# EFFECT OF INCORPORATING BLOOD MEAL INTO FEED ON THE GROWTH PERFORMANCE OF CATFISH (*Clarias gariepinus*).


## ABSTRACT

**Aims:**To evaluate the effect of incorporating blood meal into the diet of catfish (*Clarias gariepinus*).

**Study design**: Experimental study to reduce the cost of fish feed

**Place and Duration of Study**: a 63-day trial was conducted at the aquaculture research unit of University of Kara, in Togo, from May 28 to July 30, 2024

**Methodology:**After a two-week acclimation period, 120 juvenile catfish, with an average weight of 138 ± 0.9 g, were distributed in 2.5 $m^3$ tanks at a density of 20 individuals per happa, in triplicate. These fish were fed two isoprotein pelleted diets containing 42% crude protein, with 30% blood meal (A1) and 40% blood meal (A2), respectively; these were distributed manually three times a day throughout the trial. A control fishing operation was conducted weekly to record analytical parameters and adjust the ration.

**Results:**At the end of the trial, the results showed that the highest survival rate, 98.3 ± 1.44%, was recorded in fish fed diet A1, which also exhibited a relatively low feed conversion ratio of 2.23 ± 0.11. The economic analysis revealed a gross profit margin of 1382 FCFA for diet A1, compared to a loss of -2208 FCFA for diet A2.

**Conclusion:**Therefore, it would be advisable to incorporate blood meal into the catfish diet at a rate of 30%.


**Keywords**: *Clarias gariepinus*, blood meal, growth, gross margin

## INTRODUCTION

Aquaculture is now one of the fastest-growing food production sectors, with an average annual growth rate of 8.8% (FAO, 2012). Global aquaculture production of animal species increased by 2.7% in 2020 compared to 2019, the lowest annual growth rate in over 40 years. Fisheries production reached an all-time high of 179 million tons in 2018, driven by aquaculture, which provided approximately 90 million tons. It then declined slightly in 2019 (down 1% compared to 2018), before recovering very slightly (0.2%) to 178 million tons in 2020 (FAO, 2022). In Togo, with a fish production of around 25,000 tons per year, the country must import between 70,000 and 80,000 tons of fish to meet the needs of this population estimated at nearly 100,000 tons per year based on 13 kg/pers/year (Focus infos, 2020). Faced with this situation, one solution is the development of aquaculture based on species with high growth potential (Béné et al., 2015). Among the promising aquaculture species, the African catfish (Clarias gariepinus) stands out for its robustness and its ability to adapt to varied conditions and is very popular in many countries (Compaore et al., 2016). Its culture has considerable potential to improve food security and generate income in rural areas. However, this field faces the challenge of the high cost of fish feed (Tacon and Metian, 2008). Indeed, this cost represents approximately 50 to 70% of the total operating cost in fish farming (El-Sayed, 2004). This is due to fish meal which is the main ingredient in fish feed. To reduce the price of complete feeds, it is necessary to search for alternative high protein sources to replace fishmeal (Dasuki et al., 2013). Several studies have been conducted in this direction (Eyongetta and Oben, 2016; MbagwuChioma et al., 2022) on the incorporation of blood meal into catfish feed. The availability of this ingredient at the local level led to this study, the objective of which is to contribute to the improvement of catfish farming. Specifically, the aim is to determine the optimal rate of incorporation of blood meal into the diet of juvenile catfish, to evaluate its impact on their growth performance and to carry out an economic analysis of the use of experimental feeds.

## MATERIALS AND METHODS

### ➢ Study environment and rearing system

The study was conducted at the aquaculture experimental unit of the Higher Institute of Agricultural Professions (ISMA) at the University of Kara in Togo. This unit is located in commune 2 of the Kozah prefecture; more precisely, in the canton of Pya, approximately 420 km north of Lome, the capital of Togo. For this feeding trial, 2.5 m³ concrete tanks containing 1 m³ happas, part of an open circuit, were used. Water from the Togolese Water Company (TdE) was used in this unit. This water was stored in a tank for 72 hours and then transferred to rearing tanks. Each tank was supplied with water using a submersible pump from the water storage tank.

### ➢ Biological Material

The experiment was conducted on juvenile catfish *Clarias gariepinus* with an average weight of 138 ± 0.9 g. These fish were sourced from the Shalom farm located in Kovie, Zio Prefecture (Maritime Region).

