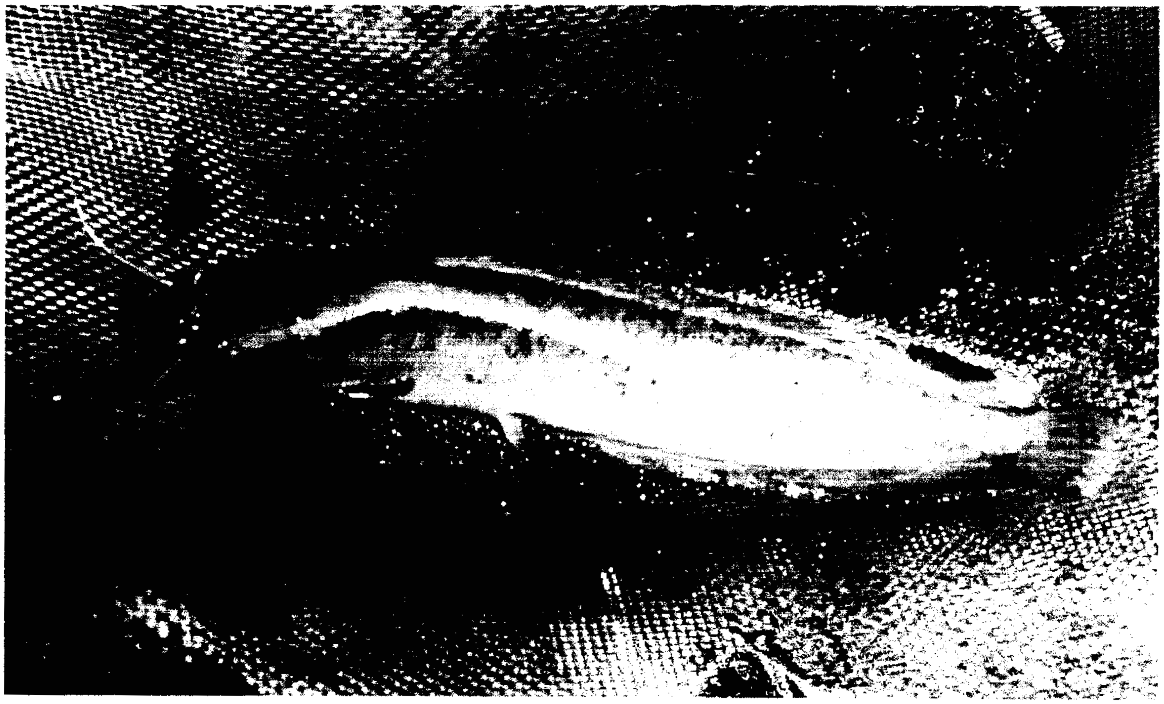

Introduction

Chinese catfish, *Clarias fuscus, are* native to Eastern Asia in southern China, Taiwan, and the island of Ishigakijima, Japan (Masuda et al., 1984). They are freshwater fish and are found in inland waters such as streams and lakes (Man and Hodgkiss, 1981). These fish can grow up to 24.5 centimeters in standard length. They are yellowish brown or dark gray with a light ventral area. They have scaleless bodies and are found to be slimy (Zheng and Pan, 1990). They are sometimes confused with the channel catfish, but can be differentiated by their rounded tails and long dorsal and anal fins (Yamamoto and Tagawa, 2000). In their natural environment, Chinese catfish are nocturnal feeders that feed on nekton, fish, benthic crustaceans, and insects. They prefer temperatures of 20°C to 25°C and a pH between 6.0 and 7.5 (Man and Hodgkiss, 1981).

Prior to 1900, Chinese immigrants introduced the Chinese catfish to Hawaii from Asia as a source of food (Maciolek, 1984 and Devick, 1991). In the early 1980s, these fish had begun to be produced commercially. Spawning, rearing, maturation, and marketing methods for Chinese catfish under Hawaii's conditions were developed by Hawaii Fish Company. Hatchery and production techniques were further developed by the Hawaii Institute of Marine Biology and supported by the United States Department of Agriculture, United State Agency for International Development, University of Hawaii Sea Grant, and Hawaii Aquaculture Development Program (Szyper et al., 2001 and Fast, 1998). Chinese catfish was an alternative fish to those caught in Hawaiian waters and the industry for them grew tremendously, with the value of the crop in 1984 jumping from $15,000 to $372,600 only ten years later (Anonymous, 1996).

