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Effect of the combination of two types of fish feed with nutritional quality on the performance of two species of fish raised on rural and peri-urban farms in Cote D'ivoire

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Abstract

For 160 days, juvenile *Oreochromis niloticus and Heterobranchus longifilis* were in ponds on a farm in San Perdo located in the southwest of Côte d'Ivoire.The juveniles grouped in four lot per species and in triplicate were fed in pairs of industrial feed and feed produced on the farm and an agri-feed by-product from four feeding techniques (Batch 1: juveniles fed with an industrial lime in the pre-growing phase followed by an agricultural by-product in the growing phase. Batch 2: Juveniles fed with an industrial feed then a feed formulated with an agricultural product during the growing phase ; Batch 3: juveniles fed with an agricultural by-product in the pre-growing phase followed by an industrial feed in the growing phase. Batch 4: Juveniles fed with a formulated feed in the pre-growing phase then with an industrial feed in the growing phase). At the end of the experiment, the best zootechnical parameters were obtained whatever the species by the juveniles fed in the pre-grossing phase with a produced feed followed by industrial feed in the production growing phase.

Keywords: Effect; Combination; Fish feed; Nutritional quality; Performance; Fish raised

1. Introduction

In Côte d'Ivoire, Tilapia *Oreochromis niloticus* and African catfish *Hetrobranchus longifilis* are used on farms [1]. However, their production remains low due to the high cost of quality industrial foods [2 ;3]**.** Indeed, faced with the high prices of industrial feed, more than 70% of fish are raised with fish feed (agricultural by-products, formulated feed, etc.) with low nutritional value [1 ; 2]. The nutritional quality of feed sellers commercial feeds, industrial, fish farmer's feeds and all agro-industrial byproduct used for fish feeding and not always met the requirement of all stage growth [3]. Moreover, the good growth management and feeding practices of fish fingerling enhance fish growth and is very important in this fish production. These major constraints lead to the coupling of feeds in the same breeding cycle with various feeding methods. In rural and peri-urban regions with low economic means, to reduce production costs industrial feed in a single production phase. Industrial feed is used in association either with agricultural by-products or with feed formulated on fish farms [3]. The combination of quality feed and feed with low nutritional value can increase the zootechnical performance of farmed fish species and improve the productivity of Ivorian farms. However, good mastery of feeding techniques with several foods is essential to ensure a better compensatory effect in the growth of reared fish [4 ; 5 ; 6]. It is therefore important to assess the real impact of the combination of fish feed, namely an industrial feed coupled with an agricultural by-product or with a formulated feed, on the productivity and production

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of Ivorian farms. The present study aims to identify the best method of combining two types of fish feed for better growth of fish raised in semi-intensive farming.

2. Material and methods

2.1. Fish feed used

The feed used is composed of industrial feed, agri-food by-products and feed produced on fish farms.

2.2. Biological material

The biological material used in this study consists of juveniles of *Oreochromis niloticus* and *Heterobranchus longifilis.*

2.3. Protocole expérimental

The experiments were carried out on two fish farms located in the San Pedro region, southwest, of the Ivory Coast. The juveniles of *Orechromis niloticus* and *Heterobranchus longifis* were raised for six months in ponds by combining foods using four feeding technic. thus four lot per species with trplicat were formed :

- **Batch 1**: juveniles fed with an industrial lime in the pre-growing phase followed by an agricultural by-product in the growth phase.
- **Batch 2**: Juveniles fed with an industrial feed then a feed formulated with an agricultural product during the growth phase.
- **Batch 3**: juveniles fed with an agricultural by-product in the pre-growing phase followed by an industrial feed in the growing phase.
- **Batch 4**: Juveniles fed with a formulated food in the pre-growing phase then with an industrial food in the growth phase.