### ➢ Experimental Material

The trial was conducted with two locally produced isoprotein diets containing 42% crude protein, made from six (6) ingredients, the composition of which is shown in Table 1.

**Table 1**: Formula of experimental feeds (g)

| INGREDIENTS | A1 | A2 |
|---|---|---|
| Corn | 25 | 32 |
| RoastedSoybeans | 30 | 13 |
| Fish Meal | 10 | 10 |
| Blood Meal | 30 | 40 |
| CMV | 3 | 3 |
| PalmOil | 2 | 2 |
| **Total** | **100** | **100** |

## ➢ Experimental Protocol

To assess the effect of incorporating blood meal into the diet on the zootechnical performance of the catfish *Clarias gariepinus*, juveniles with an average weight of 138 ± 0.9 g were used. After two (2) weeks of habituation, the fish were distributed in tanks at a density of 20 individuals per happa (MbagwuChioma et al., 2022) and fed two pelleted isoprotein feeds containing 42% crude protein in triplicate. These were the local feeds, A1 and A2, containing 30 and 40% blood meal, respectively (Table 1). The fish were manually fed three times a day (8 a.m., 12 p.m., and 4 p.m.), every day for two months, with both feeds at a rate of 2.8 to 2% of the fish biomass. The physicochemical parameters of the water (temperature, pH and dissolved oxygen) were recorded twice a week. Water was renewed once a week. Control fishing was carried out once a week to collect data for calculating zootechnical parameters and readjust the ration according to the fish biomass per happa.

## ➢ Blood meal manufacturing procedure

Blood samples were collected at the Kara slaughterhouse. To prevent the blood from clotting, upon receipt, it was immediately poured into a 25-liter plastic container without adding any anticoagulant. Blood meal manufacturing followed the procedure of Boma et al. (2020). Thus, the blood collected in the container was heated over low heat for 10 minutes, at a maximum temperature of 100°C. This eliminates germs and helps evaporate water. After heating, the resulting blood clots were pressed to extract the water. The dehydrated clots were then dried, crushed in a mortar, and sieved to obtain blood meal.

## ➢ Production of experimental local feeds

The production of the experimental feeds followed the procedure of Adjankeand al. (2016). Thus, after sieving and weighing the floury ingredients according to the recipe indicated in Table 1, they were separated into two batches: those containing starch (corn and roasted soybeans) and those without (blood meal, fish meal, and CMV). Hot water was added to the mixture of starch-containing ingredients to gelatinize them. The remaining non-starch ingredients were added and thoroughly mixed. A little water and red oil were added to the mixture, followed by a manual pelletizer to form pellets that were dried on a tarpaulin in the sun, then harvested and stored in pots for use during the trial.

## ➢ Analysis Parameters

To estimate fish growth during the trial, characterize the efficiency of using the different experimental diets, and perform an economic analysis of this trial, the following parameters were calculated (Table 2).

**Table 2**: Formulas for the analysis parameters of the experiment

| Analytical Parameters | Formulas |
|---|---|

| | |
|---|---|
| ***Production Parameters*** | |
| WG: Weight Gain (g) | $WG = Afw - Aiw$ |
| IDG: Individual Daily Growth (g/d) | $IDG = WG/\text{test duration (d)}$ |
| FCR: Feed Conversion Ratio | $FCR = D / (Bf + Bd - Bi)$ |
| S: Survival Rate (%) | $S = 100 \text{ x } (Nf / Ni)$ |
| ***Economic Parameters*** | |
| DC: One Kilogram of Diet Production Cost (F CFA) | $DC = \sum Pi \text{ x } ri$ |
| FC: One Kilogram of Fish Production Cost (F CFA) | $FC = DC \times FCR$ |
| GPM: Gross Profit Margin (F CFA) | $GPM = \text{Total recette} - \text{Total charges}$ |

Aiw: Average initial weight; Afw: Average final weight; D: Quantity of feed distributed; Bi: Initial biomass; Bd: Biomass of dead fish; Bf: Final biomass; Ni: Initial number; Nf: Final number. Pi: Price per kg of the ingredient on the local market; ri: Incorporation rate of the ingredient in the feed.