In Hawaii, Chinese catfish is often fed feed formulated for channel catfish. Since channel catfish feed is made for herbivores and Chinese catfish are carnivores, the feed formulation is thought to be inadequate for optimum growth. In realization of this nutritional inadequacy, farmers have tried several other feeds with improved success but coupled with higher feed cost. Currently there is not one feed recommended for Hawaii catfish producers and this has added to the costs by feed suppliers being asked to order small quantities of various feeds. It has been suggested that if a superior feed could be identified then there could be a price reduction for Hawaii Chinese catfish producers ordering a large quantity of the same feed. In this study, three feeds will be tested: Rangen, Silver Cup Trout, and Silver Cup Flounder. The most suitable feed for *Clarias fuscus* growout in Hawaii will be determined by finding the feed that allows the fastest growth and has the lowest feed conversion ratio. In determining the most suitable feed, the price per bag of the feed will then become comparable to the channel catfish feed as feed suppliers order large quantities.

Methods and Materials

The project was conducted at the Windward Community College Aquaculture Complex and was supervised by Kathleen McGovern-Hopkins. For the experiment, nine 150-liter tanks were used. The tanks were filled up halfway and screens covered them to prevent the fish from jumping out and to protect them from predatory birds. Water was constantly dripping into the tanks while water drained out through the standpipe. This type of system is called flow-through. Air-line tubing was wrapped around each standpipe with an air stone tied to the base of the standpipe. The air bubbles that surrounded the standpipe helped prevent food from escaping the tank.

Three different feeds, varying in percentage of fat and protein, were used: Rangen: Extruded 350 W/XX Mold Inhibitor, Silver Cup Trout: Extruded Floating, and Silver Cup Flounder: Extruded Floating (Table 1).

Table 1. Size and percentage of fat and protein of each feed.

Feed	Rangen: Extruded 350 W/XX Mold Inhibitor	Silver Cup Trout: Extruded Floating	Silver Cup Flounder: Extruded Floating
Pellet size (mm)	3.2	3.5	3.5
Percent fat	5%	10%	10%
Percent protein	35%	40%	52%

For each treatment, there were three replicates. Tanks 10, 11, and 12 were fed with Rangen. Tanks 19, 20, and 21 were fed with Silver Cup Trout. Tanks 22, 23, and 24 were fed with Silver Cup Flounder.

In each tank, 20 juvenile Chinese catfish were stocked. The catfish were individually weighed to obtain the initial biomass of each tank and the total body length was recorded. Three percent of the biomass determined the starting amount of food given per day. For each tank, a 500-milliliter plastic bottle was used to store the feed. Each treatment was assigned a unique color. The 500-milliliter bottles, tanks, and feedbags were labeled with the assigned colored tape to prevent possible errors. All of the bottles started off with 230 grams of feed. When a tank consumed the feed in the bottle, an additional 230 grams of feed was added and recorded. Rangen was labeled with white, Silver Cup trout with blue, and Silver Cup Flounder with red. The fish were fed twice a day. The amount of feed at each feeding was measured in a 50-ml beaker. Feed amounts were increased and adjusted to provide maximum consumption. The amount of feed was increased in the afternoon if all the feed was eaten from the morning feeding. Excess feed was left in the tank overnight since they feed mainly at night. If excess feed was still present in the morning, it was removed.

Temperature and pH were measured daily using a pH meter. The dissolved oxygen and ammonia levels were recorded once a week. A dissolved oxygen meter was used to measure the amount of dissolved oxygen and a nitrogen ammonia kit was used to determine the level of ammonia. The Chinese catfish were weighed and measured every three weeks. From each tank, ten fish were randomly selected. The fish were measured from head to tail (total length) in centimeters and weighed in grams using a ruler and an electronic scale.

Results

Data was collected from January 24, 2003 to May 2, 2003. The Chinese catfish were measured every three weeks. The weights of the three replicates within each treatment were averaged giving the average weight. The average weights calculated within the nine-week period can be seen in Table 2 and Figure 1. An increase in average weight can be seen in each treatment.

