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Formulation Trial of a Broiler Chicken Feed Based on Locally Available Raw Materials in Senegal: Evaluation of Zootechnical Performance and Profitability Compared with a Commercial Feed

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Abstract **Original Research Article**

The increasing cost of commercial poultry feeds strongly limits the profitability of broiler chicken production in Senegal. Thus, in order to significantly reduce their production costs, poultry farmers must formulate their own feed using locally available raw materials. This study evaluates rations formulated from local raw materials as an alternative to commercial broiler feed. Subsequently, to confirm feed efficiency, the produced rations were tested on an experimental flock composed of 50 broiler chickens divided into two groups of 25 birds each. At the end of the experiment, chickens from the control group (fed commercial rations) achieved an average live weight of 1809.2 g, while those from the experimental group reached 1636.1 g. However, the economic analysis showed a much lower production cost for birds in the experimental group, resulting in a net gain of 283 FCFA per chicken compared to birds from the control group.

Keywords: Broiler chicken, Local feed, Zootechnical performance, Profitability.

I. INTRODUCTION

Senegal is a country whose economy is essentially agricultural. Poultry meat has several advantages, notably its low price compared to other meat products, the absence of religious prohibitions against its consumption, its nutritional qualities, and the ease of production (short rearing cycle). Despite a strong growth in demand driven by population growth, broiler chicken production remains subject to several constraints (Jaovelo, 2007: p. 45). Among these, the high cost of poultry feed is the major problem. Indeed, commercial poultry rations are becoming increasingly expensive due to the surge in prices of feed inputs. Feeding plays a determining role in the success and economic profitability of poultry production. It can represent up to 70% of the variable costs of egg or meat production (Brah, Houndonougbo & Issa, 2015).

In this context, the formulation of rations based on locally available raw materials (maize, groundnut

cake, rice bran, palm kernel cake, local fish meal, etc.) appears to be a promising economic alternative. The objective of feed formulation is to provide animals with a consumable product whose characteristics make it possible, under given rearing conditions, to obtain meat or egg production ensuring the highest profit (Malumba Kamba, 2011: p. 23). Local ingredients are accessible and inexpensive and help reduce dependence on imported or industrial feeds. Nevertheless, their nutritional value and digestibility may vary depending on origin, quality, and feed presentation (powder, crumbs), directly influencing the zootechnical performance of broiler chickens.

Thus, this study aims to:

- Formulate a complete ration for broiler chickens using locally available raw materials, adapted to the starter, grower, and finisher phases;
- Compare zootechnical performance (average weight, feed intake, feed conversion ratio) with that obtained using a commercial feed;
- Evaluate the economic profitability of the experimental feed compared with industrial feed.

II. MATERIAL

I.1 Study location and period

The study was conducted from September 19 to October 2, 2022, and was carried out in Thiès, in a 14 m² poultry house that was arranged into two compartments. Each compartment contained a 0.75 m linear feeder, a 5 or 10 L manual drinker, and 25 birds. The roof of the poultry house was made of zinc and measured 2.10 m in height. Ventilation of the building was natural, ensured by windows placed at a height of one (01) meter on one side of the building. The litter, composed of rice husks, covered the floor.

Figure 1: Poultry house used as the experimental site

I.2 Rearing equipment

The poultry equipment used was as follows:

- Drinkers (starter, grower, and finisher stages);
- Feeders (starter, grower, and finisher stages);
- Electronic scales;
- Litter: rice husks.

I.3 Animal material

The study involved 50 broiler chickens of the Cobb 500 strain. They originated from the same private hatchery (AVIFRIQUE SARL).

Figure 2: Cobb 500 broiler chicks**Appareillage**

These are the different standard equipment and tools used for the quantification of the studied parameters:

- Oven: to determine the moisture content of the product;
- Furnace: used to determine the ash content;
- Precision balance;
- Atomic absorption spectrometry.

I.4 Equipment for the preparation of experimental rations

The equipment used for the preparation of the experimental rations mainly consisted of:

- A pellet machine with a capacity of 150 kg/h;
- A 40 kg electronic commercial scale;
- Basins.

III. METHODS

III.1 Study rearing

The rearing was based on the principle of "single-batch" management, which consists of managing groups of animals of the same age, species, and production type. The study involved 50 one-day-old, unsexed Cobb 500 broiler chicks, divided into 2 groups of 25:

- **Group 1**: experimental feed;
- **Group 2**: commercial feed (control group).