- **Statistical analysis**

The effect of blood meal incorporation in *Clarias gariepinus* was evaluated by comparing the different production and feed utilization parameters using one-way analysis of variance (ANOVA 1). The Fisher LSD test was used to assess significant differences at the 5% threshold between the different treatments. Statistical analyses were performed using STATISTICA 5.0 software.

## RESULTS AND DISCUSSION

### Results

- **Water Physicochemical Parameters**

The water physicochemical parameters recorded during the test were temperature, dissolved oxygen, and pH. The mean temperature values were 27.34 ± 0.82 °C for batch A1 and 27.12 ± 0.81 °C for batch A2; the mean pH values were 6.98 ± 0.47 for batch A1 and 6.93 ± 0.37 for batch A2. The dissolved oxygen concentrations were 0.94 ± 0.81 mg/L for batch A1 and 0.78 ± 0.69 mg/L for batch A2.

- **Zootechnical Parameters**

The average values of growth parameters according to heat treatments are presented in Table 3.

**Table 3:** Average values of growth parameters for different batches of fish subjected to different treatments.

| Aliment | Iaw (g) | Faw (g) | Ni | Nf | D (g) | S (%) | WG (g) | IDG (g) | FCR |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 137.27 | $215.25^{a}$ | 20.00 | $19.67^{a}$ | $3443.45^{a}$ | $98.33^{a}$ | $77.98^{a}$ | $1.24^{a}$ | $2.23^{a}$ |
| A2 | 137.92 | $197.35^{b}$ | 20.00 | $19.00^{b}$ | $3189.70^{b}$ | $95.00^{b}$ | $59.43^{b}$ | $0.94^{b}$ | $2.75^{b}$ |

A1 and A2: Diet containing 30% and 40% blood meal, respectively. Pmi: Initial average weight; Pmf: Final average weight; D: Feed quantity distributed; S: Survival rate; WG: Weight gain; CIJ: Individual daily growth; FCR: Feed conversion ratio. Numbers in columns with different letters are statistically different ($P < 0.05$).

The survival rate of the different groups at the end of the trial ranged from 95.0 ± 0.0% to 98.3 ± 1.4%. The survival rate was higher in group A1 compared to that of group A2, with a significant difference between the two groups ($P < 0.05$).

Feed utilization is characterized by the Feed Conversion Rate (FCR). It was noted that feed conversion was poor in fish from group A2 compared to those from group A1, with a significant difference between the two groups ($P < 0.05$).

The Individual Daily Growth (IDG) values of the different groups of fish at the end of the trial show that fish from group A1 gained more weight daily than those from group A2, with a significant difference between these two groups ($P < 0.05$).

Figure 1 shows the evolution of the average individual weight of fish from the different groups during the trial. Growth was effective in all groups from the beginning to the end of the trial. At the beginning of the trial, the average weight of fish from both groups was identical. However, from this point until the end, a divergence in growth was observed. Fish from group A1 had a higher average final weight than those from group A2 ($P < 0.05$).