The fish were fed twice a day. The amounts fed were recorded in milliliters. The total amount of feed was calculated and then multiplied by the density giving the total weight of feed in grams (Table 3). The feed conversion ratio (FCR) of each tank was calculated by dividing the total weight of feed by the net production (final weight minus the starting weight) (Table 3 and Figure 2). Figure 3 shows the food conversion ratios of each replicate within each treatment. The average food conversion ratio was calculated for each treatment. Rangen had a FCR of 1.7, Silver Cup Trout had a FCR of 1.2, and Silver Cup Flounder had a FCR of 1.3 (Figure 4).

Table 2. Average weight calculated every three weeks for each treatment.

week	Rangen	[redacted]	
0	24.5g	21.8g	21.2g
3	35.2g	32.9g	31.0g
6	51.0g	51.5g	51.0g
9	60.3g	70.0g	61.5g

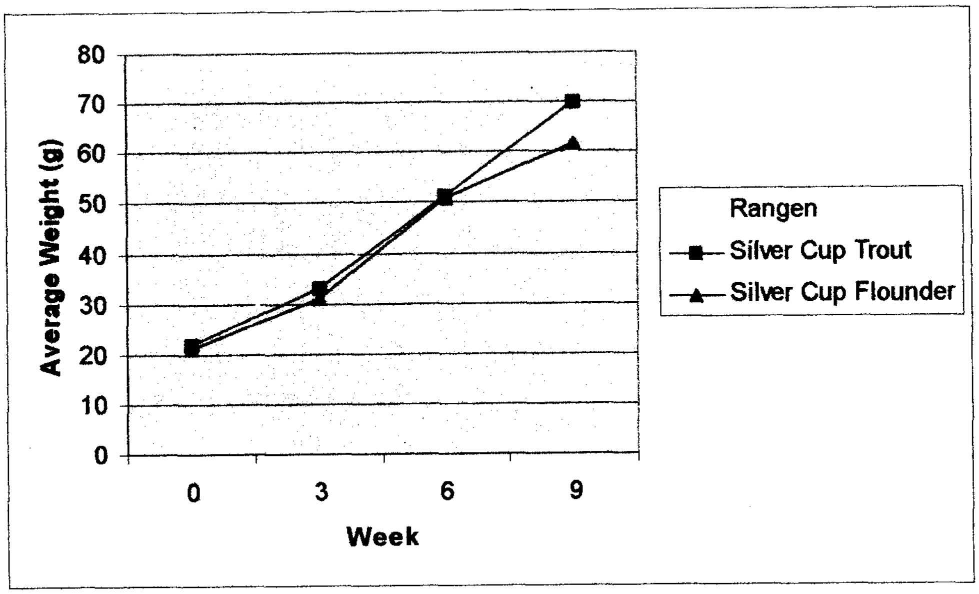

Figure 1. Average weight calculated every three weeks for each treatment.

Table 3. Results of Experiment.

Treatment	Rangen			[redacted]					
tank	10	11	12						
total feed (mL)	2631	2235	2631	2145	2436	1755	2009	2202	2440
density of feed (g/ml)	0.46	0.46	0.46	0.54	0.54	0.54	0.47	0.47	0.47
total weight of feed (g)	1200	1019	1200	1154	1311	944	938	1028	1139
final biomass (g)	1256	970.6	1393	1760	1382	1060	1197	1174	1322
initial biomass (g)	549	452	552	522	448	384	404	417	453
net production (g)	707	519	841	1238	934	676	793	756	869
FCR	1.7	2.0	1.4	0.9	1.4	1.4	1.2	1.4	1.3

