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Impact of using unconventional feeds on the growth and survival of Nile tilapia fry (Oreochromis niloticus)

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تأثير استخدام الأعلاف غير التقليدية على نمو وبقاء يرقات البلطي النيلي (Oreochromis niloticus)

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الملخص:

أُجريت هذه الدراسة لمدة 60 يومًا بهدف تقييم تأثير استخدام علائق غير تجارية تحتوي على مسحوق الدم **(BM)**كبديل جزئي لمسحوق السمك**(FM)** ، وهو المصدر الرئيسي للبروتين الحيواني، على أداء النمو لأسماك البلطي النيلي **(Oreochromis niloticus)** المستزرعة في الأحواض. تم إعداد عليقتين متساويتين في المحتوى النيتروجيني (35% بروتين خام)، حيث شكّل مسحوق الدم 29% من العليقة في المعاملة الأولى **(T1)** ، و25% في المعاملة الثانية**(T2)** ، بينما استُخدمت عليقة تجارية تحتوي على 35% بروتين خام كمجموعة ضابطة.

تم توزيع 135 إصبعية عشوائيًا على ثلاث مجموعات تجريبية، بواقع ثلاث مكررات لكل مجموعة (15 إصبعية لكل مكرر). تم تغذية الأسماك يدويًا ثلاث مرات يوميًا عند الساعة 9:00 صباحًا، و1:00 ظهرًا، و5:00 مساءً. جُمعت بقايا العلف يوميًا قبل الوجبة الأولى. حُددت معدلات التغذية بنسبة 6% من وزن الجسم خلال الأسابيع الثلاثة الأولى، ثم عُدّلت إلى 5% و3% خلال الأسابيع الثلاثة الأخيرة. تم تقييم مؤشرات أداء النمو، بما في ذلك معدل الزيادة الوزنية اليومية**(DWG)** ، ومعدل النمو النسبي**(RGR)** ، ومعدل النمو النوعي**(SGR)** ، ونسبة البقاء، وكفاءة استخدام العلف.

أظهرت النتائج أن الأسماك التي تغذت على العليقة الضابطة حققت وزنًا نهائيًا أعلى معنويًا (69.48 جم؛ **p 0.05>**) مقارنة بالمعاملة الأولى (47.46 جم) والمعاملة الثانية (44.37 جم). ومع ذلك، أظهرت العلائق

غير التجارية أداءً مقبولًا في النمو وكفاءة استخدام العلف. وتشير هذه النتائج إلى إمكانية استخدام مسحوق الدم كبديل جزئي لمسحوق السمك في علائق البلطي النيلي دون تأثير كبير على أداء النمو، مما يوفر بديلًا اقتصاديًا مناسبًا في مجال الاستزراع المائي.

الكلمات الدالة: مسحوق الدم، أداء النمو، كفاءة استخدام العلف، تغذية الاستزراع المائي.

Abstract

Type here (This study was conducted over a 60-day period to evaluate the effects of a non-commercial diet containing blood meal (BM) as a partial substitute for fish meal (FM), the primary source of animal protein, on the growth performance of Nile tilapia (Oreochromis niloticus) reared in ponds. Two iso-nitrogenous diets (35% crude protein) were formulated: in Treatment 1 (T1), blood meal constituted 29% of the diet, while in Treatment 2 (T2), it constituted 25%. A commercial diet with 35% crude protein served as the control.

A total of 135 fingerlings were randomly distributed into three experimental groups, each with three replicates (15 fish per replicate). Fish were hand-fed three times daily at 9:00 AM, 1:00 PM, and 5:00 PM. Uneaten feed was collected daily before the first feeding. Feeding rates were set at 6% of body weight during the first three weeks and adjusted to 5% and 3% during the final three weeks. Growth performance indicators, including daily weight gain (DWG), relative growth rate (RGR), specific growth rate (SGR), survival rate, and feed utilization efficiency, were assessed.

