Testing Local Grasses as a Source of Fish Feed in an Aquaponics System

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Introduction

Figure 1: Lettuce grown in the CEI system.

Aquaponics is the combination of aquaculture and hydroponics. Aquaculture is the raising of fish in a controlled environment and hydroponics is the growing of plants in a medium other than soil. Specifically on Eleuthera, aquaponics works well because there are limited fertile soil, fresh water, space, and energy resources. The aquaponics method is also a potential solution to the growing problem of overfishing (Buchan 2000). The products of the Cape Eleuthera Institute's (CEI) aquaponics system are Nile tilapia (*Oreochromis niloticus*) and varieties of salad greens and herbs. At CEI, there is an effort to localize inputs to the aquaponics system as plans are made to expand it. The two major inputs that are currently imported are growing media for the plants and fish feed, which is made from mainly fishmeal and soybeans. The issue of growing media has been addressed by past research at CEI, and it was found that coconut coir could be found locally and substituted as growing media. Past aquaculture research has shown that Nile tilapia will consume and subsist off of grass species (King et al. 1999). **The purpose of this experiment was to test the viability of local grasses as a fish feed for Nile tilapia in a recirculating aquaponics system.**

Figure 2: CEI Aquaponics spawning tank (left) and a 2,839L rearing tank (right).

Figure 3: Two of the ten 5.5 m^2 hydroponic grow beds in the CEI system.

Methods

Experiment

A controlled study was conducted with a small-scale aquaponics system constructed at CEI. Special equipment included tanks, PVC pipes, tubing, growing beds, a sump, biofilter, and aeration system. The aeration system consisted of air stones, an air blower, and air diffusers.

Variables

The effectiveness of three alternative diets as replacements for the current commercial tilapia feed was tested. Ten tilapia fingerlings, weighing 18.00g ± 2.00g, were placed in twelve 19-liter buckets. Each diet was randomly assigned to three buckets: three control buckets were fed the commercial feed; three were fed Diet #1, three were fed Diet #2, and three were fed Diet #3 (Figures 11-15). The grasses were dried, cut, ground, and sifted into a finely processed feed. The way in which the grasses were combined and assigned to diets was based on the relative abundance of each amino acid found in preliminary tests conducted on the grass samples. After an acclimation period of one week where all the fish were fed the same commercial feed, each bucket was fed its designated diet, at 2% of their body weight per day.

Collection of Data

Each fish was measured for length (mm) and weight (g) once every seven days for the duration of the 35-day study (Figure 4).

Figure 4: Weighing (left) and measuring (right) the Nile tilapia (*Oreochromis niloticus* L.) during the study.

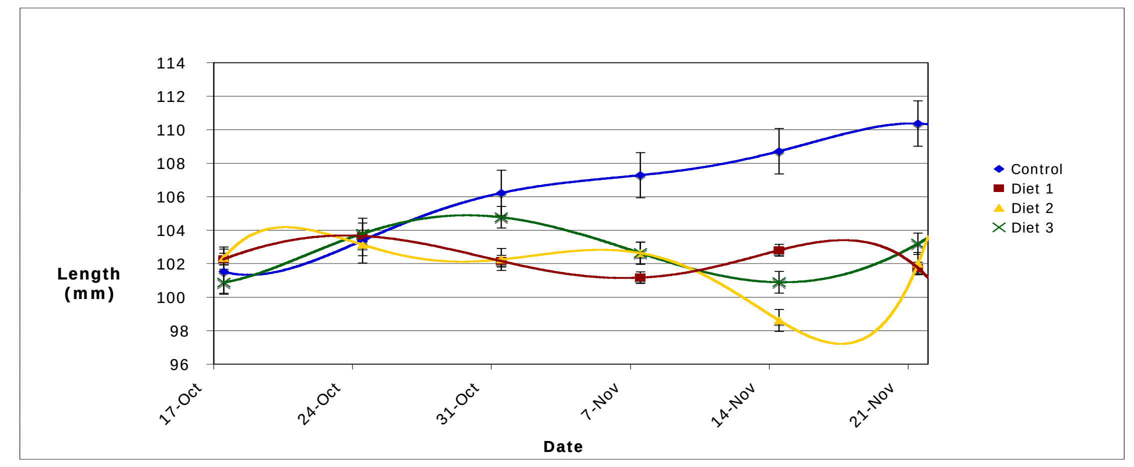

Figure 5: Mean Nile tilapia length (mm) at each sampling date.