Rearing management parameters such as hygiene, rearing standards, and environmental conditions were respected as much as possible. The initial stocking density was 40 chicks/m² and the final density at the end of the cycle was 10 chickens/m².

III.2 Biosecurity and chick management

The poultry house underwent a sanitary break including dust removal, washing with large amounts of water, and disinfection with quicklime, followed by cleaning and disinfection of the equipment with bleach. After 10 days of closure to eliminate germs, a second disinfection was carried out two days before the arrival of the chicks.

On the day of reception, the area was prepared with a thick litter of rice husks (4 kg/m²) and, if necessary, heated with a charcoal stove. The chicks were checked (number, average weight, condition of beak, legs, and navel) and then distributed into two groups of 25 birds, balancing the average weight at 42.9 g.

III.3 Feeding and watering

Chickens in Group 2 (control) received commercial feed: crumbles for the starter phase, then pellets for

the grower and finisher phases. Those in Group 1 (experimental) were fed the formulated feed prepared for the trial: meal during the starter phase and pellets for the subsequent phases. Drinking water, available at all times and renewed daily, was also used for the administration of medications and vaccines.

III.4 Measured parameters

Zootechnical performance was evaluated through:

- Average live weight: recorded individually on days 0, 7, 14, 21, 28, 35, and 42;
- Feed consumption;
- Feed conversion ratio.

IV. RESULTS

IV.1 Bromatological composition of the rations

The calculated chemical composition of the experimental and commercial rations is presented in Table 1. From this table, it should be noted that the crude protein content of the experimental rations ranged from 16.2 to 19.7% for the grower phase and from 18.5 to 15.5% for the finisher phase (the commercial finisher feed was not analyzed due to unavailability on the market).

Table 1: Bromatological composition of the rations

Parameters	Phase					
	Starter		Grower		Finisher	
	E.R	C.R	E.R	C.R	E.R	C.R
Moisture %	7.52	8.523	7.88	8.662	7.17	ND
Dry matter %	92.48	91.477	92.12	91.338	92.23	ND
Crude protein %	17.5	21.88	17.06	19.25	16.63	ND
Crude fat %	8.49	5.01	8.17	6 .53	8.54	ND
Crude fiber %	6.73	ND	6.21	ND	6.81	ND
Ash en %	8.27	7.5885	7.35	7.1677	7.8	ND
Metabolizable energy (kcal/kg)	3478	ND	3544	ND	3493	ND
Sodium %	0.178	0.246	0.173	0.261	0.160	ND
Calcium %	1.17	1.19	1.16	0.97	0.85	ND

E.R: Experimental ration; **C.R**: Commercial ration; **ND**: Not determined

IV.2 Zootechnical performance

V.2.1 Feed consumption

Figure 3 presents the average feed consumption per individual of the different groups according to the rearing periods.

The results obtained during the experiment show that feed consumption increased with age. Overall, at the end of the 45-day rearing period, the average feed consumption per bird was lower in Group 1 (81.16 g) compared to Group 2 (92.40 g).

