THE EFFECT OF NUTRITION FROM VARIOUS FEEDS ON THE GROWTH AND SURVIVAL OF AFRICAN CATFISH (*Clarias gariepinus*) FRY

PENGARUH NUTRISI PADA BERBAGAI PAKAN TERHADAP PERTUMBUHAN DAN KELANGSUNGAN HIDUP BENIH IKAN LELE DUMBO (*Clarias gariepinus*)

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ABSTRACT

The success of the African catfish (*Clarias gariepinus*) seeding stage is largely determined by the availability of feed with high nutritional efficiency in the early seedling phase. This study aimed to evaluate the nutritional efficiency of African catfish fry growth and survival. The study was conducted using a completely randomized design with three natural feed treatments, namely silkworms (*Tubifex* sp.), water fleas (*Daphnia* sp.), egg yolk, and commercial pellets as the control. The parameters observed included Nutrient Composition and Its Implications for Seed Performance, Survival Response and Nutrient Utilization, Growth Performance and Energy Distribution. The results of proximate analysis showed that silkworms had the highest protein content (57%) compared to *Daphnia* sp. (37.38%) and egg yolk (16.6%). Fry fed with silkworms showed the highest growth and survival performance with a SR value of 78%, length growth of 3.60 cm, weight growth of 0.65 g, and SGR of 0.3575% per day. This performance indicates improved nutrient utilization efficiency, supported by a balance of protein and energy that allows optimal nutrient allocation for somatic growth. This study indicates that silkworms have the highest nutritional efficiency as a natural feed for African catfish fry and have the potential to be implemented as an economical feeding strategy to improve fry quality in hatchery systems.

Keywords: Nutritional efficiency; natural feed; *Clarias gariepinus*; seed growth; survival rate

ABSTRAK

Keberhasilan tahap pembibitan ikan lele Afrika (*Clarias gariepinus*) sebagian besar ditentukan oleh ketersediaan pakan dengan efisiensi nutrisi tinggi pada fase pembibitan awal. Penelitian ini mengevaluasi efisiensi nutrisi pertumbuhan dan kelangsungan hidup benih ikan lele Afrika. Penelitian ini dilakukan menggunakan rancangan acak lengkap dengan tiga perlakuan pakan alami, yaitu ulat sutra (*Tubifex* sp.), kutu air (*Daphnia* sp.), kuning telur dan pelet sebagai perlakuan kontrol. Parameter yang diamati meliputi komposisi nutrien dan implikasinya terhadap kinerja benih, respons kelangsungan hidup dan pemanfaatan nutrien, kinerja pertumbuhan dan distribusi energi. Hasil analisis proksimat menunjukkan bahwa ulat sutra memiliki kandungan protein tertinggi (57%) dibandingkan dengan Daphnia sp. (37,38%) dan kuning telur (16,6%). Benih yang diberi pakan ulat sutra menunjukkan kinerja pertumbuhan dan kelangsungan hidup tertinggi dengan nilai SR 78%, pertumbuhan panjang 3,60 cm, pertumbuhan berat 0,65 g, dan SGR 0,3575% per hari. Performa ini menunjukkan peningkatan efisiensi pemanfaatan nutrisi, didukung oleh keseimbangan protein dan energi yang memungkinkan alokasi nutrisi optimal untuk pertumbuhan somatik. Studi ini menunjukkan bahwa ulat sutra memiliki efisiensi nutrisi tertinggi sebagai pakan alami untuk benih ikan lele Afrika dan berpotensi untuk diimplementasikan sebagai strategi pemberian pakan ekonomis untuk meningkatkan kualitas benih dalam sistem penetasan.

Kata kunci: Efisiensi nutrisi; pakan alami; *Clarias gariepinus*; pertumbuhan benih; tingkat kelangsungan hidup

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INTRODUCTION

African catfish (*Clarias gariepinus*) is a freshwater aquaculture commodity with high economic value and plays a crucial role in supporting food security, particularly in developing countries. This species is known for its rapid growth rate, broad environmental tolerance, and good adaptability to intensive cultivation systems (Kwikiriza et al., 2025; Popoola et al., 2021). As market demand increases, successful catfish production depends heavily on hatchery efficiency, as seed quality is a key factor in the sustainability of the cultivation cycle.

