Effect of Replacement of Fishmeal With Lima Bean Meal on the Zootechnical Performances of African Catfish (Clarias Gariepinus) in the Batié Sub-Division, West Region of Cameroun

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Abstract
This study was conducted to evaluate the effect of the substitution of fishmeal by Lima bean flour on the growth performance, survival rate and feed cost of Clarias gariepinus between March and May 2018 within the AIO ICG of the Batié District. It also aimed to contribute to the development of alternative sources of animal protein on a global scale. For this purpose, 300 fry of Clarias gariepinus with an average weight of 3 ± 1.41 g were divided into five batches and fed three times a day with rations corresponding to 5% of their ichthyobiomass. The rations $R_0$, $R_{25}$, $R_{50}$, $R_{75}$ and $R_{100}$ respectively corresponded to the substitution rates of 0, 25, 50, 75 and 100% of fish meal by that of Lima bean. The physic-chemical characteristics of the water (pH, temperature, dissolved oxygen, nitrites and nitrates) were measured daily. The following results were obtained: The highest weight gains were obtained with the rations $R_{25}$ (20.56 ± 0.40 g), $R_{50}$ (20.64 ± 0.32 g), $R_{75}$ (20.98 ± 0.46 g) and the lowest with the rations of $R_{100}$ (16.21 ± 0.28 g). The highest average daily gain were 0.36 ± 0.02 g; 0.37 ± 0.01 g ; 0.38 ± 0.01 g respectively for the $R_0$, $R_{50}$ and $R_{75}$ rations and the lowest with $R_{100}$ (0.29 ± 0.01 g). The highest value of the specific growth rate (2.47 ± 0.07%) was obtained with the ration $R_0$ and the lowest (1.61%) with the ration $R_{100}$. The consumption index reached its highest and lowest values with the rations $R_{100}$ (4.74 ± 0.42) and $R_{50}$ (3.57 ± 0.43) respectively, compared to the value of the ration $R_0$ (3.31 ± 0.37) for this parameter. Concerning the condition factor K, the highest value was recorded with the $R_{50}$ diet (1.11 ± 0.49) while the lowest value was obtained with the $R_{75}$ diet (0.95 ± 0.45). The cost of producing one kilogram of food was higher with the $R_{25}$ ration (504.59 FCFA) and lower with the $R_{100}$ ration (443.20 FCFA). Our results revealed that incorporating 75% Lima bean flour into the feed increases the growth performance of Clarias gariepinus fry and reduces the cost of food production.

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**Introduction**

Global fish production and demand are steadily increasing and have increased fivefold in less than 10 years (FAO, 2017)\(^\text{11}\). Production increased from 39 million tons in 2010 to 174.1 million tons in 2016 (FAO, 2017)\(^\text{11}\). In addition, its global *per capita* consumption per year has increased from an average of 9.9kg in the 1960s to over 20kg in 2016 (FAO, 2016)\(^\text{10}\). In sub-Saharan Africa, fish products contribute an average of 50% of GDP in protein intake of animal origin but are still insufficient (FAO, 2012)\(^\text{9}\). In Cameroon, the high protein demand linked to the impetus of the demographic growth of the population is generating interest in fish farming, which represents an alternative that can promote self-sufficiency of rural populations and food security (Marquet, 1985)\(^\text{20}\). However, fish farming faces many constraints, the main ones being the lack of fry and quality feed, the unavailability of by-products and the high costs of imported food (Hishamunda and Ridler, 2003, Moehl et al., 2006)\(^\text{14,23}\). Because of the high costs of imported feeds and the unavailability of certain ingredients, the protein component mainly made of fishmeal, remains the most expensive (Alphonsus et al., 2009)\(^\text{5}\) and it is urgent to find alternative sources available and less expensive. Thus, several studies have been conducted on the substitution of fishmeal by other protein sources, whether of plant or animal origin (Pouomogne, 1994; Olaniyi and Salau, 2013)\(^\text{25,26,28}\). Hence, this has led to the attempt or the replacement to total or partial fish meal with that of Lima bean (*Phaseolus lunatus*). The species *Phaseolus lunatus* is one of the least used legumes in Cameroon. This bean has an amino acid profile similar to that of common beans (Ologhobo, 1980, Aletor and Aladetimi, 1989)\(^\text{27,4}\) but because of the ignorance of its nutritional potential, its culture is neglected. Thus, in order to get breeders to take an interest in this alternative source of protein, this research work has been initiated with the global objective of contributing to the development of alternative sources of protein in the diet of fish. More specifically, it was undertaken to evaluate the effect of Lima bean flour on the survival rate, growth performance and finally on the economic cost of producing *Clarias gariepinus*.

