Effect of Using Cobia Waste as Silage on the Weight and Length of Nile Tilapia in a Recirculating Aquaponics System

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Introduction

Using fish waste as silage to feed Nile tilapia in CEI's aquaponics system is a study of scientific interest because it's important for aquaponics systems to move towards more sustainable methods. There is a global movement towards aquaponics systems; as capture fishing industries, which result in over-fishing and by-catch, are environmentally unfriendly, and fish remains to be a major source of food around the world. Currently, 25% of the fish consumed by humans is provided by aquaponics and aquaculture systems. If the need for shipping commercial fish feed to Eleuthera is reduced, CEI will be significantly decreasing both transportation cost and pollution. The cost of the feed will also be reduced, and the ingredients given to the tilapia will be known, reducing CEI's support of large-scale companies that use unknown ingredients in their feed. In addition, using wild-caught fish for food for farmed fish adds to the depletion of wild fish stocks. Using the fish waste as feed also decreases the waste output for cobia production within CEI's aquaponics system, reducing the byproduct that comes from aquaculture systems.

Using cobia carcasses and chicken grain to make silage provides the tilapia with the protein and nutrients they need for survival. We predict that feeding nile tilapia (*Oreochromis niloticus*) cobia silage will promote more of an increase in weight and length than fish fed 35% protein commercial feed formulations. If the tilapia are healthy and growing living off the homemade silage, the efficiency of the system will have increased. In the past, teams at CEI have tested feeding tilapia with sea oats, natural grasses, cockroaches, maggots and duckweed as fish feed, but none of these food sources have been implemented as a regular feed. If silage does supply fish with the nutrients they need, aquaponics systems will be one step closer to being sustainable. Cobia silage is a good solution because it involves simple technology that doesn't involve import. To test whether or not silage is a suitable substitute for the commercial feed, the growth rates of fish being fed silage must be compared to fish being fed the commercial feed. Tilapia have a high tolerance to poor water quality and are known to eat a number of natural food organisms, making them a good fish to do testing on (Popma and Masser 1999). They also are ideal fish to have in CEI's aquaponics systems because they thrive in this climate. A protein level of 32 to 36 percent is recommended for fingerling tilapia, and the homemade silage offers that to the tilapia (Riche and Garling 2003). If the study proves successful, CEI's aquaponics system will be much more efficient, economically and environmentally, and will provide a use for waste from cobia farming.

Image 1: Tank set up

Image 2: Puréeing onion as a preservative for silage

Image 3. Commercial feed

Image 4. Silage feed

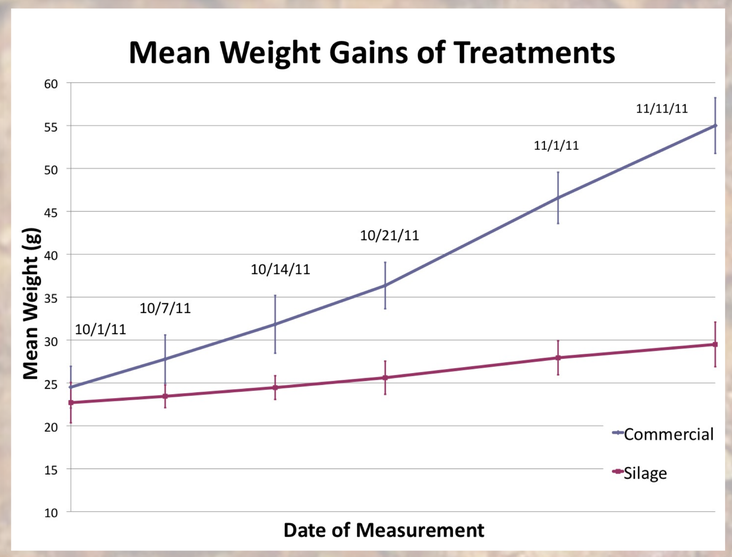

Figure 1. Mean accumulative change in weight (grams) over a six-week period for Nile tilapia fed commercial fish feed or cobia silage. October 1st, 2011 to November 11th, 2011. Cape Eleuthera Institute, Eleuthera, Bahamas.

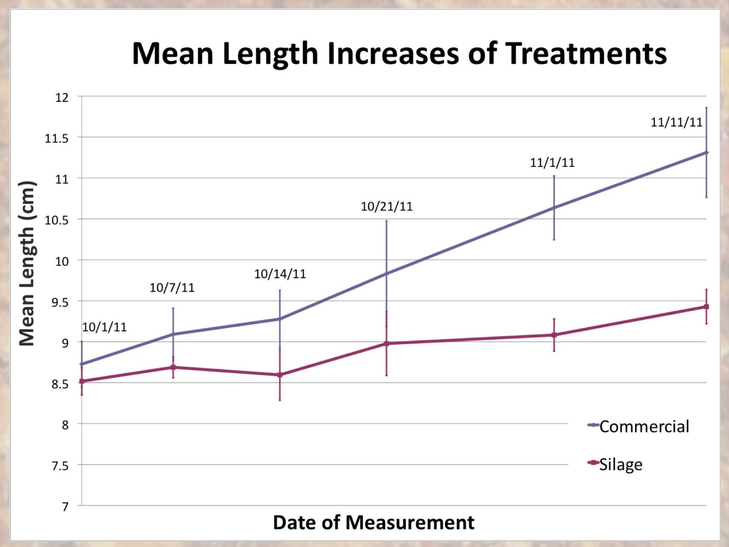

Figure 2. Mean accumulative change in length (cm) over a six-week period for Nile tilapia fed commercial fish feed or cobia silage. October 1st, 2011 to November 11th, 2011. Cape Eleuthera Institute, Eleuthera, Bahamas.