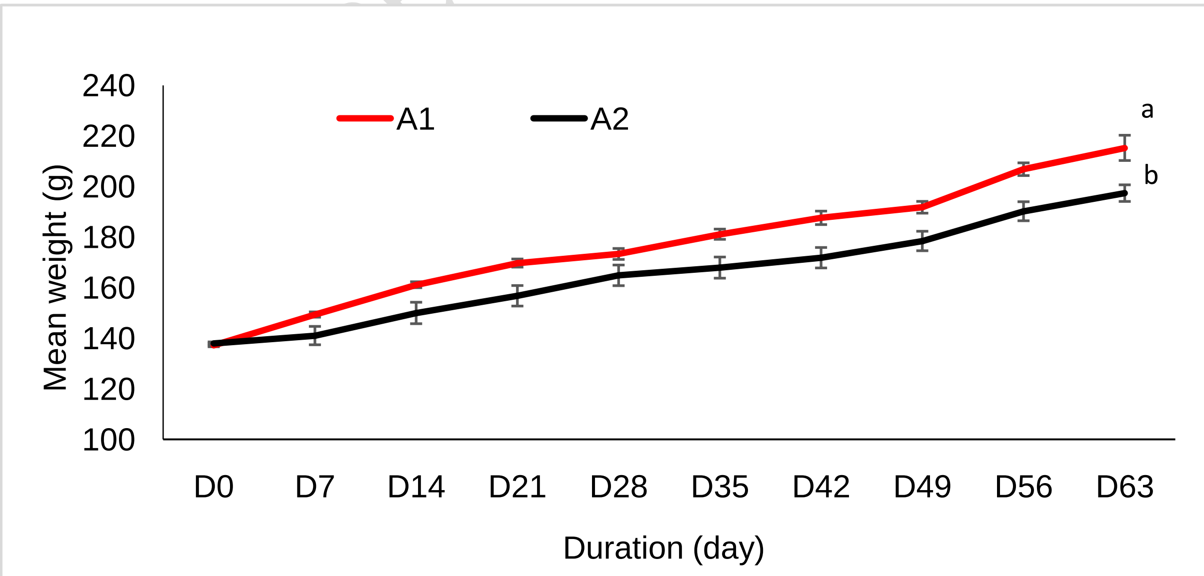


**Figure 1**: Weight growth of *Clarias gariepinus* flocks fed different diets

A1 and A2: Diets containing 30% and 40% blood meal, respectively. Curves with different letters are statistically different (P<0.05).

- **Economic Analysis of Feed Use**

The cost per kilogram of feed was determined based on the price of raw materials available on the local market and the percentage incorporation of different ingredients in the formula. Thus, after calculation, the local pelleted feed containing 30% blood meal (A1) costs 585 FCFA per kilogram, while the feed containing 40% blood meal (A2) costs 620 FCFA per kilogram.

The feed cost of producing one kilogram of fish was estimated by multiplying the price of one kilogram of feed by the feed conversion rate. Thus, one kilogram of fish produced with feed A1 costs 1,305 CFA francs compared to 1,705 CFA francs with feed A2. This calculation demonstrates that producing one kilogram of fish with feed A2 costs more than with feed A1.

The trial incorporating blood meal into catfish feed is primarily a production trial. To this end, we intentionally ignored other costs inherent to the operation, considering only the costs of feed at production value, water pumping, feeding, and control fishing. Table 4 illustrates the gross profit margin for using the different diets for each batch of fish during the trial.

**Table 4:** Gross profit margin by treatment

| **Category** | **A1** | **A2** |
|---|---|---|
| ***Revenue*** | | |
| Total fish biomass produced (kg) | 4,5 | 2,97 |
| Price per kilo of fish (FCFA) | 2500 | 2500 |
| Total revenue (FCFA) | **11125** | **7425** |
| ***Expenses*** | | |
| Feed (FCFA) | 6043 | 5933 |
| Water pumping (FCFA) | 1000 | 1000 |
| Feeding (FCFA) | 1200 | 1200 |
| Control fishing (FCFA) | 1500 | 1500 |
| **Total expenses (FCFA)** | **9743** | **9633** |
| **Gross profit margin (FCFA)** | **1382** | **-2208** |

A1 and A2: Diet containing 30% and 40% blood meal, respectively. Control fishing: weekly water renewal and fish biomass intake. Feeding: distribution of feed to the fish at regular times (8 a.m.; 12 p.m.; 4 p.m.). Water pumping: use of the water pumping machine to supply water to the tanks.

This calculation highlights the economic benefits of using A1 feed rather than A2 feed. The A1 diet appears to better utilize local by-products, while maintaining satisfactory growth performance.

## Discussion

### ➢ Physicochemical Water Parameters

During the trial, the average values of the physicochemical water parameters (temperature, pH, and oxygen) recorded corresponded to the ranges required for optimal catfish growth. The average temperature recorded was 27 ± 0.82 °C. This value is within the optimal catfish growth range according to Hecht (2013). The average pH recorded ranged around 6.95 ± 0.42. Kanangire (2001) showed that the optimal pH for *Clarias gariepinus* growth is between 6.5 and 9. The dissolved oxygen content of the recorded water ranged around 0.86 ± 0.75 mg/L on average. This value, although low, cannot influence juvenile catfish because these individuals have supra-branchial apparatus allowing them to take advantage of atmospheric oxygen (Fagbenro and Sydenham, 1988).