**Materials and Methods**

**Study Zone**

The study took place within the Joint Initiative Group of Integrated Western Aquaculture (ICG AIO), located between 5° 17′0″-5° 18′53″ of latitude North and 10° 17′0″-10° 19′31″ east longitude and at an altitude of 1700 m in the West Region of Cameroon, Haut-Plateau Division, specifically in the Batie Sub-division. The climate is the Sudano-Guinean type and includes a rainy season (mid-March to mid-November) and a dry season (mid-November to mid-March). The temperature and average rainfall are respectively 23 °C and 1621 mm / year.

**Biological Material**

Three hundred (300) *Clarias gariepinus* fry with a mean weight of 3 ± 1.41 g and a mean total length of 7 ± 1.45 cm were used. These fry were divided into five (5) batches according to the different diets tested. The loading of these fry, resulting from an artificial reproduction made within the GIC, was 20 fry per basin. Lima bean (*Phaseolus lunatus*) and agricultural byproducts were purchased from the Bafoussam city market.

**Production of Lima Bean Flour**

Fourteen (14) kilograms of beans were boiled 100°C for 2 hours and then dried under the sun to constant weight. It was then crushed and mixed with other agricultural by-products according to the food rations formulated.

**Experimentation and Data Collection**

Fifteen (15) circular basins of 1m\(^3\) each, filled with drilling water were used. The volume of water in each basin was 900 liters and the water was renewed to two-thirds (2/3) every day. To this, three hundred (300) *Clarias gariepinus* fry with comparable size and weight were randomly divided into five lots with three replicates per batch. Each batch was randomly assigned to one of the R0, R25, R50, R75 and R100 experimental diets formulated. The compositions and the bromatological characteristics are given in Table 1. The feed was distributed three times a day (7am, 12h and 18h) at 5% of ichthyobiomass (Tomedi et al., 2008, Ani et al.,
for 56 days during the experiment, and the quantity was readjusted after each control fishery.

Every two weeks, a control fishery was conducted and 25% of the fish in each treatment were individually weighed using an electronic scale of 0.1 gram precision and measured with a 0.1mm precision ichthyometer. This made it possible to evaluate the growth characteristics of the fish and readjust the quantity of food to be distributed during the two following weeks.

In parallel with the data collection, the physical and chemical parameters of the water were obtained in situ between 06:00 and 07:00 in each basin: it consisted of taking the temperature, the pH, the ammonia, the nitrites, nitrates and dissolved oxygen from the water respectively using a HANNA mini-maxi thermometer, a Waterproof pH meter, a Tera nitrite chemical kit, and an EUTECH instrument or meter instrument. At the end of the test, all the fish were counted, weighed and measured.