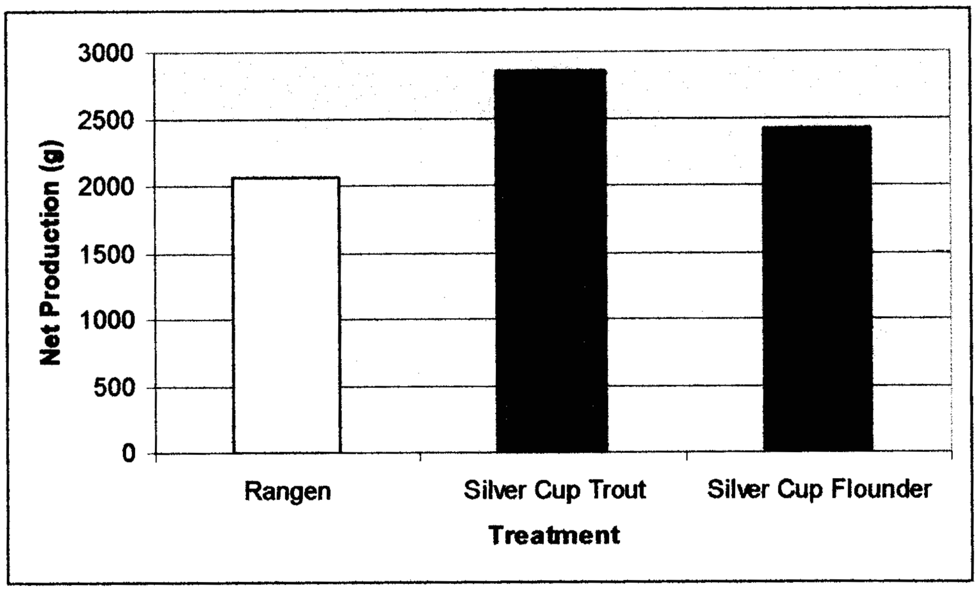

Figure 2. Net production of each treatment.

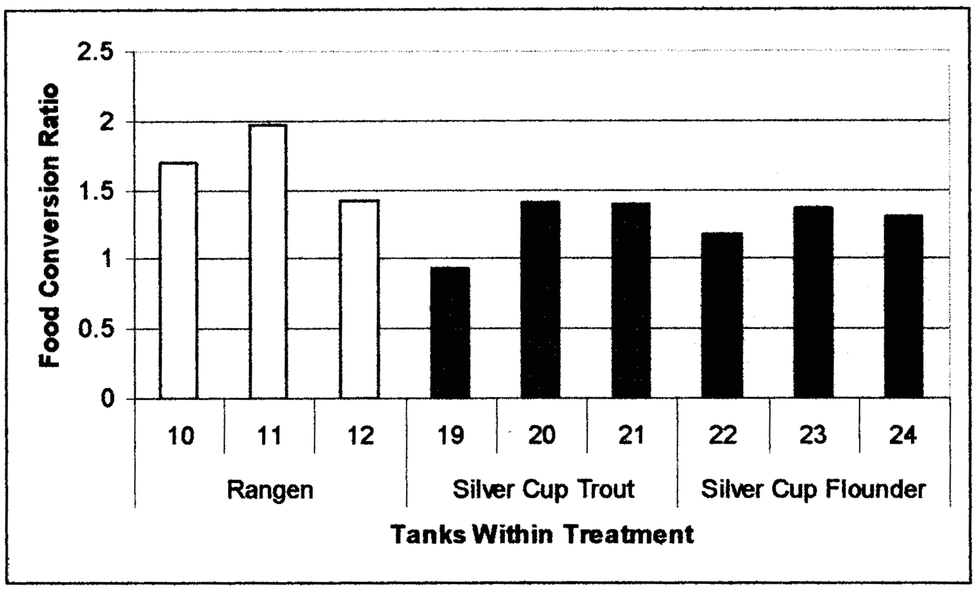

Figure 3. Food conversion ratios of replicates within each treatment.