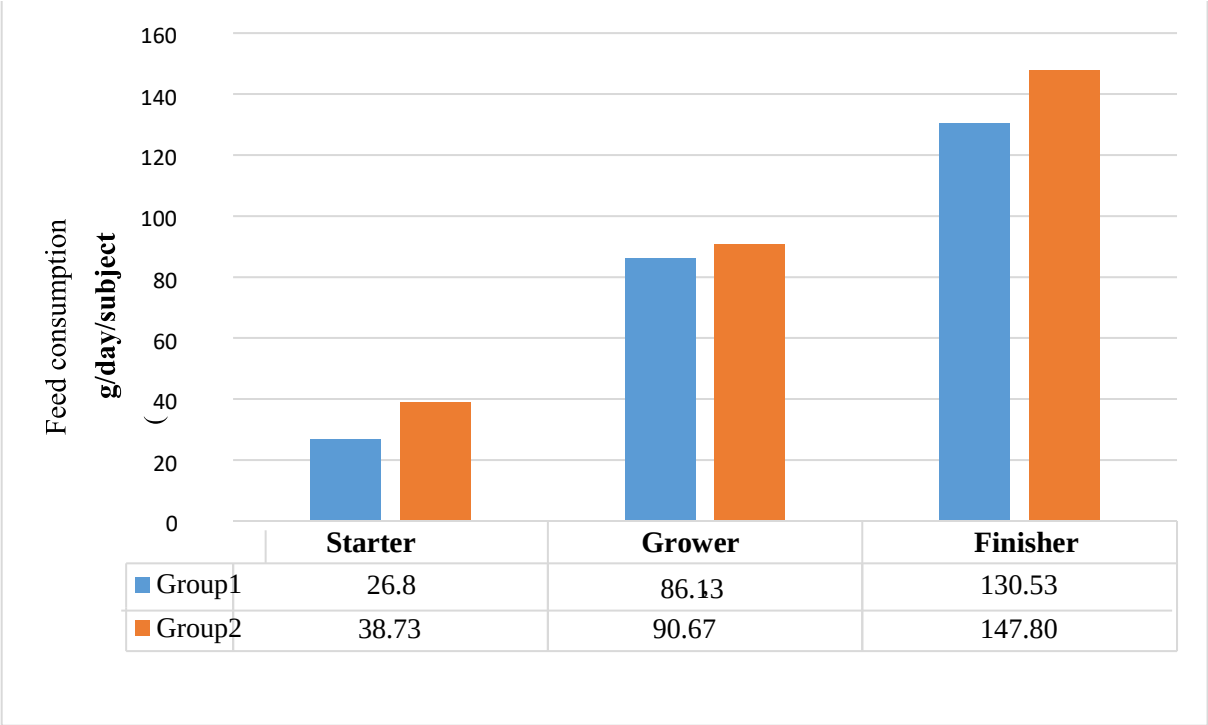

Figure 3: Evolution of individual feed consumption

V.2.2 Feed conversion ratio

Figure 4 presents the evolution of the feed conversion ratio (FCR) of the chickens by group during the trial. The results show that, for all groups, the feed conversion ratio increased over the periods, indicating a deterioration of FCR with age.

Over the entire duration of the experiment, birds in Group 1 had the lowest feed conversion ratio. The overall FCR was 2.29 for Group 1 and 2.35 for Group 2.

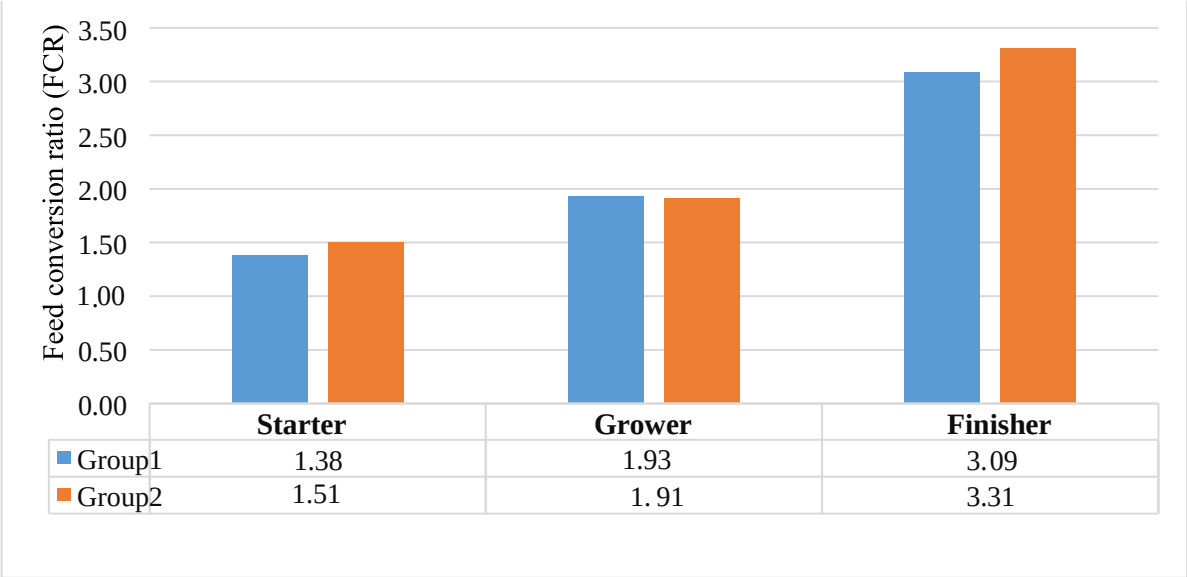

Figure 4: Evolution of the feed conversion ratio of the different groups

V.2.3 Evolution of live weight

Figure 5 presents the evolution of the chickens' weight by group during the trial. At the beginning of the trial (Day 1), both groups had the same average weight of 42.9 g. During the first week, no significant difference was observed between the average weights of the chickens according to the groups. At the end of the rearing period, the average weight reached 1,636.1 g for Group 1 and 1,809.2 g for Group 2, and the difference between the values was significant. As shown in Figure 5, the average live weight of the control group remained higher than that of the experimental group throughout the experimental period.