Survival Rate and Growth Parameters
- The survival rate is the ratio (in percentage) between the number of fish at the end of the observation and the initial number of fish.

\[
\text{Loss of survival (\%) } = \frac{\text{Final number of fish}}{\text{Initial number of fish}} \times 100
\]
- Weight gain: It evaluates the growth (weight) of fish at a given time.

\[
\text{Weight gain (g) } = \frac{\text{Final average weight}}{\text{Initial number of fish}} \times 100
\]
Initial average weight

- **Average daily gain** gives information on the daily growth rate of fry during the experimental period.

\[
\text{Average daily gain (g/d) = Weight gain / time (number of days)}
\]

- Specific growth rate: it helps to evaluate the weight gained by the fish every day from its live weight.

\[
\text{Specific growth rate (%) = } \left( \frac{\text{final average weight} - \text{initial average weight}}{\text{time (number of days)}} \right) \times 100
\]

- Condition factor K: it gives the overweight of fish during the experiment.

\[
\text{Condition factor K (%) = } \left( \frac{\text{weight in g}}{\text{L} \times \text{total length}^3} \right) \times 100
\]

- Consumption index: it is a coefficient which is often used by zootecnicos to characterize the efficiency of feed.

\[
\text{Consumption index = quantity of food served / weight gain}
\]

**Financial Evaluation**

The financial evaluation of the ration was made on the basis of the prices of the different ingredients on the market and on the basis of the cost of production of the kilogram of Lima beans.

- **Cost of Feed Consumption** = Cost of Kg of Feed x Feed Consumption
- **Production Feed Cost** = Feed Consumption Cost x Consumption Index

**Statistical Analyzes**

The growth and biochemical parameters were expressed on mean standard deviation and in percentages. One-way analysis of variance (ANOVA) was used to test the effects of treatment and the Ducan test (at 5% threshold) to separate the means when there was a significant difference. SPSS 20.0 software was used for analysis.

**Results and Discussion**

**Results**

*Effect of the Substitution of Fishmeal by Lima Bean Meal in the Feed on the Survival Rate of Clarias Gariepinus*

The effect of fish meal replacement by Lima bean flour on the survival rate of *Clarias gariepinus* is shown in Figure 1. It shows that the highest survival rate (98.4 ± 2.3%) was obtained with the R50 ration followed by R75 and R100 (97.6 ± 2.5%). The lowest value (96.5 ± 2.5%) was recorded with the R25 diet, although no significant difference was observed between the diets (R0, R25, R50, R75 and R100).

*Effect of Fishmeal Substitution by Lima Bean Flour on the Growth Characteristics of Clarias Gariepinus*

The effect of the substitution of fishmeal by Lima bean flour on growth characteristics is summarized in Table 2 and illustrated in Figures 2 to 6. It is generally apparent that all characteristics were significantly affected. From Table 2, it appears that the R100 diet gave the significantly (p < 0.05) lowest weight gains (GP). On the other hand, no significant (p > 0.05) difference (p > 0.05) was observed between the other treatments. Regarding average daily earnings (ADG), the lowest significant (p < 0.05) value was obtained with the R100 ration. The latter was comparable (p > 0.05) to rations R25. The R75 diet gave the highest value but comparable (p > 0.05) to that of the R0 and R50 values.

With respect to the specific growth rate, the values were comparable (p > 0.05) with the R0 to R75 diets and significantly low with the R100 diet. With regard to the condition factor K, it recorded the values significantly (p < 0.05) higher with the ration R50, R25 and R0 and significantly (p < 0.05) lower with the R75 and R100. The opposite trend was observed with the consumption index with R100 having the significantly (p < 0.05) higher index value.

*Effect of Fish Meal Substitution by Lima Bean Meal on Clarias Gariepinus Weight Gain*

The effect of fish meal replacement by Lima bean flour on the weight gain of *Clarias gariepinus* fry, as shown in Figure 2, shows that the weight gain generally increased over time regardless of the food ration experienced. However, weight gains were significantly greater with the R75 (20.98 ± 0.46g), R50 (20.64 ± 0.32g), R0 (20.25 ± 0.44g) and R25 (18.56 ± 0.40 g) in contrast to the R100 diet which was the lowest value (16.21 ± 0.28 g).
**Figure 1.** Effect of fishmeal substitution by Lima bean meal on the survival rate of *Clarias gariepinus*

