ANALYZING DAPHNIA AND BLACK SOLDIER FLY PERFORMANCE FOR FISH PROTEIN

ABSTRACT

The effectiveness of Daphnia and Black Soldier Fly (BSF) larvae as substitute protein sources for fish diet is examined in this study. The quest for sustainable aquaculture methods has led to a rise in the need for substitute protein sources. Since they may be raised using organic waste materials and have a high protein content, daphnia and BSF larvae are seen as attractive possibilities. In this study, we assess the digestibility, nutritional makeup, and growth performance of fish fed diets including BSF larval protein and Daphnia. We also evaluate the environmental impact and economic viability of adding these substitute protein sources to fish diets. Our research provides important new information on the viability of using BSF larvae and Daphnia as protein sources to improve fish production sustainability and lessen dependency on conventional

Key words: *Daphnia, Azolla, Black soldier fly larvae*

INTRODUCTION

In order to reduce reliance on fishmeal and soybean-based feeds, which are linked to environmental issues including overfishing and deforestation, sustainable aquaculture operations require the development of alternative protein sources (Tacon & Metian, 2015). Due to their high protein content and capacity to use organic waste resources for growing, daphnia and Black Soldier Fly (BSF) larvae have emerged as viable substitutes (Lalander et al., 2019;Gupta et al., 2020).

The nutritional value and potential of Daphnia, a genus of small freshwater crustaceans, as a feed ingredient in aquaculture have been extensively researched (Beitinger& Fitzgerald, 1979). Comparably, BSF larvae have drawn notice for their quick development rate, effective biomass production from organic waste, and nutrient-rich makeup (Diener et al., 2009; Lalander et al., 2019). Still, thorough There are currently few assessments of their effectiveness as additives in fish feed.

By analyzing the growth performance, nutritional makeup, and digestibility of fish fed diets including Daphnia and BSF larvae protein, this study seeks to close this gap. We also assess the sustainability of the ecosystem and the economic feasibility of adding these substitute protein sources to fish diets. In order to promote sustainable aquaculture practices and lessen the environmental impact of traditional feed production methods, it is imperative to comprehend the potential of Daphnia and BSF larvae as ingredients for fish feed.

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LITERATURE REVIEW

With the introduction of trout into rivers for sport fishing in the early 1900s, aquaculture gained traction in Kenya (Ngugi et al., 2007). Static pond culture, which included the culture of tilapia, common carp, and catfish species, replaced sport fishing later in the 1920s. The first small-scale rural fish farms were Sagana and Kiganjo trout farms. Warm-water and cold-water species raising were the farms' primary goals (Ngugi &Manyala, 2004; Ngugi et al., 2007). By 1960, aquaculture was well-liked in most of the nation's regions, and the previous ten years had seen a sharp expansion of the industry. At the moment, Kitui had less aquaculture practice than Kakamega, Bungoma, Busia, Kisii, Meru, Nyeri, Kisumu, Muranga, and Embu counties. having less experience in Elgeyo Marakwet, Kitui, and Lamu (Opiyo et al., 2018). Oreochromis niloticus was the predominant species in warm water aquaculture in Kenya, with a share of 75% and 18% of the total production, respectively, followed by Clarias gariepinus (Opiyo et al., 2018). The reason tilapia was found in most culture systems was because of its versatility and prolific reproduction. Furthermore, they were highly preferred by customers in both local and regional marketplaces. African catfish and tilapia polyculture was used in conjunction with sex reversal of tilapia to regulate tilapia breeding and populations in ponds. According to Popma and Masser (1999) and Lorenzen et al. (2001), 90% of the cultured Nile tilapia in Africa made it the most widely cultivated species in the continent. Oreochromis niloticus was the species that was most common in Africa. This may have been because of their quick rates of growth, flexibility in a variety of environments, resilience to stress, which permitted relatively high stocking densities, high resistance to diseases in unfavorable environments, capacity to develop and procreate in captivity, and ability to feed on low trophic levels (El-Sayed, 2006; Ngugi et al., 2007). Popma and Masser (1999) and Lorenzen et al. (2001) reported that 90% of Africa's cultured species were Oreochromis niloticus, the Nile tilapia. This could have been because of the fish's quick growth rates, flexibility in a variety of environmental settings, resilience to stress, which permitted relatively high stocking densities, and high resistance to illnesses in unfavorable environments, capacity to develop and procreate in captivity, and capacity to consume food at low trophic levels (El-Sayed, 2006; Ngugi et al., 2007). When the water temperature was between 22 and 29 °C, preferably 28 °C, nile tilapia thrived at good rates (Morgan, 1972). Fish could not reproduce at temperatures below 20 °C, and their growth rate was reduced at temps below 16 °C (Morgan, 1972). Fish exhibited decreased eating activity around 15^0C, and if no action was taken, a subsequent drop in temperature (less than 12^0C) was seen to result in fish death (Yashouv, 1960; El-Sayed, 2006; Ngugi et al., 2007). Tilapia could withstand dissolved oxygen concentrations of less than 3 mg/L as long as the temperature and pH were maintained in a way that was beneficial to them (Ngugi et al, 2007). The ideal pH range for nile tilapia was between 6.5 and 9, and when the fish were exposed to pH values outside of this range, their epithelial cells were damaged (El-Sayed, 2006; Ngugi et al., 2007). Fish could not survive in unionized ammonia, which was primarily found in fish excrement and leftover feed. Less than 0.01 mg/L of ammonia should be maintained in the ponds (El-Shiafey, 1998). Fish did not react negatively to ionized ammonium, however toxicity did increase as dissolved oxygen (DO) levels dropped, whereas toxicity decreased as carbon dioxide levels rose (Chervinski, 1982). According to Munguti et al. (2009), fish were fed based on their body weight, and this could be accomplished by feeding fish until they were satisfied using demand feeders, automatic feeders, and hand feeding (Pillay & Kutty, 2005). Fry and fingerlings were fed at a rate of 5 to 8% of their body weight, according to research, whereas adults were only fed 3%. Fish were fed when the temperature was favorable and the dissolved oxygen content was high, ideally in the morning and evening, as temperature and DO have an impact on fish metabolism (Pillay & Kutty, 2005). Because fish meal was expensive and subject to intense competition, using less expensive feeds was advised. This raised the cost of production. These feeds contained plant sources like grasses and leaves (like cassava) and arrowroot) as well as the seeds of leguminous shrubs; aquatic plants such as water hyacinth, water lettuce, and Lemna; by-catch fish from lakes; rice (broken, bran, hulls); wheat (germ, bran); maize (bran, germ); seed cakes (groundnut, cotton, sunflower, soybean); brewers waste; slaughterhouse wastes and blood-meals (Liti et al., 2006; Munguti et al., 2012, 2014); and live feeds to substitute for the frequently used fish meal. Our research involved assessing live feeding, specifically daphnia and black army flies, which were used as fish protein sources.