2.3.1. Physico-chemical Parameters of Water

Water temperature, dissolved oxygen and pH were monitored during rearing period. Water temperature was recorded daily using a mercury thermometer suspended in breeding pond. Dissolved oxygen, and pH were recorded daily at 7.30 h using Oxy meter (WTW OXI 330) and pH meter (WTW pH 330) respectively**.**

2.3.2. Feeding

Oeochromis niloticus fingerlings (8.50 ± 0,31g) were randomly stocked of 6 fish per square meter in twelve similar dimensions earthen ponds. Twelve groups of *Hererobranchus longifilis* juveniles with an average weight 10.50 ± 0.21 g were randomly distributed into ponds at a density of 3 fish per m^2. Each day, the juveniles were fed to satiation (ration of 100% of their biomass) manually three times per day for six months of rearing. the pre-growing phase and the growing phase each lasted three monthsThe different species were raised in monoculture

2.3.3. Weighing and measuring

Every 30 days, we carry out control fishing followed by sorting and then randomly take 30 juveniles of each species and weigh them in order to correct the food ration. At the end of breeding, all the fish were weighed.

The reared fish were weighed individually using a scale. The data (weight, number) collected made it possible to determine the zootechnical parameters of the fish raised to better assess the quality of the feed combination distributed.

2.3.4. Biochemical analysis of feeds used

The biochemical compositions of the experimental foods were determined according to the methods defined by [7]. The moisture content of each sample was determined after drying in an oven at 105°C for 24 hours. The ash content was obtained by calcination of the sample in a muffle furnace at 550°C for 24 hours. The protein content was determined according to the Kjeldahl method measuring total nitrogen (N x 6.25). Total lipids were determined by the Soxhlet method with hexane as solvent. Fiber contents were obtained by acid hydrolysis of the samples. Gross energy content was calculated using nutrient conversion factors defined by [8]: Protein = 22.2 kJg-1, lipids = 38.9 kJg-1 and non-nitrogenous extractives = 17.2 kJ.

2.4. Expression of results

The following zootechnical parameters were determined: weight gain (Weight Gain = Final Weight – initial Weight); Daily Weight Gain (DWG) = Final weight– Initial weight / Number of days of breeding); Cost feed used = Quantity of feed distributed x Price of feed.

2.5. Statistical analysis

Data were expressed as mean ± standard deviation. The data were analyzed by one-way ANOVA at the threshold $\alpha = 0.05$. Multiple comparisons of means were carried out with the Duncan test. Analyzes were considered significant at $p < 0.05$. Statistica 7.1 software was used for statistical analysis.

3. Results

3.1. Quality of breeding water

The average values of dissolved oxygen in the different rearing environments vary from 6.6 ± 0.5 to 6.9 ± 0.3 mg/l. Moreover, the average temperature values oscillate between 29.2 ± 1.3 and 29.6 ± 0.9 °C. As for pH, the average values are between 7.5 ± 1.1 and 8.3 ± 0.9. As for the content of dissolved solids, it varies between 23.1 ± 1,9 and 23.7 ± 1.5 mg/l. No significant difference ($p > 0.05$) in the physicochemical parameters studied is observed regardless of the feeding technique adopted (Table1).

Table 1 Oxygen, pH, température and TDS of experimental earthen ponds

Parameters	**Batch 1**	**Batch 2**	**Batch 3**	**Batch 4**
Dissolved Oxygen (mg/l)	6,7 ± 0,4[a]	6,6 ± 0,5[a]	6,8 ± 0,3[a]	6,9 ±0,3[a]
Température (°C)	29,4 ± 1,9[a]	29,2 ±1,3[a]	29,6± 0,9[a]	29,5 ± 1,0[a]
pH	7,5± 1,1[a]	7,6± 0,8[a]	8,3± 0,9[a]	7,7± 1,0[a]
TDS (mg/l)	23,7 ± 1,5[a]	23,4 ± 2,1[a]	23,1 ± 1,9[a]	23,6 ± 3,1[a]