R0-R100: Rations containing respectively 0%, 25%, 50%, 75% and 100% Lima bean flour; TS: survival rate

**Figure 2.** Effect of the substitution of fishmeal by Lima bean meal on the weight gain of *Clarias*

R0-R100: Rations containing respectively 0%, 25%, 50%, 75% and 100% Lima bean flour
Figure 3. Effect of the substitution of fish meal by bean flour on the average daily gain of *Clarias gariepinus*

**ROI-R100**: Rations containing respectively 0%, 25%, 50%, 75% and 100% Lima bean flour
Average Daily Gain of Clarias Gariepinus Fry

Figure 3 illustrates the effect of fish meal replacement by Lima bean flour on average daily gain in Clarias gariepinus fry. Generally, it appears that the average daily gain increased throughout the study period regardless of the treatment. However, it was significantly (p<0.05) higher with the R0 (0.36 ± 0.02g), R50 (0.37 ± 0.01g) and R75 (0.38 ± 0.01g) rations, while the most less values 0.33 ± 0.01 g and 0.29 ± 0.01 g were obtained with R25 and R100 respectively.

Effect of Fish Meal Replacement by Lima Bean Meal on the Specific Growth Rate of Clarias Gariepinus

The effect of fish meal replacement by lima bean meal on the specific growth rate of Clarias gariepinus (Figure 4) shows that R0 (2.47 ± 0.07%), R25 (2.2 ± 0.05%), R50 (2.33 ± 0.1%) and R75 (2.18 ± 0.45%) were significantly (p<0.05) higher than the R100 diet (1.61 ± 0.04%) which recorded the lowest value.

Effect of Fishmeal Substitution by Lima Bean Meal on the Condition Factor of Clarias Gariepinus

The effect of the substitution of fishmeal by Lima bean flour on the condition factor K is shown in Figure 5. It is apparent that the overall trend, profile and the pace are comparable between treatments. However, the rations R25 (1.11 ± 0.49), R50 (1.01 ± 0.43) and R0 (0.99 ± 0.38) recorded the significantly (p<0.05) highest values, unlike the 0.96± 0.38 and 0.95 ± 0.45 values of R75 and R100 respectively.

Effect of Fishmeal Substitution by Lima Bean Meal on the Consumption Index of Clarias Gariepinus

The consumption index of Clarias gariepinus, as illustrated in Figure 6, was signficantly (p<0.05) affected by the substitution of fishmeal with Lima bean flour. Thus, the lowest index value (3.31 ± 0.37) was recorded in the lots that received the R0 ration followed by R50 (3.47 ± 0.43) and the highest (4.74 ± 0.42) was obtained with R100. This characteristic tends to increase with the level of substitution.

Correlation between the growth Characteristics of Clarias gariepinus and the Physicochemical Parameters of Water

In general, the growth characteristics were not influenced by the physical and chemical parameters of the water, with the exception of the consumption indices of the R0 and R50 diets, which significantly (p<0.05) were affected by the temperature of the water and the rate of nitrite; and mean daily gain (ADG) that was significantly influenced (p<0.05) by pH and dissolved oxygen. (Table 3)

Financial Evaluation

The economic evaluation of the different rations is summarized in Table 4. It appears that the R100 ration had the lowest production price (443.2 FCFA), followed by R75 (469.48 FCFA) and R50 (487.09FCFA). However, the best value for money was obtained with R75. (Table 4)

Discussion

The results show that survival rates were not significantly affected by the different percentages of fish meal substitution by Lima bean flour. This rate varied from 96.5 ± 2.50 to 98.4 ± 2.30%. These results are similar to those obtained by Pouomogne (2013)30 who recorded a maximum survival rate of 96.66% and those of Keremah et al. (2014)18 who obtained a survival rate ranging from 76.7 to 96.7%. They are also similar to those obtained by Lacroix (2004)19 who registered a survival rate ranging from 98 to 100% in Clarias gariepinus in breeding fish ponds. The lack of difference reflects the fact that Lima beans can substitute fishmeal without affecting the survival of fish.