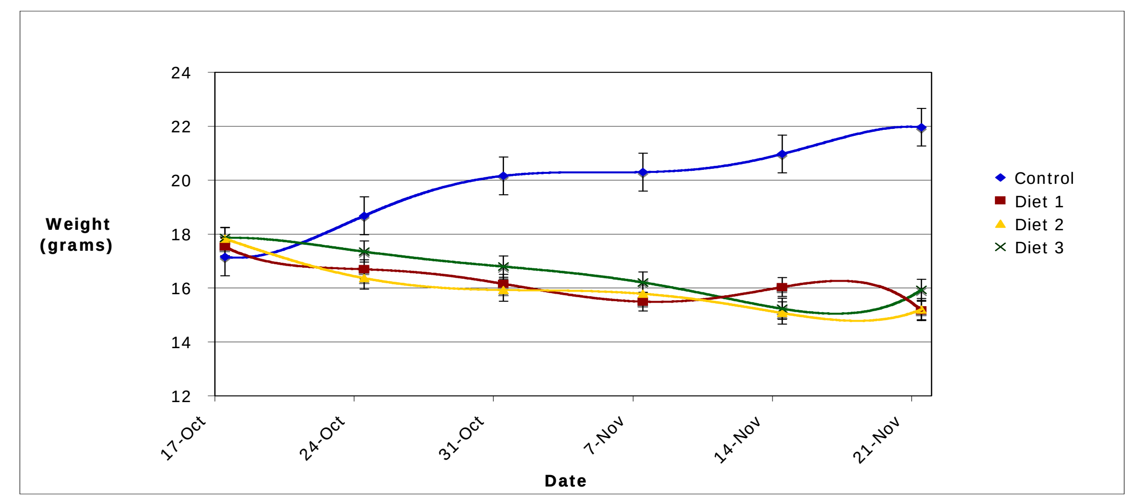

Figure 6: Mean Nile tilapia weight (g) at each sampling date.

	Diet 1	Diet 2	Diet 3
Baseline, 10/17	0.862	0.526	0.492
Sample 1, 10/24	0.001	0.000	0.059
Sample 2, 10/31	0.000	0.000	0.000
Sample 3, 11/7	0.000	0.000	0.000
Sample 4, 11/14	0.000	0.000	0.000
Sample 5, 11/21	0.000	0.000	0.000

Figure 7: The p-values for the difference in weight of fish for each treatment diet compared to the weight of the fish fed the control diet at each sampling date.

	Diet 1	Diet 2	Diet 3
Baseline, 10/17	0.851	0.816	0.897
Sample 1, 10/24	0.995	0.997	0.977
Sample 2, 10/31	0.003	0.006	0.655
Sample 3, 11/7	0.000	0.001	0.001
Sample 4, 11/14	0.011	0.000	0.000
Sample 5, 11/21	0.000	0.000	0.000

Figure 8: The p-values for the difference in length of fish from each treatment diet compared to the length of the fish fed the control diet at each sampling date.

Results

At the end of the 35-day period, there was a positive trend in the growth rates of the control fish while a negative trend in the growth rates of the grass fish was observed. Specifically, the control fish increased in weight by 28.05% and in length by 3.80%. The fish that were fed the sea oats and knot grass combination decreased in weight by 13.57% and in length by 5.42%. The fish that were fed big blue stem decreased in weight by 14.75% and in length by 5.22%. The fish that were fed guinea grass decreased in weight by 10.81% and in length by 2.66% (Figures 5 & 6).

The data were analyzed through SYSTAT using the ANOVA and Tukey's Post-hoc test. A statistically significant difference was found between the growth rates of the fish that were fed the grass diets when compared to the growth rates of the fish that were fed the control diet. A p-value of less than 0.05 indicates a statistically significant difference between two groups of data. By the third week of the experiment p = 0.000 (Figure 7) for all three grass diets when compared to the control for the growth rates in terms of weight. In terms of length, the p-value indicated a significant difference by the fourth week (Figure 8).