Batch 1: juveniles fed with an industrial lime in the pre-growing phase followed by an agricultural by-product in the growing phase**. Batch 2**: Juveniles fed with an industrial feed then a feed formulated with an agricultural product during the growing phase ; **Batch 3**: juveniles fed with an agricultural by-product in the pre-growing phase followed by an industrial feed in the growing phase. **Batch 4**: Juveniles fed with a formulated feed in the pre-growing phase then with an industrial feed in the growing phase; a, b, c, alphabetical letters on the same line show a significant difference among treatments at the threshold of $\alpha = 0.05$

3.2. Nutritional quality of the feed farm used

Nutritional composition and cost of the three feeds used for *Oreochromis niloticus* and *heterobranchus longifilis* fingerlings are shown in Table 2. the protein, carbohydrate, calcium, phosphorus contents and the protein/energy ratio are significantly high with industrial feeds. however, the contents of the biochemical compositions were recorded with the agri-feed by-products.

Table 2 Biochemical, mineral composition and prices of industrial feeds, feeds produced on farms and agricultural by-products used

Paramètres	**Industrial feed**	**Fish farmers feeds**	**Agro-industriel byproducts (Wheat bran, Corn bran, Rice bran, Low rice flour, De-oiled cashew flour, Corn flour)**
Moisture(%)	9,1 ± 0,2[a]	9,8 ± 0,5[a]	10 ± 0,8[a]
Crude protein (%)	30,2 ± 3,1[c]	22,2 ± 0,4[b]	15,2 ± 0,9[a]
Crude lipid (%)	5,5 ± 0,1[a]	7,1 ± 0,5[b]	8,2 ± 1,2[b]
Ash (%)	11,2 ± 0,8[c]	8,5 ± 0,3[b]	5,5 ± 0,7[a]
Crude fibre (%)	6,7 ± 0,4[a]	23,5 ± 2,6[b]	23,8 ± 2,8[b]
Carbohydrate content (%)	39,2 ± 5,6[b]	31,5 ± 2,5[a]	35,3 ± 4,1[a]
Gross Energy (kJ/g)	16,7 ± 0,5[b]	16,8 ± 0,2[b]	13,4 ± 0,4[a]
Protein/Energy ratio	16,8 ± 0,7[c]	11,4 ± 0,3[b]	8,1 ± 0,4[a]
Calcium (mg/g)	18,5 ± 1,4[c]	9,2 ± 0,1[b]	2,9 ± 0,1[a]
Phosphore (mg/g)	12,0 ± 0,5[c]	9,1 ± 1,3[b]	2,3 ± 1,0[b]
Calcium/Phosphore ration	1,5 ± 0,2[a]	1,0 ± 0,0[a]	1,3 ± 0,0[a]
Cost (FCFA/kg)	365 ± 15[c]	195 ± 55[b]	60 ± 10[a]

a, b, c, alphabetical letters on the same line show a significant difference among treatments at the threshold of $\alpha = 0.05$. Price in CFA pound : 100 FCFA = 0.17 $ based on 2024 exchange prices in Côte d'Ivoire.

3.3. Growth performance, survival rate and economic parameters

The different zootechnical parameters are recorded in Table 3. Regardless of the species of fish raised. The values of the zootechnical parameters obtained are significantly high ($p>0.05$) with the use of feed formulated on farms in the pre-growing phase followed by industrial feed in the growing phase (Batch 4). The zootechnical values of the different species raised with an industrial feed in the pre-growing phase then with an agricultural by-product are low compared to the opposite. The same applies to the use of the industrial feed pair followed by the formulated feed. The final weight of tilapia (383.1 ± 25,8 g) and final weight catfish (2591.7 ± 19.2g) were significantly elevated with the use of 'a feed produced in the pre-growing phase followed by industrial feedd in the growing phase. Regarding the DWG tilapia (2.08 ± 0.1g/day) and DWG catfish (14.4 ± 1.8g/day), the best values obtained with the use with the use of the industrial feed in the growing phase and the formulated feed in the pre-growing phase are significantly different ($p < 0.05$). Whatever the feeding technic, the use of industrial feed during the growing phase makes it possible to obtain the best zootechnical values of raised fish. Regardless of the feeding technique used, the survival rates of the different reared species are not significantly different ($p> 0.05$) and are greater than 95% (Table 3).