Results on growth characteristics indicated that the weight gain, average daily gain, and specific growth rate of fish fed with the feed containing different levels of Lima bean meal were significantly comparable to those receiving the control diet, with the exception of fish fed with the R100 diet. These results are in accordance with the work of Adeparusi and Olute (2000)2 who evaluated the influence of a food-based diet of Lima bean (80%) in Oreochromis niloticus and found that the diet containing approximately 20% of fish meal gave the best results. They are also similar to those obtained by Ekoue et al., (2013)8 who observed that feed with similar composition gave the best results with substitution rates of 30 and 60% of fish meal by lima bean meal on juveniles of Clarias gariepinus. These similar results may be due to the fact that proteins and other nutritive substances in the lima bean were assimilated by the fry of Clarias gariepinus. However, these results are in contrast with those of Abel et al.,1
Figure 4. Effect of the substitution of fishmeal by Lima bean flour on the specific growth rate of *Clarias gariepinus*

**R0-R100**: Rations containing respectively 0%, 25%, 50%, 75% and 100% Lima bean flour

Figure 5. Effect of the substitution of fishmeal by Lima bean meal on the overweight of *Clarias gariepinus*

**R0-R100**: Rations containing respectively 0%, 25%, 50%, 75% and 100% Lima bean flour

Figure 6. Effect of fishmeal substitution by Lima bean meal on the consumption index of *Clarias gariepinus*

**R0-R100**: Rations containing respectively 0%, 25%, 50%, 75% and 100% Lima bean flour
### Table 3. Correlation between the growth characteristics of *Clarias gariepinus* and the physicochemical parameters of water

<table>
<thead>
<tr>
<th>Rations</th>
<th>Growth characteristics</th>
<th>Correlation</th>
<th>T(°C)</th>
<th>pH</th>
<th>NO₂⁻(mg/l)</th>
<th>NO₃⁻(mg/l)</th>
<th>Oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td>R₀</td>
<td>K</td>
<td></td>
<td>0.351</td>
<td>0.163</td>
<td>0.773</td>
<td>-0.026</td>
<td>-0.903</td>
</tr>
<tr>
<td></td>
<td>CI</td>
<td>0.999*</td>
<td></td>
<td>-0.889</td>
<td>0.840</td>
<td>-0.959</td>
<td>-0.686</td>
</tr>
<tr>
<td></td>
<td>ADG</td>
<td>0.639</td>
<td></td>
<td>-0.169</td>
<td>0.938</td>
<td>-0.353</td>
<td>-0.994</td>
</tr>
<tr>
<td></td>
<td>weights</td>
<td>0.371</td>
<td></td>
<td>0.143</td>
<td>0.785</td>
<td>-0.047</td>
<td>-0.911</td>
</tr>
<tr>
<td>R₂₅</td>
<td>K</td>
<td>-0.087</td>
<td></td>
<td>-0.574</td>
<td>0.423</td>
<td>0.423</td>
<td>-0.201</td>
</tr>
<tr>
<td></td>
<td>IC</td>
<td>-0.437</td>
<td></td>
<td>-0.828</td>
<td>0.071</td>
<td>0.071</td>
<td>-0.537</td>
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<tr>
<td></td>
<td>ADG</td>
<td>0.765</td>
<td></td>
<td>0.985</td>
<td>0.341</td>
<td>0.341</td>
<td>0.834</td>
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<tr>
<td></td>
<td>weights</td>
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<td>-0.225</td>
<td>0.731</td>
<td>0.731</td>
<td>0.181</td>
</tr>
<tr>
<td>R₅₀</td>
<td>K</td>
<td>-0.941</td>
<td></td>
<td>0.988</td>
<td>-0.848</td>
<td>-0.779</td>
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<td></td>
<td>CI</td>
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<td>-1.000*</td>
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<td></td>
<td>ADG</td>
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<td>-0.766</td>
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<tr>
<td></td>
<td>weights</td>
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<td></td>
<td>-0.996</td>
<td>0.693</td>
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<tr>
<td>R₇₅</td>
<td>K</td>
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<td>-0.056</td>
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<td></td>
<td>CI</td>
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<td>-0.941</td>
<td>-0.289</td>
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<td>ADG</td>
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<td>0.667</td>
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<td>-0.919</td>
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<td>0.189</td>
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<td>R₁₀₀</td>
<td>K</td>
<td>0.520</td>
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<td>0.854</td>
<td>-0.155</td>
<td>-0.024</td>
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<tr>
<td></td>
<td>CI</td>
<td>0.989</td>
<td></td>
<td>-0.931</td>
<td>-0.150</td>
<td>-0.971</td>
<td>-0.931</td>
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<tr>
<td></td>
<td>ADG</td>
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<td></td>
<td>-1.000**</td>
<td>-0.499</td>
<td>-0.991</td>
<td>-1.000**</td>
</tr>
<tr>
<td></td>
<td>weights</td>
<td>-0.971</td>
<td></td>
<td>0.961</td>
<td>0.241</td>
<td>0.989</td>
<td>0.961</td>
</tr>
</tbody>
</table>