The fry stage is a critical period in the fish's life cycle, characterized by relatively high mortality rates and limitations in the digestive system's ability to utilize complex nutrients (Pradhan et al., 2012; Xu et al., 2012). At this stage, the availability of feed with high nutritional efficiency is crucial, as consumed nutrients serve not only as an energy source but also as key structural components in the formation of body tissues (Fei et al., 2024; Syamsunarno et al., 2021). Nutritional imbalances during the early growth phase can lead to developmental delays, reduced survival, and lower fry quality.

Natural feed remains the primary choice for catfish hatchery production because it has a particle size that fits the fry's mouth opening, is easily digested, and stimulates a natural feeding response (Jiang et al., 2024; Mischke et al., 2019). Some commonly used live feeds include silkworms (*Tubifex* sp.), water fleas (*Daphnia* sp.), and egg yolk as alternative feeds. However, each of these feeds has a different nutritional composition, particularly in protein and energy content, potentially affecting the efficiency of nutrient utilization by fry.

Nutritional efficiency in the context of fish fry is determined not only by the nutrient content of the feed, but also by the fry's ability to digest, absorb, and allocate these nutrients for somatic growth and metabolic maintenance (German, 2011; Zhu et al., 2021). Feeding with a high protein content and an appropriate energy balance can induce a protein-sparing effect, in which more protein is utilized for growth than as an energy source (Ismail & Khoo, 2019). Conversely, feeding with an unbalanced nutrient composition can lead to low nutrient conversion efficiency and inhibit the accumulation of fry biomass.

Although the use of natural feed in catfish hatcheries has been widely reported, most studies still focus on comparing growth performance without emphasizing the nutritional efficiency and energy utilization mechanisms during the fry stage. Comparative information on the nutritional efficiency of various types of natural feed for the growth and survival of C. gariepinus fry remains limited, particularly in small-scale hatchery systems that require effective, economical feeding strategies.

Based on this background, this study was conducted to evaluate the nutritional efficiency of several types of natural feed on the growth and survival performance of African catfish fry. The results are expected to provide a scientific basis for selecting optimal natural feed and contribute to the development of nutrient-efficiency-based hatchery strategies to improve fry quality and the sustainability of catfish production

METHOD

Time and Location

The research was conducted at the Karang Harapan Raja Lele Fish Farm (Pokdakan Raja Lele Karang Harapan), a relatively advanced catfish rearing facility. Water quality parameter analysis was conducted at the Water Quality Laboratory of the Faculty of Fisheries and Marine Sciences, Borneo Tarakan University.

Experimental Design

The research used an experimental method with a Completely Randomized Design (CRD) consisting of four treatments and three replications. The treatments consisted of different feed types:
P1: *Tubifex* sp.

P2: *Daphnia* sp.
P3: egg yolk
P4: Pellets (control)

A total of 12 containers were used as experimental units. Each container measured 30 x 30 x 40 cm and was filled with 8 L of fresh water. Four-day-old African catfish fry were stocked at a density of 40 per container.

Maintenance Procedures

Catfish fry were acclimatized before being treated and reared for 30 days. All tanks were equipped with continuous aeration. Water changes were performed every 2 days, approximately two-thirds of the media volume was replaced, and waste and feed were siphoned off. Feeding was conducted ad libitum four times daily at 8:00 AM, 12:00 PM, 4:00 PM, and 8:00 PM WITA (Central Indonesian Time). Before the next feeding, any remaining feed was removed to maintain water quality.

Survival Rate (SR)

Survival rate (SR) was calculated based on the number of fry surviving at the end of the study using the following equation (Effendie, 1997):

$$\text{SR}\ (\%) = \frac{N_t}{N_0} \times 100 \qquad (1)$$

where N_t is the number of fish surviving at the end of the rearing period, and N_0 is the initial number of fish stocked.

Length and Weight Growth

Absolute length growth is calculated as the difference between the final and initial length, while absolute weight growth is calculated as the difference between the final and initial weight of the seed (Effendie, 1997).

$$Length\ Growth = L_t - L_0 \qquad (2)$$
$$Weight\ Growth = W_t - W_0 \qquad (3)$$

Where *Lt* is the final length (cm), *L0* is the initial length (cm), *Wt* is the final weight (g), and *W0* is the initial weight (g).