3.4. Economic parameters

In terms of economic parameters, low values were recorded with the combination of industrial feed in the pre-growing phase and agricultural by-product in the growing phase. However, high economic values were observed with the product feed pair used in the pre-growing phase and the industrial feed in the growing phase (Table 3).

Table 3 Growth performance and economic parameters of fish fed with with the different combinations of feeds used

Parameters	**Batch 1**	**Batch 2**	**Batch 3**	**Batch 4**
Oreochromis niloticus				
Final weight (g)	210 ± 31,2[a]	250,8 ± 55,2[b]	279 ± 46,0[c]	383,1 ± 25,8[c]
Weight gain (g)	265 ± 51,2[a]	345,8 ± 55,2[b]	270,5 ± 66,0[a]	375,1 ± 55,8[c]
Daily weight gain (g/day)	1,1 ± 0,1[c]	1,3 ± 0,2[b]	1,5 ± 0,2	2,08 ± 0,1[b]
Survival rate (%)	96,0 ± 8,9[a]	97,0 ±11,3[a]	97,5 ± 7,9[a]	96,1 ± 6,8[a]
Heterobranchus longifilis				
Final weight (g)	1175 ± 17,3[a]	1207,5 ± 34,5	2133,3 ± 57[b]	2591,7 ± 19,2[c]
Weight gain (g)	1164,5± 34,6[a]	1196± 24,6[a]	2121,8± 43,6[b]	2580,2± 12,1[c]
Daily weight gain (g/day)	6,5 ± 1,4[b]	6,6 ± 1,1	11,8 ± 1,6[b]	14,4 ± 1,8[c]
Survival rate (%)	99,1 ± 10,2[a]	98,8 ± 11,1[a]	97,9 ± 9,5[a]	99,4 ± 12,2[a]
Economic parameters				
Average cost feed (FCFA/kg)	145 ± 10[a]	190 ± 9[b]	145 ± 8	190 ± 10[a]

Batch 1: juveniles fed with an industrial lime in the pre-growing phase followed by an agricultural by-product in the growing phase**. Batch 2**: Juveniles fed with an industrial feed then a feed formulated with an agricultural product during the growing phase ; **Batch 3**: juveniles fed with an agricultural by-product in the pre-growing phase followed by an industrial feed in the growing phase. **Batch 4**: Juveniles fed with a formulated feed in the pre-growing phase then with an industrial feed in the growing phase; a, b, c, alphabetical letters on the same line show a significant difference among treatments at the threshold of = 0.05. Price in CFA pound : 100 FCFA = 0.17 $ based on 2024 exchange prices in Côte d'Ivoire

4. Discussion

Average values of temperature (29.2 ± 1.3 - 29.6 ± 0.9 °C), dissolved oxygen (6.6 ± 0.5 - 6.9 ± 0.3 mg/l) and pH (7.5 ± 1.1 - 8.3 ± 0.9) obtained are included in the intervals, [(6.5–9), (27–29 °C) and (>2.3 mg/l) respectively for pH, temperature and dissolved oxygen]. The results of the physicochemical parameters obtained are similar to those reported by [9] and [10] for good semi-intensive rearing conditions respectively for tilapia and catfish in ponds. Despite the difference recorded between ponds water dissolved oxygen, TDS values, temperature and pH values recorded wereranged between recommanded values for the good conditions of O. niloticus fingerlings breeding in earthen ponds [11 ; 12 ; 13].

Otherwise, the values recorded in the ponds for these most important water parameters in aquaculture (T, pH, dissolved oxygen) were within in the suitable ranges of recommended values for good growth of African catfish [14 ; 15]**.** According to [16], the levels of TDS in pond water is attributed to the use of feeds by fish and feeding have been reported to increase the level of TDS of water.