Results indicated that fish fed the control diet achieved significantly higher final body weight (69.48 g; $p < 0.05$) compared to those fed T1 (47.46 g) and T2 (44.37 g). However, the non-commercial diets showed acceptable growth performance and feed utilization efficiency. These findings suggest that blood meal can be used as a partial replacement for fish meal in Nile tilapia diets without markedly compromising growth performance, offering a cost-effective alternative for aquaculture practices.

Keywords: Nile tilapia, blood meal, growth performance, feed efficiency, aquaculture nutrition.

Introduction

Fish farming is the process of raising fish in a controlled aquatic environment, where water quality and nutrition are fully managed. This is achieved by controlling variables that affect fish survival to increase production in the shortest time and at the lowest cost (Abdul Bari Muhammad Mahmoud, 2004). Among the most commonly farmed fish species worldwide, six major species are cultivated, including Nile tilapia (Oreochromis niloticus) (Piracha & Awais, 2015). Aquaculture production must be increased to meet the growing demand for fish as food, as fish provide essential amino acids, fatty acids, vitamins, and minerals for human nutrition. Furthermore, fish production is important in low-income regions for improving economic gains and supplementing food supplies that may be deficient (Avault, 1970–1985).

he success of fish farming has been driven by several factors, including: (a) depletion of fish stocks due to overfishing; (b) rising costs of fishing equipment; and (c) declining freshwater resources caused by pollution (Abdul Bari Muhammad Mahmoud, 2004). Therefore, aquaculture provides an affordable source of animal protein for low-income populations and plays a significant role in poverty alleviation through income generation (Kassam, 2014).

Fish, like other animals, require high-quality protein sources to ensure rapid growth. Protein quality is increasingly important in intensive fish farming systems, which rely entirely on artificial feed and provide little natural food. Animal protein sources are particularly crucial for feeding juvenile fish in intensive systems. However, this has led to two major challenges. First, increasing demand for fish meal (FM) has put pressure on wild fish stocks that are already overexploited (Naylor et al., 2009; Hannesson, 2003). Second, the high price of fish meal, driven by increasing demand, affects the recommended inclusion levels of FM in fish diets (FAO, 2009; Tacon & Metian, 2008).

Consequently, the aquafeed industry has sought alternative protein sources that are cost-effective to reduce dependence on fish meal (Hardy, 2010). It is clear that the developing aquaculture sector cannot continue to rely on limited fishmeal stocks from wild-caught fisheries, which have previously been classified as overexploited and mismanaged (NRC, 1999). Sustainable aquaculture therefore requires affordable, high-quality alternative protein sources. Other animal protein sources, such as blood meal (BM), provide an excellent alternative (Naylor et al., 2000). Using such alternatives not only reduces pressure on wild fisheries but also improves economic efficiency in aquaculture.

Research has increasingly focused on evaluating and utilizing non-traditional protein sources, particularly from neglected and underutilized animal by-products, including fish waste, poultry waste, slaughterhouse waste, dried blood meal, and other by-products (Olvera-Novoa et al., 1988; Makkar & Becker, 1999; Richter, 2003). Due to the lack of sufficient local data, the present study investigates the use of blood meal as a partial substitute for fish meal in the diet of Nile tilapia (Oreochromis niloticus) fry

Materials and Methods

Experiment: Fish Feeding

The blood of cows was collected from the slaughterhouse in the city of Al-Bayda, washed, and heated for fifteen minutes. It was then filtered, cut, and placed in an oven at 60°C to dry, while being constantly monitored to prevent burning. After that, it was left to cool, then ground and sifted to obtain blood powder according to the method of (Keremi et al., 2016 .The blood was stored in a glass container for use.

The experiment was conducted in the Department of Animal Production, Faculty of Agriculture, Omar Al-Mukhtar University. It lasted 60 days and was carried out in nine 40-liter glass tanks. These tanks were washed and sterilized with 10% formalin. Water from a university well was used. Nile tilapia fry (Oreochromis niloticus) were obtained from a fish farm in the Al-Tamimi area.