MATERIALS AND METHODS

The study was conducted from 20-01-2024 to 16-03-2024 at Egerton University, Njoro sub-county, Nakuru county, 25km, Southwest of Nakuru town. The coordinates of Egerton university are 0°22'16.3"S and 35°55'59.3"E. The study was carried out on the ponds inside a greenhouse. Black Soldier Fly (BSF) feed, daphnia feed and fishmeal, Fish: Tilapia, *Orechromisniloticus*, was used for trials, Fish Tanks or Ponds: 3 tanks in the greenhouse were used for the experiments, Weighing Scale: An electronic weighing balance was used for taking the fish's weight, Water Quality Testing Kits: Ph meter was used, Recording Equipment: A notebook and a pen were used for recording data. A total of 90 fingerlings of uniform size, mean initial weight of 3.53g and mean length of 3.1cm were randomly assigned to one of three groups, (A, B, and C), 30 fingerlings per tank. For 8 weeks, Group A (control group) was fed with a 100% commercial diet; Group B was fed with BSFL feed; Group C was fed with daphnia feed.Fish growth performance, including parameters such as weight gain, specific growth rate (SGR), and survival rate, were monitored throughout the feeding trial period. After the trial, fish were sampled from each treatment group and measured for length and weight. The daphnia feed used was obtained from agro-science fish farm while BSF larvae feed was made by incorporating Azolla, dried BSF larvae, egg shells to provide calcium and maize meal as a carbohydrate source. Canola oil was then added in the lab for pelleting to help in floatation while feeding fish.

Feeding trial

The tilapias were obtained from one of the fishponds at the park. They had a mean initial body weight of 3.53g and a mean initial length of 3.1cm. Each group of fish was fed twice a day with approximately 5% of their body weight except on Sundays. Water quality parameters were maintained at optimal levels. Ph meter was used to check for changes in Ph which is supposed to be around 7.2 while turbidity was maintained by ensuring that unconsumed fed was removed and approximately 50% of water changed every 2 weeks. The feeding lasted for seven weeks at the end of which the mortality in each tank was estimated and the mean weight of the fingerlings was obtained using the same electronic balance at weekly intervals.

Calculated parameters

To evaluate the growth and feed efficiency the following standard formulas were used:

Body weight gain = final weight (g) - initial weight (g).

Length gain = final length – previous length

Survival rate = (final number of fish)/ (initial number of fish).

RESULTS

The results of mean body length, weight gained are tabulated in the table below. The initial fish stocking density was 30 fish per pond.