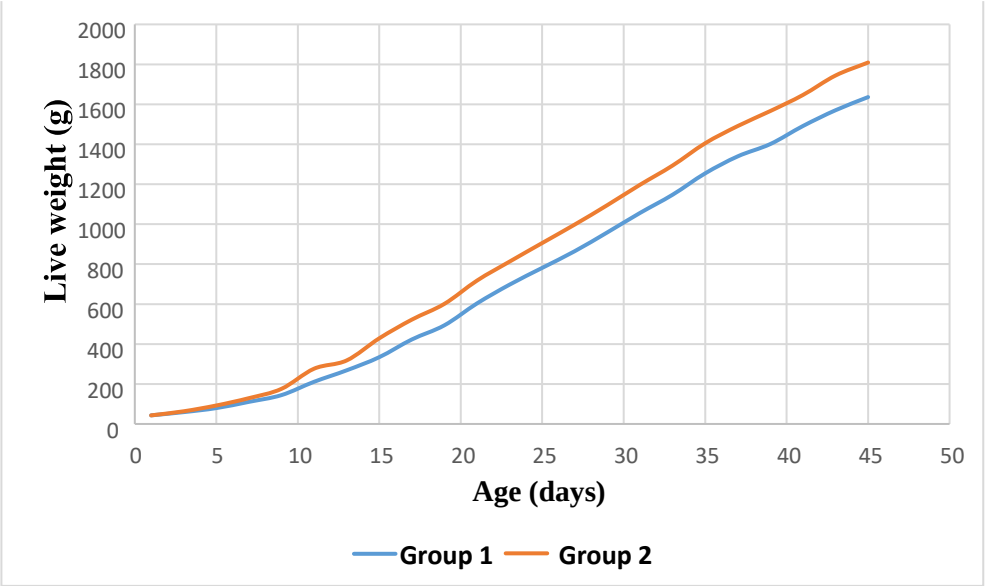

Figure 5: Evolution of the live weight of the different groups (g)

IV.3 Economic study

The parameters considered were the production cost per kilogram of live weight of a chicken (Group 1 and Group 2), the price per kilogram of the formulated feed, and the gross profit.

IV.3.1 Estimation of the economic cost of the rations

It was carried out based on the wholesale prices on the local market of the raw materials used in the formulation of the experimental feeds. Table 2 presents the composition of the experimental rations and the prices of the feed ingredients.

Table 2: Composition of the experimental rations and prices of feed ingredients

Ingredients	Composition (%)			Unit price per kg (FCFA)
	Starter	**Grower**	**Finisher**	
Corn	53	60	70	300
Ground peanut cake	30	23	22	300
Fish meal	12	12	5	300
Table salt	0,35	0,35	0,35	60

DCP	2.65	2.65	1.65	800
Broiler premix 2%	2	2	1	1250
Total	100	100	100	-

DCP: Dicalcium phosphate dihydrate

On the market, the price of one kilogram of commercial feed is 450 FCFA/kg.

Table 3: Economic cost (in FCFA) of the experimental and commercial rations

Parameters	Group 1	Group 2
Feed intake (kg) **Starter** **Grower** **Finisher**	 0.402 1.292 1.958	 0.581 1.360 2.217
Feed price (FCFA/kg) **Starter** **Grower** **Finisher**	 331.41 331.41 316.91	 450 450 450
Total feed cost (FCFA)	1182	1871

Total feed cost = ∑ (feed intake × feed price)

IV.3.2 Estimation of economic profitability

On the market, the minimum selling price of broiler chicken is 2,500 FCFA/kg of carcass weight. Table 4 presents the economic study on the estimation of gross profit per broiler chicken for the different groups.