Fifteen tilapia fingerlings were placed in each tank and incubated for three days. During conditioning, the fry were fed 4% of their body weight. The current experiment consisted of three treatments, one control, and two other treatments. The treatments were defined as follows: 29% blood meal and 25% blood meal. Each treatment and control group had two replicates. The fry weighed 8.4 ± 0.1 g at the start of the experiment. Ventilation was provided to all tanks using ventilation pumps equipped with air stones for diffusion.

Hand-fed fish were fed three (3) times daily, at 9:00, 1:00, and 17:00. Uneaten food was collected from the bottom of the tank using a tube every morning before the first feeding throughout the experimental period. Fry were fed 6% of body weight for the first three weeks (3% and 5% of body weight for the last three weeks).

Three diets were formulated as shown in Table (1).

Table 1: The composition of the diets used in the experiment (%)

Parameter	BM%		
	Control (0%)	29%	25%
Blood meal (BM)	-	29	25
Algae meal	-	20	24
Semolina	-	8.5	8.5

Corn oil	-	2	2
Bread flour	-	35	35
Corn starch	-	5	5
Vitamins and minerals	-	0.5	0.5
Total	-	100	100

Evaluation of growth parameters

Fish were weighed weekly to calculate the mean body weight (QEA 00) with an accuracy of 1 gram, the biomass present in each tank, and to re-estimate the daily feed intake for the following week. At the end of the experiment, all fish in each tank were weighed individually. Fish growth and feed efficiency were monitored in terms of weight gain (WG), feed intake (FI), feed conversion ratio (FCR), specific growth rate (SGR), and survival rate (S). Biological indicators were calculated as follows:

Mean final weight (g) = Total fish weight (g) / Number of fish

Weight gain (WG) = final body weight (g) – Initial body weight (g)

Feed Intake (FI) = Σ in [(Total feed consumption (g)) / (Number of fish)] / Number of days

Feed conversion ratio (FCR) = Feed consumption (g) / Weight gain (g)

Specific growth rate (SGR) = [(Final weight - Initial weight) / Number of days] × 100

Survival rate (S) = (Number of fish / Number of fish) × 100

Statistical analysis

Descriptive statistics for the studied trajectories were calculated using the SAS summary method (2004). The effect of factors including the addition of blood meal as a substitute for fish meal in the diet on tilapia fingerlings was studied.

Table 2: The chemical composition of commercial feed used in control

chemical composition	moisture	Crude protein	Crude lipid	Ash	Carbohydrates
Control	11	35	8.2	9.3	36.5

Table 3 : Chemical composition of feed (%)

İngredients	moisture	Crude protein	Crude lipid	Ash	Carbohydrates
Treatment 1	10	35	7.6	6.2	41.3
Treatment 2	12.2	35	7.3	5.3	40.3
Control (Commercial feed Protein content 35 %					

Results

Survival and Growth Performance

The survival rate was high and similar among all three diets, averaging 96% (Table 4). Fish fed the control diet exhibited the highest daily weight gain (DWG) (0.50 g/day; $P < 0.05$), followed by fish in Treatment 1 (0.35 g/day) and Treatment 2 (0.27 g/day) (Table 4). Similarly, the highest final average weight per fish (48.69 g) was recorded in Treatment 1, while the lowest (44.37 g) was observed in Treatment 2.

The highest specific growth rate (SGR) was recorded in fish fed the control diet (0.58%), followed by fish fed Diet 2 (0.55%). The lowest SGR (0.51%) was observed in fish fed Diet 1.

The relative growth rate (RGR) was highest in Treatment 1 and lowest in the control group.