*. Correlation is significant at 0.05 (bilateral)

**. Correlation is significant at 0.01 (bilateral).

### Table 4. Evaluation of the cost of different rations

<table>
<thead>
<tr>
<th>Experimental rations</th>
<th>R₀</th>
<th>R₂₅</th>
<th>R₅₀</th>
<th>R₇₅</th>
<th>R₁₀₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of a kg of feed</td>
<td>522.195&lt;sup&gt;b&lt;/sup&gt;</td>
<td>504.59&lt;sup&gt;b&lt;/sup&gt;</td>
<td>487.09&lt;sup&gt;b&lt;/sup&gt;</td>
<td>469.48&lt;sup&gt;a&lt;/sup&gt;</td>
<td>443.20&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Feeding cost of a kg of fish</td>
<td>1044.39</td>
<td>787.16</td>
<td>774.47</td>
<td>1065.72</td>
<td>899.69</td>
</tr>
</tbody>
</table>

R₀–R₁₀₀: Rations containing respectively 0%, 25%, 50%, 75% and 100% of Lima bean flour. Prices with the same letters for the same line are not significantly different (p>0.05).
(1984) who observed that the feed of mirror carp containing 50% of soy bean meal treated with heat replacing half of the fish meal reaches 60 to 65% of growth with feed made from fishmeal.

Moreover, the individual average daily gain registered in the present study (0.35g/day) is higher than that obtained by Gandaho (2007)[12,13] with moringa leaves (0.19g/day) but remains inferior to 0.47g/j as reported by Mouori (2007)\(^{24}\) and to 0.45g/day obtained by Ekoué (2013)\(^{8}\) who substituted fish meal by soy bean meal in juveniles of *Clarias gariepinus*. This average daily gain is equally ten times inferior to 3g/day obtained by Micha (1974) and Lacroix (2004)[19,21] in juveniles of *Clarias gariepinus* fed with feed grading 40 and 30% protein respectively and raised to 30°C. These results can justified by the environmental conditions of these studies specifically the average temperature which is around 23.01°C.It is the same with the values of the specific growth rate (1.61% to 2.51%) which are greater than 0.04 to 0.18%/day obtained by Pouomogne (1995)\(^{29}\) and to 0.78% reported by Keremah et al., (2014)\(^{18}\). However, they are inferior 2.90 %/day; 3.4 %/ day and 4.14 to 5.80 %/day obtained respectively by Lacroix (2004); Hoffman et al., (1997) and Toko (2007)[15,16,19] in *Clarias gariepinus*. The values of the specific growth rate are also inferior3.60%/day as presented (Ekoué, 2013)\(^{8}\) in juveniles of the same species and to the values obtained by Kanangire (2001)\(^{17}\) in the same species. The values obtained by Kanangire (2001)\(^{17}\) are around 4.26; 4.05 and 3.85 %/j gotten respectively for feed in Azolla (0%, 30%, and 50%). These low performances may be due to the experimental conditions. In facts, the average temperatures (23.01°C) of our experiment were lower than 27.4°C of Keremah et al., (2014)\(^{18}\). The thermal interval favourable to a better growth of *Clarias* is around 26 and 30°C (Baras and Jobling, 2002)\(^{7}\). The difference observed can be due to the genetic material used and to the feed quality because is an omnivorous species with a carnivorous tendency.