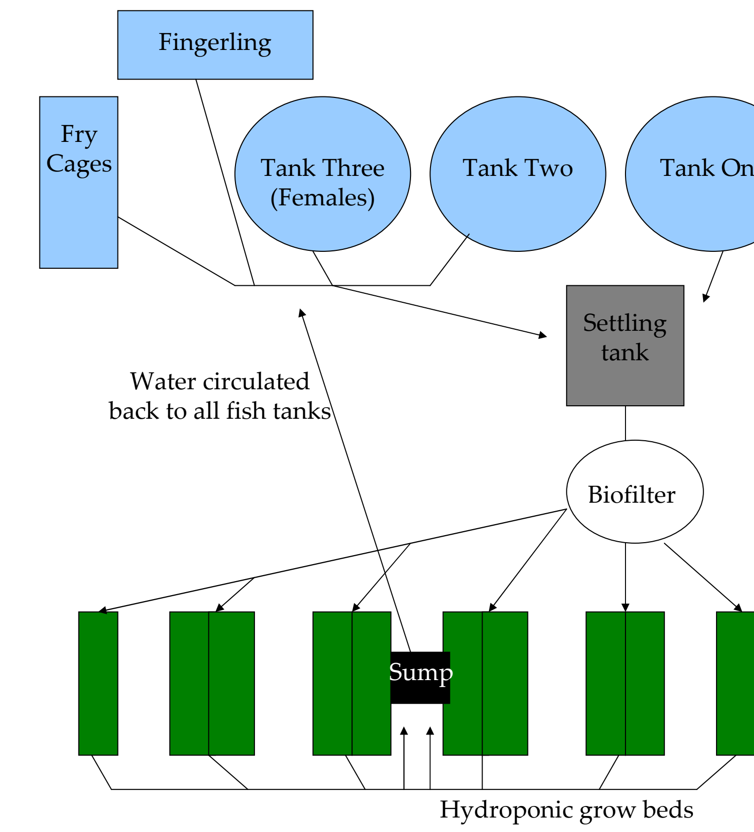

Figure 9: In the CEI recirculating aquaponics system, water is carried through fish rearing tanks, a filtration system, into hydroponic plant grow beds, and then back to the fish tanks. A typical system consists of fish tanks from which fish waste flows into a solids settling tank, followed by a biofilter. Bacteria in the biofilter convert the ammonia from the fish into nitrite, and then into nitrate, which is the usable form of nitrogen for the plants. The water then flows to the grow beds where plants thrive on the nutrients provided by the fish waste and water is filtered for return to the tanks by the sump pump. (Rakocy et al. 2006)

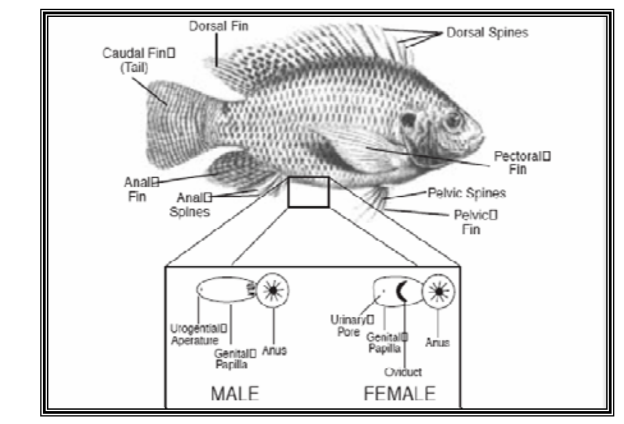

Figure 10: Nile tilapia *(Oreochromis niloticus)* (Popma & Masser 1999)

Discussion

The results indicate that the local grasses, in the form used, are not suitable to replace the commercial feed. The statistical analysis showed no significant difference among the growth rates of the fish that were fed the treatment diets, which means the different grasses affected the fish in the same way. The decrease in weights of the fish is not necessarily due to a lack of nutrients in the grasses; there was uneaten grass present in the bottom of the tanks, so the weight loss may be due to the fish not eating the grasses. A future study could test the grass diets in pellet form, which is the form of the commercial (control) diet. Diet #3 in particular would be the best grass to focus on since it was not until the 3rd and 4th weeks that the fish showed a statistically significant difference in their weights and lengths, respectively. A future study could test the grass diets as a supplement to the commercial feed because we concluded that the grass had some nutritional value since none of the fish mortalities were due to starvation. These studies could be a helpful step to reduce the system's dependence on the imported feed, making the CEI system more sustainable and potentially more economical overall.

Figure 11: Knot Grass *(Paspalum distichum)*
Diet #1

Figure 12: Sea Oats *(Uniola paniculata)*
Diet #1

Figure 13: Big Blue Stem *(Andropogon gerardii)*
Diet #2

Figure 14: Guinea Grass *(Panicum maximum)*
Diet #3

Figure 15: Commercial tilapia feed
Control

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Acknowledgements:
We gratefully acknowledge the key financial and logistical support of the Cape Eleuthera Institute and the Cape Eleuthera Island School. Thank you Colleen O'Brien and Ashley King for your insights on our study and providing us with the resources that we need, John Reid of Bioshelters for assisting with the methodology of our study, New Jersey Feed Labs for assessing the amino acid content of the grasses, Annabelle Oronti for organizing the research program and for helping to improve the study, and Chris Maxey for his encouragement and support of the aquaponics research group.