Meat, plants, or both? A food preference study in Siamese fighting fish, Betta splendens

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Meat, plants, or both?

A food preference study in Siamese fighting fish, Betta splendens

Bouradée Kim and Boutavee Kim, Department of Biology, University of Southern Maine, Portland, Maine; Advisor: Chris Maher, Ph.D.

Abstract
Most animals choose food based on its nutrient content and time and energy involved consuming and digesting the food. We used a discrete food preference test to investigate if Siamese fighting fish (Betta splendens) preferred particular foods based on the food’s nutritional value. Among foods that Siamese fighting fish commonly eat, freeze-dried brine shrimp consist of high amounts of proteins, plus lipids and carbohydrates, and shrimp are easily digestible; pellet food is a mixture of plants and small crustaceans; and flake food contains meat, yeast, and gluten. With this knowledge, we predicted that Siamese fighting fish consume freeze-dried brine shrimp first, followed by pellet food, and then flake food. We offered pairs of food choices consisting of pellets, flake food, or freeze-dried brine shrimp to male Siamese fighting fish. We recorded latency for fish to consume food, recording preference as the first food chosen. We found no significant difference in mean latency to choose food, but significant difference in food preference where the fish chose pellet food first most frequently, followed by freeze-dried brine shrimp, then flake food. The results of this study help us determine if Siamese fighting fish display food preference, and whether nutritional value is a factor when choosing which type of food to consume.

Data Analysis
We used repeated measures ANOVA to analyze data, followed by pairwise comparisons, using JMP 12.2 (SAS Institute, Inc. 2015). We used chi-squared testing to analyze choice data. Significance level at P < 0.05.

Table 1. Nutritional values of freeze-dried brine shrimp, pellet, and flake food used to feed Siamese fighting fish over 3 weeks.

<table>
<thead>
<tr>
<th>Food Choice</th>
<th>Crude Protein</th>
<th>Crude Fat</th>
<th>Crude Fiber</th>
<th>Moisture</th>
<th>Ash</th>
<th>Vitamin A</th>
<th>Vitamin E</th>
<th>Riboflavin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeze-dried brine shrimp</td>
<td>4.5%</td>
<td>max. 1.0%</td>
<td>0.2%</td>
<td>max. 12%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flake food</td>
<td>3.5%</td>
<td>max. 1.5%</td>
<td>0.4%</td>
<td>max. 7.0%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pellet food</td>
<td>3.0%</td>
<td>max. 1.0%</td>
<td>0.1%</td>
<td>max. 10%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

C. Results
Mean latency for each fish to choose their food option differed only by 0.4 s between the most chosen food choice and least chosen food choice (Fig. 1). Fish chose pellet first between the three food choices (Fig. 2).

Pairwise comparisons with t-tests of differing food options between pellet, freeze-dried brine shrimp, and flake food showed the mean latency for pellet vs. flake is not significant (t = -0.05, df = 8, p-value = 0.9557) compared to flake vs. shrimp (t = -0.74; df = 8; p-value = 0.4839) and shrimp vs. pellet (t = -1.02; df = 9; p-value = 0.3360).

D. Discussion
We predicted that Siamese fighting fish would choose to consume freeze-dried brine shrimp first, followed by pellet food, and lastly, flake food. Our results do not support our predictions. In our experiment, pellet food consumption varied with that of freeze-dried brine shrimp and flake food. Fish chose to consume pellet first, freeze-dried brine shrimp second, and flake food third. During the experiment, food items contained equal masses, but food particle shape and size differed, with some pieces larger than others. Pellet food could have been chosen more frequently due to its larger and rounder size compared to freeze-dried brine shrimp and flake food. Further testing on varying food sizes and shapes would need to be performed to test this hypothesis.

From our results, latency to choose food does not differ between the three food choices. Therefore, latency to choose food does not affect food preference. The difference in time to choose food is very small, which could be due to the time separation between each trial.

Fish displayed food preference while consuming foods varying in nutritional value. Although freeze-dried brine shrimp is high in protein and fatty lipids (Leger et al., 1987), and pellet food is low in protein, but high in fiber and fat content (Table 1), fish chose to consume pellet food first more frequently. The results supported our predictions for flake food, which was chosen lastly with its content consisting of meat, yeast, and gluten.

Optimal foraging theory states that an animal’s fitness is maximized by food choice, energy intake, and time spent gathering and eating food (Pyke, Pulliam, & Charnov, 1977). Our results supported the theory subject to food selection and energy intake, but not subject to time spent gathering and consuming food.

We can conclude that food choice in Siamese fighting fish is more complex than high amounts of protein or vitamin content. Animals incorporate multiple factors into their food preference. Although we do not know all the reasons behind food preference, we examine food choice behavior and attempt to understand how these behaviors can maximize animal fitness and survival.

Acknowledgements
The Institutional Animal Care and Use Committee approved this study (020317-02). We thank Chris Maher for help and support throughout this study and the Department of Biology for funding. We also thank Ann Perry for access to the lab.

References

B. Methods
Housing
This study occurred in 160 Science at the University of Southern Maine. We kept ten male Siamese fighting fish in 5-L water tanks, each holding 2 fish separated by a divider. We placed handmade cardboard dividers between each tank to prevent the fish from seeing each other as this could cause unnecessary aggression (Bronstein, 1998).

Collection
We conducted preference tests normally as we fed fish. Every weekday for 3 weeks, fish were given trials once every 12 hours. We gave the fish 10 mg of random pairs of food choices consisting of pellets (Zoo Med), flake food (Tetra BettaMin), or freeze-dried brine shrimp (Hikari). We introduced food at the same time and recorded latency with a stopwatch to the nearest tenth of a second for fish to choose food, recording preference as the first food chosen.

Table 2. Nutritional values of dry brine shrimp, dried shrimp, and flake food used to feed Siamese fighting fish over 3 weeks.

<table>
<thead>
<tr>
<th>Food Choice</th>
<th>Crude Protein</th>
<th>Crude Fat</th>
<th>Crude Fiber</th>
<th>Moisture</th>
<th>Ash</th>
<th>Vitamin A</th>
<th>Vitamin E</th>
<th>Riboflavin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry brine shrimp</td>
<td>min. 48.0%</td>
<td>min. 10%</td>
<td>max 1.0%</td>
<td>max. 12%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dried shrimp</td>
<td>min. 40.0%</td>
<td>min. 1%</td>
<td>0%</td>
<td>max. 7%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flake food</td>
<td>min. 47.0%</td>
<td>max. 10%</td>
<td>max. 0.1%</td>
<td>max. 7%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>