Specific Growth Rate (SGR)

The specific growth rate is calculated using the following equation (Steffens 1989):

$$\text{SGR}\ (\%) = \frac{\ln W_t - \ln W_0}{\text{T}} \times 100 \qquad (4)$$

Wt is the final weight (g), W_0 is the initial weight (g), and T is the length of maintenance (days).

Water Quality

The water quality parameters observed included temperature, pH, dissolved oxygen (DO), and ammonia. Temperature, pH, and DO were measured twice daily (morning and evening), while ammonia was measured every seven days.

Data Analysis

Growth and survival data were analyzed using analysis of variance (ANOVA) at a 95% confidence level. If significant differences were found between treatments, the analysis was continued with the least significant difference (LSD) test. Data processing was performed using Microsoft Excel.

RESULT AND DISCUSSION

Nutrient Composition and Its Implications for Seed Performance

The results of the nutrient composition analysis showed significant differences between the types of natural feed (Table 1). Silkworms (*Tubifex* sp.) had the highest protein content at 57% with moderate fat content (13.30%), followed by water fleas (*Daphnia* sp.) with 37.38% protein and 13.29% fat. Meanwhile, egg yolk had the lowest protein content (16.6%) but the highest fat content (32.6%). These differences indicate variations in the nutritional efficiency of each feed in supporting the growth and survival of African catfish fry. For comparison, the

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nutritional profile of silkworms (Herawati et al., 2016; Prakash et al., 2024; Sravani et al., 2025) shows that protein content ranges from 62.51% to 66.26%, fatty acids and amino acids, with lysine at 3.63%, linoleic and linolenic acids at 7.25% and 6.19%, respectively, and a relatively low carbohydrate content of around 3.73%.

Table 1. Nutrient composition of natural feed

Simplisia	Nutrition	
	Protein	Fat
Tubifex sp.	57%	13,30%
Daphnia sp.	37,38%	13,29%
Egg Yolk	16,6 %	32,6%

Differences in nutrient composition among natural feeds indicate variations in nutrient utilization efficiency by African catfish fry. The high protein content of silkworms plays a crucial role in supporting somatic growth. According to Herawati et al. (2016), Prakash et al. (2024), and Sravani et al. (2025), protein content ranges from 62.51% to 66.26%, fatty acids and amino acids, with lysine at 3.63%, linoleic and linolenic acids at 7.25% and 6.19%, respectively, and a relatively low carbohydrate content of around 3.73%. Furthermore, the research conducted by Rawat et al. (2019) on pabda fish fed a natural diet of *Tubifex* sp. demonstrated high growth and survival rates.

The high protein content of *Tubifex* sp. Contributes to a better protein efficiency ratio in fish, supporting efficient nutrient utilization for somatic growth (Herawati et al., 2020). This is because protein is a key component in the formation of body tissue. Furthermore, moderate fat content promotes a protein-sparing effect, enabling more energy to be supplied by fat and allowing protein to be optimally utilized for growth. Conversely, low protein content in egg yolks limits the supply of essential amino acids, which impacts growth performance and survival.

Survival Response and Nutrient Utilization

Seed survival rates ranged from 56–78%, with the highest values obtained in the silkworm treatment and the lowest in the egg yolk treatment (Figure 1). Statistical analysis showed that the type of natural food significantly influenced seed survival ($p < 0.05$).