Table 4: Growth performance of Nile tilapia fingerlings (Oreochromis niloticus) fed on unconventional diets

Parameter	Treatment		
	Control	Treatment 1	Treatment 2
Initial average body weight (g)	08.45±0.14[c]	08.47±0.17[b]	08.48±0.15[a]
Final average body weight (g)	48.69±1.68[a]	46.47±1.40[b]	44.37±1.12[c]
Daily weight gain (g/d)	0.5±0.02[a]	0.37±0.01[b]	0.28±0.01[c]
Specific growth rate (%)	0.58±0.02[a]	0.51±0.02[b]	0.55±0.01[c]
Relative growth rate (%)	76.48±1.04[a]	68.15±1.18[b]	72.18±0.53[c]
Survival rate (%)	96±1.16[a]	96±1.16[b]	96±2.00[c]
Feed conversion efficiency	0.03±0.00	0.03±0.00	0.02±0.00

Discussion

Survival Rate

The survival rate was similar across all diets, averaging 96%. This high survival rate in the present study can be attributed to good management practices, such as proper handling and storage of feed (keeping it dry), careful handling of fish during sampling, and daily removal of fish waste and uneaten feed. However, this high survival rate contrasts with the findings of Eyo and Olatunde (1999), who reported that fish fed the highest levels of blood meal exhibited the highest mortality rates in ponds. It was not clear whether this increased mortality was due to a nutritional imbalance in the diet or other factors.

In the current experiment, the inclusion levels of blood meal did not affect fish survival rates. This result is consistent with Agbebi et al. (2009), who reported that fish meal could be completely (100%) replaced by blood meal without any adverse effects on growth, survival, or feed conversion in juvenile Clarias gariepinus. Similarly, Aladetohun and Sogbesan (2013) reported no mortality and concluded that blood meal can perform excellently as feed at a 100% inclusion rate, effectively replacing fish meal in tilapia diets without negatively affecting growth or survival of juvenile Oreochromis niloticus. These findings are also consistent with the study of Keremi et al. (2016), who used blood meal as a fish meal substitute at varying ratios.

Growth Rate

Growth performance in this study decreased with increasing levels of blood meal in the diet, as shown in Table 4. Diet 2 exhibited the highest growth rate, likely due to its higher fish meal content as the primary source of animal protein. Fish meal is known for its balanced amino acid profile, high digestibility, and good palatability, all of which promote optimal fish growth (Hardy & Tacon, 2002).

The reduced performance of blood meal-based diets in this study is consistent with Otubusin (1987), who reported that diets with the highest blood meal content resulted in poor growth and feed conversion ratios. Huet (1994) also noted that blood meal is often imbalanced in essential amino acids. Keremi et al. (2016) observed that replacing 50% of fish meal with blood meal provides a beneficial protein diet, whereas 100% replacement results in a less effective diet.

Conclusion

The reduced growth rate can also be explained by the decreased requirements for essential amino acids as fish mature (NRC, 1993), which narrows the gap between dietary supply and nutritional requirements for fish fed diets with 50% replacement of fish meal. Furthermore, Bekibele et al. (2013) reported that an optimal combination of bone meal and blood meal can replace up to 75% of fish meal in the diets of Mozambique tilapia (Oreochromis mossambicus) fry. Good performance was observed in fish fed diets containing approximately 8–20% fish meal, as well as in diets with higher fish meal content (>20%)

The results of this study showed that fish fed commercial feed exhibited better growth compared to those fed noncommercial diets supplemented with blood meal. However, fish fed non-commercial diets also performed reasonably well with the addition of blood meal. Although blood meal and other alternative feed ingredients cannot fully match commercial feed in terms of growth performance, some locally available ingredients can help compensate for protein deficiencies. Blood meal, in particular, can be obtained free of charge from slaughterhouses.

In conclusion, the findings of this study suggest that blood meal, in combination with certain locally available ingredients, can be used in small quantities in Nile tilapia farming due to its low cost, free availability at slaughterhouses, and high protein content.

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