International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Effects of the Gradual Incorporation of *Cajanus Cajan* Leaf Meal in the Diet of Laying Hens of the Lohman Brown Strain

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Abstract

In order to enhance the leaves of *Cajanus cajan* in the diet of laying hens of the Lohmann Brown strain, a study was carried out at the zootechnics laboratory of the National School of Agronomics and Forestry (ENSAF) of Congo-Brazzaville during the period from January to June 2019. The general objective of this work is to contribute to the search for alternative ways to improve the feeding and productivity of laying hens in Congo. During this study, 40 pullets were divided into four (4) batches of 10 subjects each, subdivided into two sub-batches of 5 pullets of similar weight. Batches corresponding to four food treatments: CC0%, CC5%, CC10%, and CC15% where the flour from the leaves of *Cajanus cajan* was incorporated respectively at 0%; 5%; 10% and 15% by gradually replacing soybean meal. The food was distributed twice a day and the water ad libitum. It appears from this study that the 10% and 5% treatment gave better results compared to the Control. Statistically, no significant difference was observed between the 5%, 10% and 15% treatments compared to the control. The average live weight observed in animals fed with CC5% experimental food (1803g); CC10% (1904.5g) and CC15% (1904.5g) against 1769.65g for the control.

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The average daily gain (ADG) was more interesting in the subjects fed with the food containing the flour of the leaves of *Cajanus cajan* CC15% (17, 79g), 10% (15,30g/J) than in the subjects fed with the CC0% control feed (13.50g/d) The incorporation of up to 15% of *Cajanus cajan* leaf meal in the feed of laying hens improved the production and coloring of the egg yolk and this in the 10 and 15% treatments.

Keywords: Gradual; incorporation; Cajanus cajan; feed; laying hens.

1. Introduction

Agriculture and Livestock are among the main activities practiced by man to guarantee his subsistence and provide him with significant income. These activities allow man to fight against food insecurity and hunger as well as poverty in the world. Indeed, with 70 tons produced per year, poultry is the second most consumed meat in the world, just behind pork. Chicken accounts for nearly 85% of global poultry production [1].

In the Republic of Congo, despite a strong demand for poultry, the level of production remains low and does not meet the needs of the populations. This situation increases Congo's dependence on the outside for meat products, giving way to massive imports [2]. Consequently, the quantity of imports increases every year, it was estimated at 200 billion in 2011 [3]. This deficit in meat products is linked not only to the low productivity of local breeds but also to the insufficient mastery of production techniques and the demographic explosion that the Congo is experiencing [4]. To reverse this trend, the will of the Congolese State is to ensure the sustainability of agricultural activities by modernizing family farming towards commercial agriculture, i.e. to make this sector more productive in order to diversify its economy [5].

Poultry farming has several nutritional and socio-economic advantages, it represents an interesting source of proteins of high biological value and makes it possible to quantitatively and qualitatively improve the diets of populations [6]. It is an important activity for the development of a country's economy. In the Republic of Congo, poultry products (meat, eggs, milk and others) occupy an important place in household consumption. Indeed, the Congo imports about 50% of the total volume of animal products estimated at 45789.6 tons in 2007 [7]. Since 2002, there has been a revival of the poultry sector, particularly in peri-urban and rural areas. Despite these efforts, the poultry sector in Congo faces the problem of food. The success of poultry farming depends on several factors among many figures including food.

Indeed, the work carried out by [8] on the growth of local chickens has shown that conventional feed has a positive effect on their growth despite its very exorbitant cost. However, the use of unconventional food resources (*Moringa oleifera, Leucaena leucocéphala, Casa tora* and *Cajanus cajan* in particular), which can replace conventional protein resources (soybean, peanut, fish meal, etc.), contributes to the fall in cattle feed prices [9, 10, 11].

Thus, the studies carried out by various authors: [12, 13, 14], showed that the leaves of *Cajanus cajan* are rich in nutrients, in particular proteins, minerals and vitamins. They have been incorporated up to 15% respectively in the feed of poultry, pigeons and guinea fowl without any adverse effect on the productivity and health status of the animals. The *Cajanus cajan* is one of the unconventional food resources (RANC) very available and in all seasons in Congo [14]. It is very rich in protein (20 to 30%) of dry matter (DM), amino acids, vitamins and mineral salts. On the other hand, *Cajanus cajan* is very low in fat, which gives it certain virtues in animal and human medicine. *Cajanus cajan* has nutritional values close to those of peas or beans and can be used as dietary supplements in chicken feed [15]. The objective of this study is to contribute to the search for ways and alternatives to improve the diet and productivity of chickens in Congo.

2. Material and methods

2.1. Material

2.1.1. Study zone

The experiment took place at the farm of the National School of Agronomy and Forestry (ENSAF) of Brazzaville, Marien NGOUABI University in the period from February to June 2019. It is an experimental farm which is located within ENSAF, in district 1 Makélékélé, Moukoudzigouaka district in the department of Brazzaville. The climate is of the Bacongolais humid tropical type [16]. It is characterized by two seasons: a rainy season (October – May) and a dry season (June – September).

2.1.2. Biological material

The experiment focused on 40 chicks of the Lohmann Brown strain resulting from the incubation of fertilized eggs (figure 1) acquired from a group of breeders of the Lohmann Brown breed. These chicks after hatching were reared for six weeks where they were fed with feed. The chicks were vaccinated against Newcastle disease, Gumboro disease, Infectious bronchitis, smallpox. They were treated against coccidiosis and various diseases.

Figure 1: Hatching of fertilized eggs.