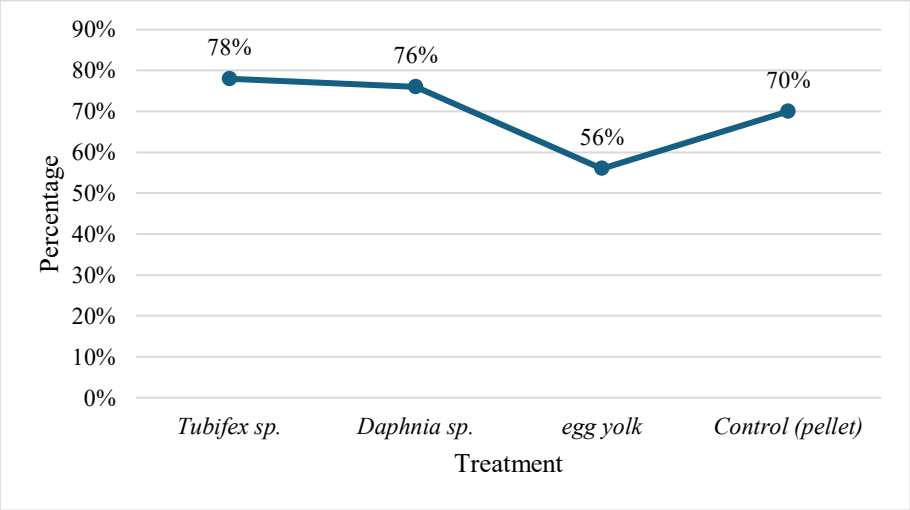


Figure 1. Survival response of dumbo catfish seeds

The high survival rate of silkworm treatment indicates improved nutrient utilization efficiency and a more stable physiological condition of the fry. According to Engrola et al. (2018), nutrition in the early stages of life is crucial

for optimal physiological development. Proper nutrition can influence myogenesis rate, muscle fiber size, and protein deposition efficiency. Therefore, energy obtained from food is allocated to various functions such as growth, reproduction, and immune response (Freire & Sampaio, 2021). Furthermore, live feeds such as silkworms and water fleas can stimulate feeding behavior and digestive enzyme activity, thereby increasing nutrient digestibility and absorption. Live feeds such as rotifers, Artemia, and microalgae are highly digestible and rich in essential nutrients, including protein, fatty acids, vitamins, and minerals. These nutrients are crucial for the growth and survival of fry (Pan et al., 2022; Khan & Rahman, 2025; Sandeep et al., 2025).

In contrast, egg yolks lack motility, thus less stimulating the fry's feeding response and potentially accelerating water quality degradation. According to Kemigabo et al. (2019) and Samaee et al. (2021), egg yolk is less effective in stimulating the feeding response of catfish fry compared to live feed. Furthermore, the decline in water quality caused by egg yolk is also due to its fine-grained texture, which can increase organic matter in the water, encouraging bacterial growth and, consequently, degrading water quality. Egg yolk also has a low protein content, limiting the supply of essential amino acids needed for tissue maintenance and the fry's immune system. Research by Falahatkar et al. (2012) and Huang et al. (2022) showed that egg yolk was less effective in stimulating the feeding of catfish fry.

Growth Performance and Energy Distribution

The growth in length and weight of catfish fry showed a similar pattern (Figure 2), with the highest values in the silkworm treatment (3.6 cm and 0.65 g) and the lowest in the egg yolk treatment (3.2 cm and 0.31 g). The specific growth rate (SGR) was also the highest in the silkworm treatment at 0.3575 % per day and was significantly higher than in the other treatments ($p < 0.05$).

The higher growth performance of the silkworm treatment indicates a balance in energy partitioning. Available nutrients not only meet basic metabolic needs but can also be allocated for biomass growth. Live feed tends to increase enzyme activity, which is crucial for nutrient digestion and absorption (Duy Khoa et al., 2020). The silkworm nutritional profile appears to provide this balance, with balanced fatty acids and amino acids, high protein, and low carbohydrate content (Herawati et al., 2016; Prakash et al., 2024; Sravani et al., 2025), allowing for optimal allocation of metabolic energy and greater utilization of protein for biomass formation.