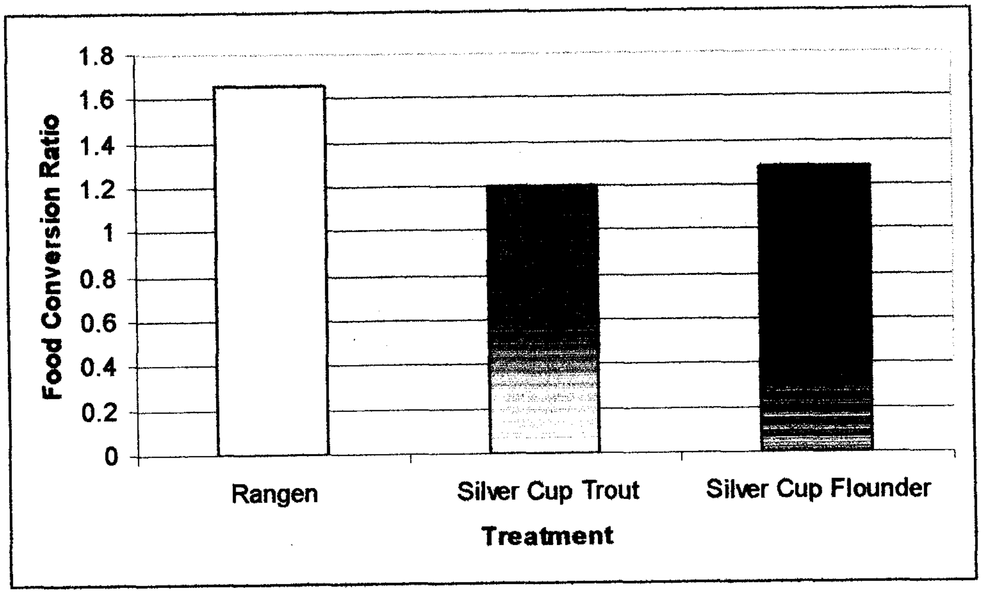

Figure 4. Average food conversion ratio of each treatment.

The pH and temperature were measured daily. The average pH and temperature of each treatment was calculated along with the standard deviation (Figures 5 and 6). The standard deviation is a measure of how widely values are dispersed from the average values (mean).

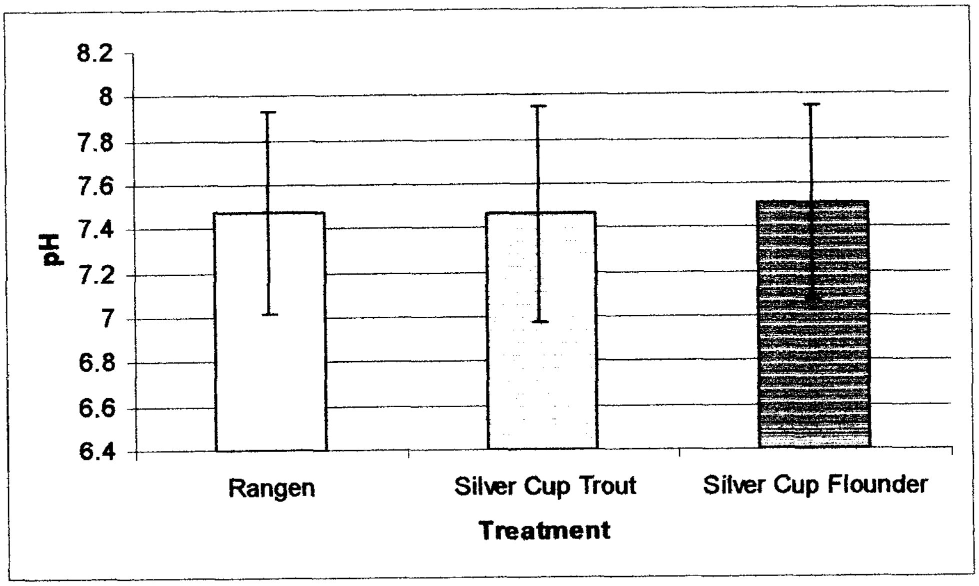

Figure 5. Average pH measured daily from each of the tanks with the standard deviation.