Table 1 : POND A GROWTH RATE (CONTROL)

DAY	1	7	14	21	28	35	42	49
MEAN LENGTH	3.1	3.7	3.9	4.5	5.1	5.8	6.7	7.6
MEAN WEIGHT	3.53	4.21	4.36	5.06	5.96	6.88	7.91	9.11

Chart 1 : POND A GROWTH RATE (CONTROL)

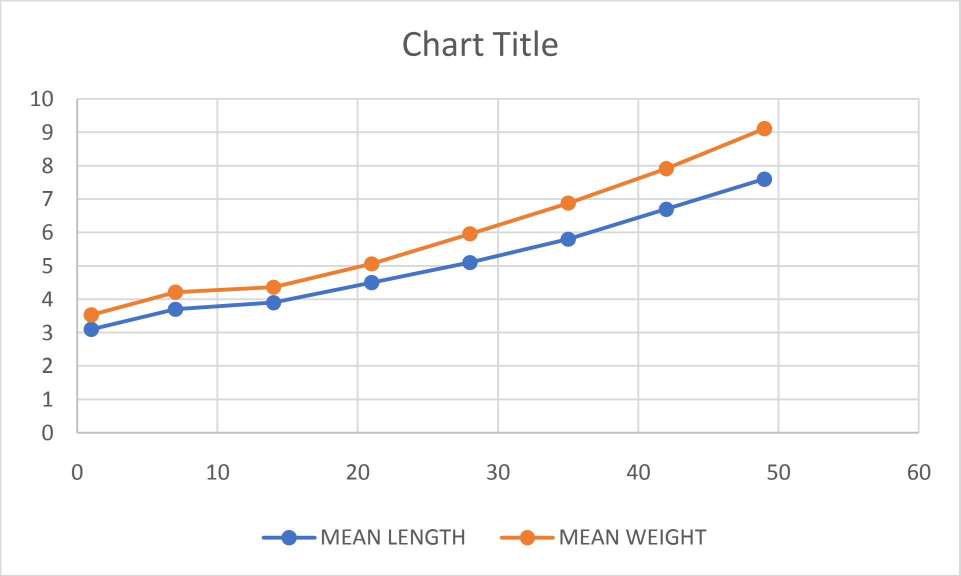

Table 2 : POND B (LIVE BSF)

DAY	1	7	14	21	28	35	42	49
MEAN LENGTH	3.1	3.9	4.2	4.4	5.3	6.0	6.9	8.1

MEAN WEIGHT	3.53	4.19	4.28	5.12	6.32	7.10	7.99	9.51

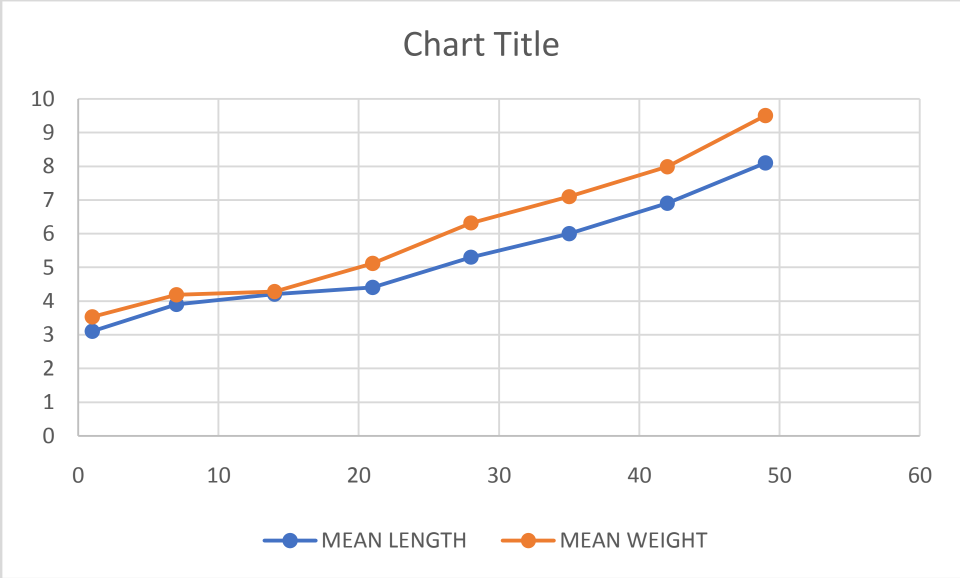

Chart 2 : POND B (LIVE BSF)

Table 3 : POND C (DAPHINIA)

DAY	1	7	14	21	28	35	42	49
MEAN LENGTH	3.1	3.4	3.7	4.2	4.9	5.5	6.1	7.0
MEAN WEIGHT	3.53	4.10	4.30	4.95	5.57	6.26	7.22	8.64