The condition factor K which gives the overweight of fish varies with the treatment (rations) and was greater than 1 for the R\(_{25}\) and R\(_{50}\)reflecting a good weight according to Fulton (1902) who reported that when K>1 it means that the fish has a good weight.In fact, the condition factor K obtained in *C. gariepinus* in this study was between 0.95 et 1.11. These values are comparable (P> 0.05) to those (0.62 à 1.86) reported by Mlewia et al., (2004)\(^{22}\) in *Protoperus aethiopicus* and superior to those obtained by par Rukera et al.,\(^{31}\) (2005) (0.79 à 0.83% ) in *C. gariepinus* raised at many density and fed with complete feed or to those reported by Ekoué (2013)\(^{8}\) (0.06 à 0.74). The difference between these values might be due to an optimal use of plant resources in livestock breeding.

Regarding dietary parameters, the consumption index was significantly comparable between the different diets (R\(_{0}\), R\(_{25}\), R\(_{50}\) and R\(_{75}\)). However, the consumption index values recorded during the study (3.31 ± 0.37 to 4.74 ± 0.42) are far superior to the values of 1.3 and 1.7 found by Lacroix (2004)\(^{19}\) by feeding fish in floating cages using feed that has 30% crude protein at a density of 100 individuals/m\(^{3}\). Similarly, this index was also higher than that reported by Yakubu et al. (2013)\(^{33}\) at a density of 95 individuals/m\(^{3}\) and at 1.46 registered by Olayini and Salau (2013)[25,26] in *Clarias gariepinus* fed with feed containing maggots meal. In this study, the incorporation of Lima bean flour generally increased ingestion in *Clarias gariepinus* fry relative to the control diet (R\(_{0}\)). This observation makes it possible to assume that the feeds tested were more appreciated by the *Clarias gariepinus* fry than the R\(_{0}\) control feed though their assimilation has been variable.

The R\(_{75}\) diet represents the best value for money (469.48 FCFA per kg of food purchased and 1065 FCFA obtained per kg of fish sold) and is therefore the most efficient bio economically. This result is in accordance with the works of Ajani et al. (2004)\(^{37}\) which show that the substitution of fish meal by maggots meal at 50 and 100% helps to reduce the production cost of a kilogram of fish at about 18 to 28% due to the low cost of ingredients.

**Conclusion**

At the end of this study on the effect of the replacement of fishmeal with Lima bean flour, aimed at contributing to the development of alternative sources of animal protein the following conclusions were drawn:

- The survival rate of *Clarias gariepinus* fry was not significantly affected by the substitution rate.
- However, the highest survival rate was recorded with
the lot fed with the R₉₀ ration; all growth characteristics were significantly affected by the substitution rate.

Ø However, it should be noted that the best characteristics were obtained with the R₉₀ ration while the feed containing 75% Lima bean flour is the most bio economically efficient.

In view of the above, the use of the ration substituted by 75% Lima bean increases the growth performance of *Clarias gariepinus* fry and reduces the cost of food production. However, the influence of Lima bean flour on reproductive parameters and the technological and organoleptic qualities of fish flesh should be examined.

References