Table 4: Economic study (Estimation of gross profit per broiler chicken)

Parameters	**Group 1: Experimental**	**Group 2: Control**
Feed cost (FCFA)	1182	1871
Production cost per chicken	2190	2879
Average carcass weight (kg))	1.4512	1.6136
Price per kilogram of chicken (FCFA)	2500	2500
Average price per chicken (FCFA)	3628	4034
Gross profit per chicken (FCFA)	1438	1155

Average price of a chicken = Price per kilogram of chicken × Average carcass weight (kg)

Gross profit per chicken = Average price of a chicken − Production cost per chicken

V. Discussion

V.1 Zootechnical performance

This section aims to interpret the results obtained during the experiment, highlighting the observed trends and comparing them with existing literature data.

Regarding feed consumption, illustrated in Figure 3, the lower consumption observed in Group 1 could be related to the higher energy level of the experimental rations. The energy level of the feed is a key factor in regulating intake in chickens (Nesseim, 2005). In general, a feed low in metabolizable energy leads to increased consumption, whereas a high energy concentration reduces it, a phenomenon also reported by Aviculture in Morocco (2022). These observations are consistent with the work of Leeson & Summers (2001), who indicate that energy balance directly influences feed intake and feed efficiency in broiler chickens.

Regarding the feed conversion ratio presented in Figure 4, the deterioration observed over time may be associated with the progressive increase in the energy requirements of the chickens as they age. This evolution is an expected phenomenon since growth is accompanied by higher maintenance requirements, as also noted by NRC (1994).

The better feed conversion ratio observed in Group 1, still referring to Figure 4, can be explained by the higher energy level of the diet provided. According to Adoum (2007), a high-energy feed contributes to improving FCR and reducing mortality, which aligns with the observations of this study. These results also agree with those of Olomu (2011), who emphasize the importance of energy density for growth and feed efficiency in poultry in tropical areas.

Figure 5 clearly shows that the control group maintained a live weight advantage throughout the experiment. This difference can be explained by the better nutritional quality of the commercial feed,

which is richer in essential micronutrients for development and bone mineralization, facilitating better growth of the chickens. These conclusions also agree with Panda et al. (2012), who observed that standardized commercial feeds improve growth compared to non-optimized local formulations.

Nevertheless, the observed weights remain below the reference values established by INRA (1979). The rearing conditions, marked by the heat of the winter season and insufficient ventilation, likely caused heat stress. This reduces digestibility, nutrient absorption, and feed efficiency, which affects zootechnical performance. This finding aligns with the work of Daghir (2009), who highlights the impact of heat stress on growth and performance of poultry in hot regions.

V.2 Economic study

From an economic perspective, animals in Group 1 achieved the best results with a gross profit of 1,438 FCFA per chicken, compared to Group 2, which recorded a gross profit of 1,155 FCFA. However, it should be noted that the higher growth of chickens in Group 2 represents a definite advantage economically. Indeed, at 45 days, the control group chickens reached the highest average weight. This is an important factor for product turnover in the market and saves time, as the duration required to produce an equivalent weight in chickens fed the commercial feed is longer.

However, their production costs appeared much higher than those of chickens on the experimental diet. Overall, the experimental ration allows a net gain of 283 FCFA per chicken. These results confirm the findings of Brah et al. (2018), who showed that the use of local raw materials in feed rations reduces production costs and increases profitability in poultry farming.

Moreover, the experimental feed optimizes the cost/feed efficiency ratio, in line with the conclusions of FAO (2010), which recommends local feed formulation to improve the economic viability of poultry farming in sub-Saharan Africa.

In summary, with the experimental rations, the production cost per kilogram of chicken is 2,190 FCFA. Compared to the commercial feed used, this cost is 689 FCFA higher. Based on the results of this economic study, the net gain from producing one's own poultry feed instead of purchasing commercial rations is therefore 283 FCFA per chicken. Thus, in the same scenario, for a flock of 1,000 chickens, farmers would gain an additional 283,000 FCFA by producing their own feed. These observations also align with Daghir (2009), who emphasizes that local feed formulation is a key lever for profitability in poultry production systems in hot regions.

VI. CONCLUSION

This study demonstrated that formulating a broiler feed using local raw materials in Senegal is an economically advantageous alternative to commercial feed, allowing a significant reduction in feed costs. In the experimental group, the net gain per chicken compared to the control group is 283 FCFA, or 2,830,000 FCFA for a farm of 10,000 broilers.

Improving the nutritional composition and transforming the local feed into pellets or crumbles could reconcile economic profitability and technical performance, thus providing Senegalese farmers with a sustainable solution to develop local poultry production.

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