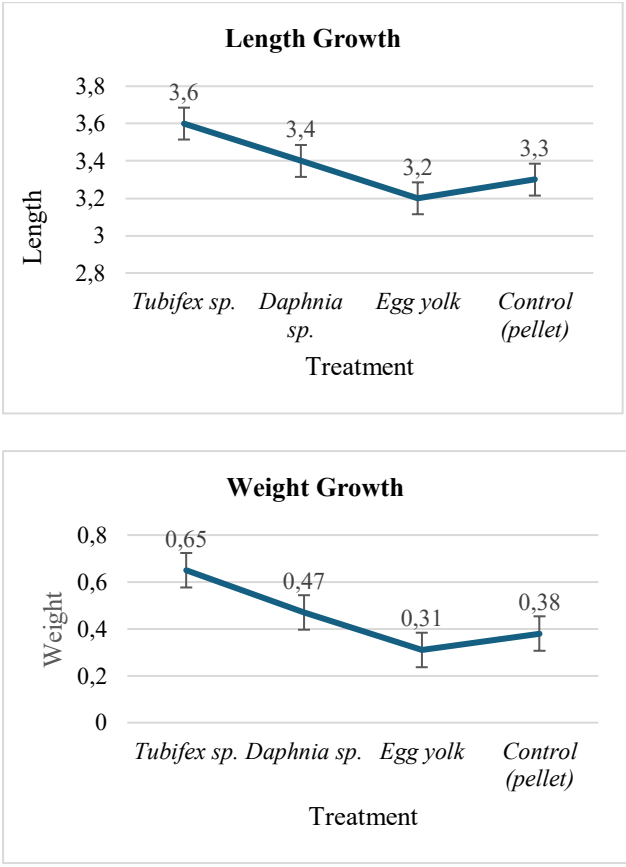


Figure 2. Growth and distribution of energy

Conversely, the high-fat, low-protein content of egg yolks results in less efficient nutrient utilization, limiting the accumulation of seed biomass. According to Guo et al. (2024) and Benini et al. (2022),

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high lipid content can lead to inefficient nutrient utilization, as seen in studies showing that lipid metabolic pathways dominate during yolk absorption. In addition, an imbalance between lipids and proteins can limit the efficient conversion of yolk nutrients into biomass, because protein is essential for tissue synthesis and enzymatic function. Yolk-derived proteins and lipids are mobilized through distinct but coordinated metabolic pathways during early development. In zebrafish, disrupting the transport of yolk-derived lipids impairs post-segmentation growth, highlighting the importance of lipid mobilization for normal embryonic development (Sun et al., 2026). Moderate growth performance in the water flea treatment is thought to be related to lower protein content and a relatively hard exoskeleton, which can reduce digestive efficiency and feed consumption during the early fry phase.

Water Quality

Throughout the study, water quality parameters remained within the optimal tolerance range for African catfish fry. This indicates that differences in fry growth and survival were more influenced by feed treatment than by environmental factors.

Table 2. Water Quality Parameters

Parameters	Observation Range	Optimal Range (SNI 2014)
Temperature (°C)	26-30	25-30°C
pH	8.6 – 9.0	6,5 – 9,0
DO (mg/l)	4,5 - 6,9	> 3
Ammonia (mg/l)	0.020-0.232	> 0,1

Implications for Hatchery Management

Overall, silkworms demonstrated the highest nutritional efficiency compared to other natural feeds, as reflected in the increased growth and survival of fry. These findings emphasize the importance of selecting nutritionally and biologically appropriate feeds in the early stages of fry rearing. In practice, silkworms have the potential to be an economical natural feed alternative for small- to medium-scale hatchery units. However, their use requires proper sanitation management to minimize the risk of pathogen introduction. The results of this study contribute to the development of nutritional efficiency-based feeding strategies to improve the quality of African catfish fry in hatchery systems.

CONCLUSION

Natural feed significantly influences the growth and survival of African catfish (*Clarias gariepinus*) fry. Among the feeds tested, silkworms (*Tubifex* sp.) showed the highest nutritional efficiency, as reflected by statistically higher increases in length growth, weight gain, specific growth rate, and fry survival compared to *Daphnia* sp. and egg yolk treatments. The superior performance of fry-fed silkworms is related to their high protein content and energy balance, which support optimal nutrient utilization for somatic growth, resulting in more efficient allocation of protein to body biomass. Conversely, feeds with low protein content showed lower nutritional efficiency and limited fry growth.

ACKNOWLEDGMENTS

We would like to thank the Mini Hatchery Laboratory of the Faculty of Fisheries and Marine Sciences, University of Borneo Tarakan, as well as students Nurlina, Siska and all parties who have contributed so that this research can be carried out well.

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