The biochemical analyzes obtained show that only industrial feeds are of better quality and meet the needs of fish species raised at this stage of their development [1 ; 3]. Agricultural by-products and foods produced on fish farms are of low nutritional quality regardless of the species of fish raised and its stage of development [6 ; 17]

The combination of industrial feed and agricultural by-product or formulated feed improves the zootechnical parameters of farmed fish and the production parameters of farms. Furthermore, the best values of zootechnical and production parameters were recorded with the use of industrial feed in the production growth phase. Indeed, whatever the growth or physiological state obtained with a formulated feed or an agricultural by-product, feed of low nutritional quality, in the pre-growth phase, the intake of industrial feed, feed with high nutritional value, in the grow-out phase improves and accelerates the growth of reared species through a compensatory effect [4]. These results are better than those obtained by [9 ; 10] with respectively the use of formulated feed in the breeding of tilapia and Clarias gariepinus in ponds. these authors found weight gains slightly below ours and this could be justified by the slightly longer rearing period in our experience.

Conversely, the low zootechnical and production values were obtained with the use of industrial feed in the pre-fattening phase and a formulated feed or a by-product in the fattening phase. The use of formulated food or a by-product,

during the growth phase, slows down growth due to the low nutritional value of these foods which do not meet the nutritional needs at this stage of fish development. These have a low protein content. Indeed, proteins provide the essential amino acids and energy necessary for the vital functions, maintenance, growth and reproduction of fish [5]. At this stage of development, agricultural by-products and foods formulated in flour form are no longer suitable. The presentation of the feed distributed (size and nature) plays an important role in its capacity for ingestion and assimilation of nutrients by different species of fish [4].

The zootechnical and production results obtained with the use of an industrial feed in the growth phase and a formulated feed in the pre-growth phase are better than those recorded with the use of an agricultural by-product in the pre-growing phase and of an industrial food in the growth phase. This would be justified by the fact that the nutritional quality of formulated foods is slightly better than that of agricultural by-products. Indeed, the growth of farmed fish species is strongly linked to the satisfaction of nutritional needs through the distribution of quality food adapted to the species and stage of development [18; 19; 3].

The combination of fish feed has a considerable impact on feed and production costs for small rural and peri-urban farms with low economic means . These costs are lower than those reported by [1] for the use of industrial feeds on Ivorian farms which are between 475 and 850 FCFA. In fact the price of quality industrial foods increases the very high cost of production and encourages their low use [3]. Using them on a high production phase of species reduces the quantity of use and lowers the cost of productionThis reduction in production costs linked to food would be justified by industrial foods having a very high cost, being used only in one production phase.

5. Conclusion

The technique of combining two foods with different nutritional quality influences the growth performance of farmed fish species and the cost of production. The use of agricultural by-products or low quality formulated feed in the pre-grossing phase of production and industrial feed, good quality, in the grow-out phase is the best technique to have good growth performance of farmed fish species.

Compliance with ethical standards

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Disclosure of conflict of interest

Authors have declared that no competing interests exist

References

[1] Koumi A.R., Kimou B.N., Ouattara I.N., Koffi K.M., Atsé B.C., Kouamé L.P (2016) : Les aliments utilisés en pisciculture semi intensive en Côte d'Ivoire et leur productivité. Tropicultura 34 (3) : pp 286-299

[2] KIMOU Béda Nestor, KONE Abdoulaye, Gozoua Emmanuel, ATSE Boua Célestin and OUATTARA Issa Nahoua (2023). Analysis of côte d'ivoire fish farm-made feeds: raw materials, production and proximate composition. Journal of Global Biosciences 12(4) : pp. 9747-9759

[3] Koumi A.R., Kimou B.N., Atsé B.C., Ouattara I.N., Kouamé L.P. (2015). Fish Feeds Used in Côte d'Ivoire: Nature, Quality, Use and Productivity. Asian Journal of Agriculture and Food Sciences 3 (2): pp 225-236

[4] New M.B.1987, Feed and feeding of fish and shrimp. A manual on the preparation and presentation of compound feeds for shrimp and fish in aquaculture. ADCP/REP, 87, 26.275p.