Methods

One hundred and forty tilapia with a mean weight of 23.5 grams were evenly distributed into fourteen identical tanks. Every tank had air systems and a regulated water flow coming from the main aquaponics system (Image 1). The volume of a tank was 60 liters. Lids were placed on each tank to prevent tilapia from jumping out.

The feed was divided equally among the tanks so that ten fish in seven of the tanks receive commercial feed (Image 3), and ten fish in seven tanks receive the fish silage (Image 4) that is made in the lab (Image 2 & 5). The positions of the tanks that received the two different feeds were randomized to minimize outside factors that may affect the results.

The fish were weighed and measured every seven days for six weeks with an electronic scale (Super-SS Model 3S-6) and centimeter ruler (Image 6). The weights and lengths of the one hundred and forty fish were recorded and the data was used to determine the average weight and length of the fish in each tank, the total biomass of each tank and the standard deviation in each tank.

The maintenance of the experiment included testing ammonia levels, pH levels, dissolved oxygen levels, and the consistency of the water and air flow (Popma et al. 1999; Riche & Garling 2003). The ammonia was tested with an AM API (Aquarium Pharmaceuticals) Ammonia NH3/NH4 + Test Kit. The pH levels were tested using an YSI pH 10. The dissolved oxygen (DO) levels were monitored with an YSI 55 dissolved oxygen meter. The ammonia, pH, and DO levels were tested once a week, and the water and air flow was monitored three days a week. The fish were fed four percent the average biomass daily: two percent in the morning and two percent in the evening.

Image 5. Silage-making process

Image 6. Measuring length of tilapia

Results

The tilapia that consumed cobia silage did not grow as fast as the tilapia that consumed commercial fish feed. During the six week experiment the fish being fed commercial feed experienced a weight increase of 90.0%, and the silage fed fish experienced had an increase of 23.0%. The commercial feed promoted a length increase of 22.0% and the cobia silage a 7.0% increase. The feed conversion ratio for commercial feed was 1.60, and 5.37 for the cobia silage. Additionally, the overall weight gain of the silage fed fish was less than the commercial treatment group, as expressed in Figure 1. Fish fed commercial feed exhibited rapid growth in terms of length increases, as evident in Figure 2. Fish fed commercial feed grew on average 1.9 centimeters and fish fed cobia silage grew on average 0.6. The differences in length and weight gain were found to be statistically significant through T-test, resulting in a p-value of 0.001.

Discussion

The objective of the study was to find an alternative to commercial feed for the tilapia in the aquaponic system at the Cape Eleuthera Institute and ensure that cobia silage offers tilapia the protein they need for survival. Though the cobia silage did support survival of the fish, it did not prove to be as effective for growing them as the commercial feed, proving our hypothesis false. In tanks fed cobia silage, tilapia spawned in five of the seven tanks, proving they had adequate nutrition needed to reproduce. This reproduction however, could have potentially taken away some of the energy the fish needed to grow to larger sizes. Additionally, the decrease in average length of the fish fed silage on 10/14/11 could be attributed to a new person weighting the fish or data being entered incorrectly.

Some possibilities for future research are changing ratios of grain to silage in the homemade feed, providing fish with the protein they need for growth. Researchers must also find out the protein content and amino acid profile of the cobia silage and compare that to the commercial feed, pinpointing key differences between the two. Future researchers may also wish to observe the effect silage has on the hydroponic section of the aquaponics system, analyzing how the lettuce grows. In the article, "Giant Salvina (Salvinia molesta) as a Partial Feed for Nile Tilapia (Oreochromis niloticus)," fish fed giant salvina had a less rapid growth rate than those fed commercial feed. These results are similar to the results from this experiment (King et al.). In the article "Use of Fish Waste as Silage - A Review," it states that there is no significant difference in performance and protein use between fish silage and fish meal (Ferraz de Arruda 2007). This article contradicts the results, as there was a significant difference in performance between the silage and the commercial feed.

This experiment was completed because studying alternative feeds provides more sustainable options for feeding fish in aquaponics systems. If it is found that using fish silage is a viable option for the aquaponics system and that enough can be produced to feed all the fish, the aquaponics system at the Cape Eleuthera Institute would be one step closer to being self-sufficient and the use of silage in aquaponics systems could then be applied across The Bahamas and through aquaponics systems worldwide.

Citations

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