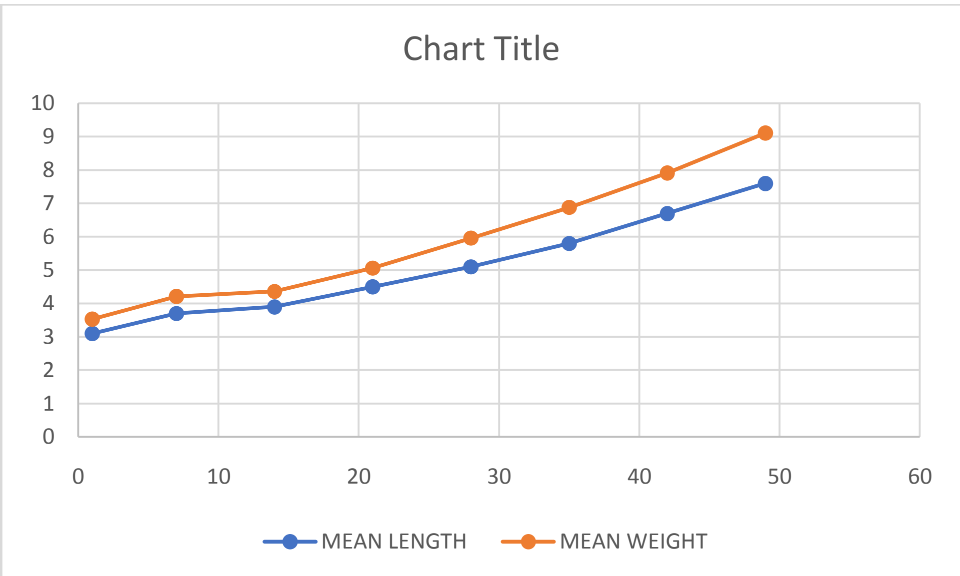

Chart 3 : POND C (DAPHINIA)

POND A

Body weight gain = final weight (g) - initial weight (g).

9.11-3.53=5.58g

Specific growth rate= $\frac{\text{final weight-initial weight x 100}}{\text{No of days}}$

$\frac{9.11-3.53 \times 100}{49}$

=11.39%

Length gain = final length – previous length

7.6-3.1=4.5

Survival rate = (final number of fish)/ (initial number of fish).

$\frac{29 \times 100}{30}$

=96.7%

POND B

Body weight gain = final weight (g) - initial weight (g).

9.51-3.53=5.98g

Specific growth rate= $\frac{\text{final weight-initial weight x 100}}{\text{No of days}}$

$\frac{9.51-3.53 \times 100}{49}$

=12.20%

Length gain = final length – previous length

8.1-3.1=5.0

Survival rate = (Final number of fish)/ (initial number of fish).

29 x 100

30

=96.7%

POND C

Body weight gain = final weight (g) - initial weight (g).

8.64-3.53=5.11g

Specific growth rate= final weight-initial weight x 100

No of days

8.64-3.53 x 100

49

=10.42%

Length gain = final length – previous length

7.0-3.1=3.9

Survival rate = (final number of fish)/ (initial number of fish).

26 x 100

30

=86.7%

DISCUSSION AND CONCLUSION

This study investigated the impact of different feed types on the growth rate and survival of tilapia (Pérez, Chávez-Sánchez, Martínez-Porchas, & Ross, 2019). Three ponds were used: Pond A (Control) where fish received a standard diet, Pond B (Live BSF) where fish were fed live Black Soldier Fly (BSF) larvae, and Pond C (Daphnia) where fish were fed live Daphnia. The results suggest that tilapia-fed live BSF larvae exhibited the most promising growth performance (Pérez et al., 2019): Specific Growth Rate (SGR): Pond B achieved the highest SGR (12.20%) compared to Pond A (control, 11.39%) and Pond C (Daphnia, 10.42%). Weight Gain: Fish in Pond B displayed the greatest weight gain (5.98g) over the study period, followed by Pond A (5.58g) and Pond C (5.11g). Length Gain: Pond B also showed the most significant increase in length (5.0 cm) compared to Ponds A (4.5 cm) and C (3.9 cm). However, an important observation is the lower survival rate in Pond C (86.7%)

compared to Ponds A and B (both 96.7%) (Pérez et al., 2019). Based on the findings, live BSF larvae appear to be a promising alternative for enhancing tilapia growth rate and weight gain (Pérez et al., 2019). However, several factors warrant further investigation to strengthen these conclusions (Tacon & Metian, 2015): Limited Sample Size: With only one pond per treatment, the results might not account for natural variations between fish. Repeating the experiment with multiple ponds per treatment would provide more robust data. Daphnia Performance: While Daphnia resulted in lower SGR and weight gain compared to BSF larvae, its impact on survival rate needs exploration. Understanding the cause of the lower survival rate in Pond C could be crucial for optimizing Daphnia use (Ramos & Gao, 2018).

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