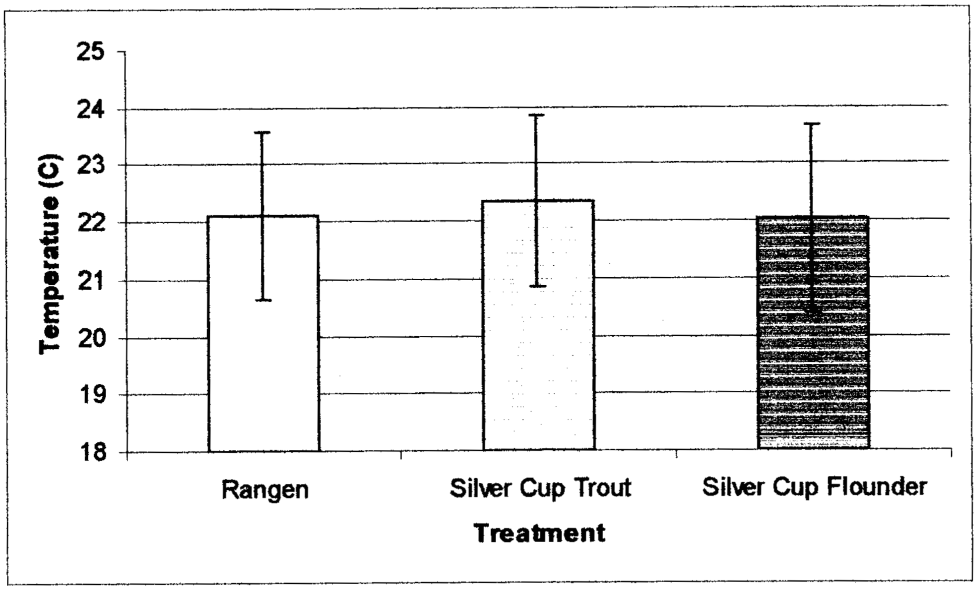

Figure 6. Average temperature measured daily from each tank with the standard deviation.

The dissolved oxygen (DO) and nitrogen ammonia levels were recorded weekly. The average DO and nitrogen ammonia level of each treatment was calculated along with the standard deviation (Figures 7 and 8).

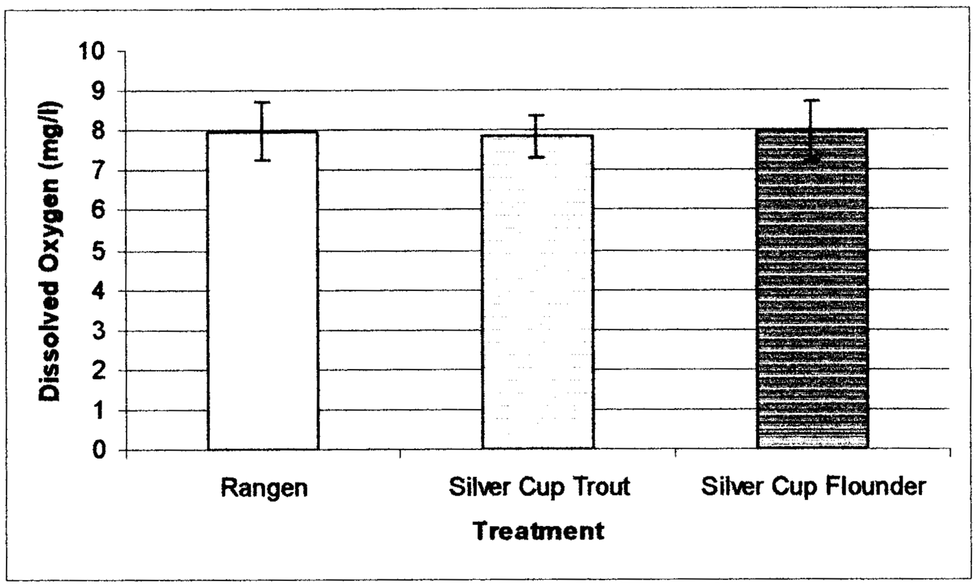

Figure 7. Average dissolved oxygen measured weekly from each tank with the standard deviation.