### ➢ Zootechnical Parameters

At the end of the trial, the survival rates obtained were 95.00 ± 0.00 and 98.33 ± 1.44%. These rates indicate excellent survival, which is crucial for the economic viability of aquaculture. Similar studies, such as those by Tacon and Metian (2008), have reported comparable survival rates using diets enriched with alternative proteins. Furthermore, Khalil (2017) observed survival rates of up to 97% when incorporating animal meal into catfish diets. The results obtained in this study are believed to be due to the increased blood meal content in the diet. Indeed, Gatlin et al. (2007) reported that protein-rich ingredients can strengthen the fish's immune system, contributing to a high survival rate. Growth parameters varied significantly from one diet to another. We observed high growth and relatively low feed conversion rate in fish fed the A1 diet. Studies such as Hossain (2007) have shown similar weight increases with protein-enriched diets, reinforcing the idea that blood meal can be an effective alternative. According to Tacon and Metian (2008), better feed assimilation promotes not only growth but also muscle development of fish. Regarding individual daily growth, the results obtained were 1.24 ± 0.07 g/d and 0.94 ± 0.07 g/d. These values are similar to those reported (1.1-1.7 g/d) by Yi and Lin (2001) in integrated cage fish farming systems. These low daily growth rates may be due to the low turbidity of the water during the experimental period. In this trial, the recorded feed conversion ratios ranged from 2.23 ± 0.11 (A1) to 2.75 ± 0.15 (A2). A FCR of less than 3 is considered satisfactory in aquaculture, indicating efficient conversion of feed into biomass. Naylor et al. (2000) reported similar FCRs when using alternative protein meals, supporting the idea that blood meal may be a viable option compared to traditional fish meals. Catfish are protein-loving fish, but blood meal is deficient in certain products (lysine and methionine), resulting in poor uptake in fish from batch A2 and better uptake in batch A1. According to Bureau et al. (2000), better protein digestibility results in lower TCA, which is beneficial for profitability in aquaculture. Studies conducted in Cameroon by Eyongetta and Oben (2016) on the use of blood meal on the growth and mortality of juvenile catfish, with feeds containing 0 to 20% blood meal showed that growth performance was better in fish fed with a feed containing 10% blood meal. Furthermore, MbagwuChioma et al. (2022) conducted a study in Nigeria on the effect of incorporating blood meal in the diet on the zootechnical performance of juvenile *Clarias gariepinus*, whose blood meal is incorporated at rates of 0 to 100%. They found that incorporating 25% blood meal in fish feed has a negative effect on fish growth. At the end of this study, an incorporation rate of 30% was found to be beneficial for the growth and survival of juvenile catfish.

- **Economic Analysis**

This section aims to compare the economic results obtained with feeds A1 and A2, which exhibited different zootechnical performances, in order to identify which is the most profitable. Traditionally, farm balance sheets involve preparing an operating statement including total costs and revenues generated (Iga-Iga, 2008). In our study, given that this is a production trial, we deliberately omitted certain operating costs to focus solely on the costs of feed, water pumping, feeding, and control fishing. In aquaculture, feed accounts for approximately 70% of total costs and its cost is the most significant factor in overhead costs (El-Sayed, 2004). Thus, this approach makes it possible to assess the gross profit margin that each feed could generate. Comparing the relatively identical costs with the production value, we obtain a gross profit margin of 1,382 CFA francs using feed A1 against a loss of -2,208 CFA francs for feed A2. From an economic point of view, feed A1 proves to be the best compromise between quality and price compared to feed A2.

## CONCLUSION

The overall objective of this study was to improve catfish farming by determining the optimal rate of blood meal incorporation into the diet and assessing its impact on the zootechnical and economic performance of juvenile catfish. By evaluating two pelleted isoprotein feeds containing 42% protein and 30% and 40% blood meal, respectively, the results showed a higher survival rate in fish fed the feed containing 30% blood meal, as well as a relatively low feed conversion rate, demonstrating the effectiveness of this diet. From an economic perspective, the 30% blood meal feed offers the best compromise in terms of quality and cost compared to the 40% blood meal feed. These zootechnical and economic performances highlight the interest of incorporating blood meal into catfish feed at a rate of 30%, which could not only optimize production costs but also improve fish welfare. This study paves the way for innovative feeding practices that could revolutionize catfish aquaculture, while addressing current economic and ecological challenges.

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