[5] Guillaume J., Kaushik S., Bergot P., Metailler R..1999:Nutrition et alimentation des poissons et crustacés. INRA Paris. pp485.

[6] N. B. Kimou, R. A. Koumi, M. K. Koffi, C.B. Atsé, I. N. Ouattara and P. L. Kouamé (2016). Utilisation des sous-produits agroalimentaires dans l'alimentation des poissons d'élevage en Côte d'Ivoire. Cah. Agric. [Online]. 25 (2) pp 1 - 9.

[7] AOAC. (Association of Official Analytical Chemists), 1995, Official methods of analysis, 16th edition. AOAC, Arlington, Virginia, USA, 1094p

[8] Luquet P, Moreau Y. Energy-protein management by some warm water fin fishes. Actes du Collogue 9, AQUACOP, IFREMER, Paris, France. 1989 ;4.

[9] Kouadio Larissa Pélagie Ella, Koumi Ahou Rachel, Atsé Boua Célestin, Gonnety Tia Jean and Kouamé Lucien Patrice. (2019). Feed utilization and growth of tilapia, Oreochromis niloticus fi ngerlings fed with three composed feeds formulated with locally available raw materials. Biosciences Biotechnologie Research Communications 12(3): 556-564

[10] E. M.-A. N'Gbaramou, A. R. Koumi, B. C. Atsé, and K. Tano (2020) : Dry Feeds Produced Based on Local Available Feedstuffs for African Catfish Clarias Gariepinus Juveniles Rearing in Earthen Ponds. European Journal of Agriculture and Food Sciences 2(4). pp 1-7

[11] Tepe Y., Boyd C.E. (2002). Sediment quality in Arkansas bait minnow ponds. Journal of the World Aquaculture Society. 33(3): pp 221-23

[12] El-Sayed A.F.M. (2006) Tilapia culture. CABI Publishing, Oxfordshire Pages 293

[13] Makori A.J., Abuom P.O., Kapiyo R. (2017). Effects of water physico-chemical parameters on tilapia (Oreochromis niloticus) growth in earthen ponds in Teso North Sub-County, Busia County. Fisheries and Aquatic Sciences. 20(30): pp 1-10

[14] C. E. Boyd, Qualité de l'eau dans les étangs pour l'aquaculture: Alabama Agricultural Experiment Station, Auburn University, Auburn, 1990, 1st Edn.

[15] N. M. Stone and H. K. Thomforde.(2003). Understanding your fish pond water analysis report; Arkansas: University of Arkansas Cooperative Extension, pp 1-4.

[16] A. E. Ogbeidu and L. O. Edutie (2002). Effect of brewery effluent on the water quality and rotifers Ikpoba river, Southern Nigeria. Afr. J. Environ. Pollut. Health. 1(1). pp 1-12.

[17] N. B. Kimou , B. C. Tia , A. Koné , C. B. Atsé and I. N. Ouattara. (2023). Study of the Substitution of Marine Animal Oils in Maggot Flour by Vegetable Oils for the Growth and Larval Survival of African Catfish, Heterobranchus longifilis Valencienne, 1840 in Aquarium. International Journal of Biochemistry Research & Review, 32(2), pp10-20

[18] Mammur-Ur-Rashin M. (2013) Improving aquaculture feed in Bangladesh: from feed ingredients to farmer profit to safe cosumption. Agricultural and Biosystem. Engin. 34:1-11

[19] Burel C, Médale F. 2014. Guide de l'utilisation des protéines d'origine végétale en aquaculture. Oilseeds Fats Crops Lipids 21:1–15