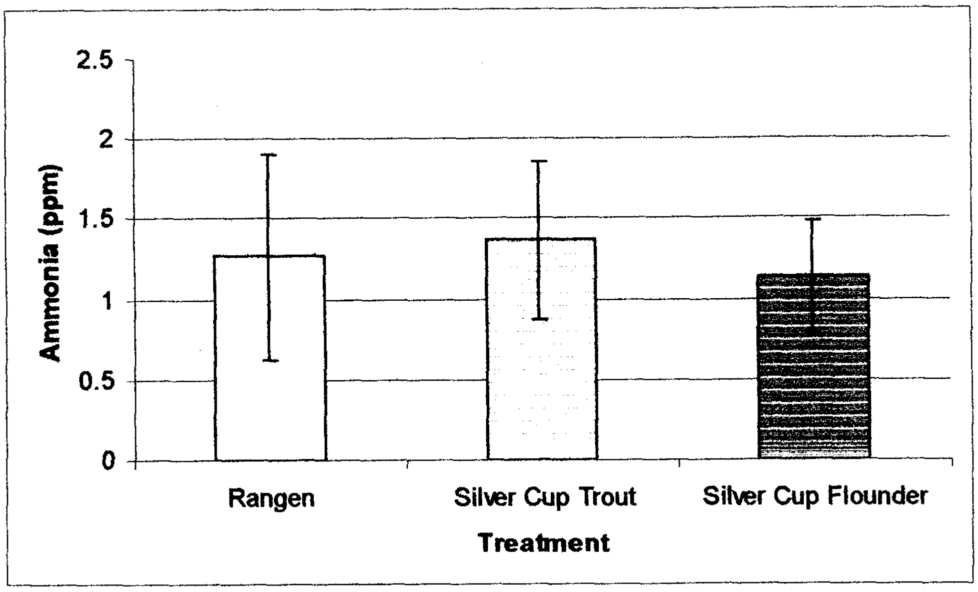

Figure 8. Average nitrogen ammonia measured weekly from each tank with the standard deviation.

Discussion

Three feeds were compared in this experiment: Rangen, Silver Cup Trout, and Silver Cup Flounder. The average weights of the treatments were similar up to the sixth week, indicating that the fish within all three treatments were growing at similar rates (Figure 1). At Week 9, Silver Cup Flounder had an average weight of 61.5g and Rangen with an average weight of 60.3g (Table 2). Silver Cup Flounder and Rangen had similar average weights but Silver Cup Trout had an average weight of 70.0g, which is somewhat higher (Table 2 and Figure 1). A higher average weight could indicate that the feed was allowing the fish to grow at a faster rate.

When comparing net productions, Silver cup Trout had the highest (2848g), Silver Cup Flounder had the intermediate (2418g), and Rangen had the lowest (2067g) (Figure 2). This indicated that the fish fed with Silver Cup Trout grew the most.

The food conversion ratio (FCR) is the ratio of dry weight of feed to the wet weight gain of fish. The lower the ratio, the more efficiently food has been converted to fish flesh. Replicates of Rangen had the highest FCR (Table 3 and Figure 3), which indicates that the fish within the treatment had the least nutrient uptake. Replicates of Silver Cup Trout and Silver Cup Flounder had lower feed conversion ratios (Table 3 and Figure3), suggesting that the feed was converted more efficiently. Silver Cup Trout had the lowest average FCR of 1.20 (Figure 4), which indicates that it had the best growth rate and the highest nutrient uptake. Silver Cup Flounder had the second to the lowest FCR of 1.28 (Figure 4). Rangen had the highest FCR of 1.65 (Figure 4). This suggests that Rangen provided the least amount of required nutrients, and was not converted efficiently to fish flesh.

For some fish, the higher protein feeds result in faster growth rates. Rangen contains 35% protein. Silver Cup Trout contains 40% protein. Silver Cup Flounder contains 52% protein (Table 1). Silver Cup Trout seemed to provide for the fastest growth, but does not have the highest protein content. The nutritional requirements for Chinese catfish are not well known. Perhaps the increased growth rate was due to the higher percentage of fat rather than protein level. Rangen contains 5% fat, Silver Cup Trout has 10%, and Silver Cup Flounder has 10% (Table 1).

Flow-through systems have both input and output, allowing water qualities to remain stable. The average pH, temperature, and ammonia were similar in each treatment (Figure 5, 6, and 8). This was expected because the systems were flow-through. Dissolved oxygen levels were similar in each tank (Figure 7). This was expected because each of the tanks had air pumped into them.

The results of this experiment may contribute to the continued development of Chinese catfish management, which in turn will strengthen the industry. It is important for farmers to obtain the optimum performing feed for the most economical price. The cost of the feed is the largest production expense, so it is essential to find a feed that can be converted efficiently. Using the available data, Silver Cup Trout was found to be the feed that allowed the fastest growth and had the lowest feed conversion ratio. The data has not yet been statistically analyzed. It will be statistically analyzed to compare differences between tanks and compare this to differences between treatments. The experiment is ongoing and will be carried out until the June 13, 2003. In determining the most suitable feed, the price per bag of the feed will then be reduced as farmers order large quantities.

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