2.2. Methods

2.2.2. Collection and processing of Cajanus cajan leaves

The leaves of *Cajanus cajan* were collected mainly in the department of Brazzaville, in particular at the National School of Agronomy and Forestry, in the market garden belt of the ENS campus and Talangaï. Twigs bearing the leaves were cut and transported to ENSAF where they were spread evenly and thinly for 1 to 2 in the sun. The twigs and twigs were then removed and the leaf leaflets were collected, spread out and then dried for 7 days in the sun (Figure 2) until they became crispy or crumbly. Drying makes it possible to reduce or eliminate any thermolabile toxic factors present in the leaves [17]. These were then transformed into flour using a 4mm mesh grinder. of diameter. The leaf flour is packaged in bags of about 40 kg to be kept until use. The other ordinary raw materials (yellow corn, soybean meal, wheat bran, limestone, and others) were purchased at local markets.

Figure 2: Harvesting *Cajanus cajan* leaves.

2.2.3. Formulation of experimental rations

After purchasing the various ingredients, four types of iso-protein and iso-energy growth-type experimental foods were formulated. This is the control ration (CC0%) containing 0% of *Cajanus cajan* leaf flour and those containing *Cajanus cajan* leaf flour respectively at (CC5%, CC10% and CC15%) in the substitute ration partial with soybean meal. These rations were formulated from existing tables while the manufacture of the latter, i.e. the weighing and mixing of raw materials, was done on site at the ENSAF school farm. Indeed, during the 16 weeks of the trial, only one food was used. It should be noted that due to the lack of a laboratory, no bromatological analysis was carried out.

Table 1 presents the composition of the raw materials of the experimental ration differences and Figure 5. The raw materials used in the manufacture of the experimental feed.

Table 1: Rations used in the experiment.

Ingredients	**Witness**	**Leaf-based foods *cajanus cajan***		
	$CC_{0\%}$	$CC_{5\%}$	$CC_{10\%}$	$CC_{15\%}$
Raw materials				
yellow corn	55	55%	55%	55%
Soybean meal	23	18%	13%	8%
Bran	17%	17%	17%	17%
Palm oil	0,5 l	0,5 l	0,5 l	0,5 l
Limestone	0,5%	0,5%	0,5%	0,5%
CMV	4%	4%	4%	4%
Nacl (cooking salt)	0,5%	0,5%	0,5%	0,5%
Cajanus cajan leaf flour	0%	5%	10%	15%
	100	100	100	100

2.2.4. Building preparation and performance monitoring

The experiment building was emptied, cleaned with soapy water and disinfected with bleach and sleet two weeks before placing the subjects, i.e. just after the chicks hatched. Livestock equipment (feeders, drinkers, etc.) has also been washed and disinfected. A second disinfection of the building was carried out with a virocide (VIRUNET) one week after the first. The experimental device was fitted out with mesh cages which made it possible to constitute the different batches and sub-batches. On the eve of placing the subjects, the surface of each cage was covered with a thick layer of litter (wood shavings). A thermometer was installed for temperature control and a footbath was placed at the entrance to the door of the experimental building. Feeders, drinkers and other performance monitoring equipment (scale, identification ring and data collection sheets) were placed in the different sub-lots. Before the installation of the subjects, a physical examination was carried out to ensure the physical aptitude of the animals then an identification was made using the identification marks. 40 subjects (pullets) with an average weight of 445g out of a total of 300 were chosen; then, the subjects were distributed according to a completely randomized random device into 4 batches of 10 subjects each of approximately equal weight and corresponding to the four previous dietary treatments (CC0%; CC5%; CC10% and CC15%). Each batch was divided into two sub-batches of 5 subjects each.

2.2.5. Collection of data

2.2.5.1. Live weight of animals

Weekly and individual weighing of the subjects was carried out every Saturday throughout the duration of the experiment using an SF-400 brand electronic scale with a capacity of 5 kg and an accuracy of ±10 g. This operation made it possible to determine the live weight of the animals which was subsequently recorded in the animal weight sheets.

2.2.5.2. Alimentary consommation

Daily weighing of the quantities of food distributed and refusals was carried out. They made it possible to obtain the daily consumption of the chickens by the difference between the quantity of food distributed and that refused. The results obtained were recorded through the data collection sheets.

2.2.6. Calculation of zootechnical variables

The data collected was entered into the Microsoft Excel spreadsheet and the various zootechnical parameters were calculated. Thus, the average daily gain (GMQ), the daily food consumption (CAQ), the consumption index (CI) and the possible mortalities, were determined by treatment.

2.2.6.1. Individual food consumption

It was determined according to the following formula:

$$\boldsymbol{IFC(g)} = \frac{\mathbf{QFD(g)/period - QFR(g)/period}}{\mathbf{duration\ of\ the\ period(j) * number\ of\ subjects}}$$

2.2.6.2. Average daily gain

The weekly live weight measurements of the subjects made it possible to calculate the ADG according to the following formula:

$$\boldsymbol{ADG} = \frac{\mathbf{weight\ gain\ for\ a\ period}}{\mathbf{duration\ of\ the\ period}}$$

2.2.6.3. Consumption index

It was calculated according to the following formula:

$$\boldsymbol{CI} = \frac{\mathbf{quantity\ of\ food\ consumed\ during\ a\ period\ (g)}}{\mathbf{weight\ gain\ during\ the\ same\ period\ (g)}}$$

2.2.6.4. Mortality rate

The mortality rate, expressed as a percentage, was calculated from the data collected on the mortality sheet according to the following formula:

$$\boldsymbol{MR} = \frac{\mathbf{number\ of\ subjects\ who\ died\ during\ the\ period}}{\mathbf{headcount\ at\ the\ start\ of\ the\ period}} * \mathbf{100}$$

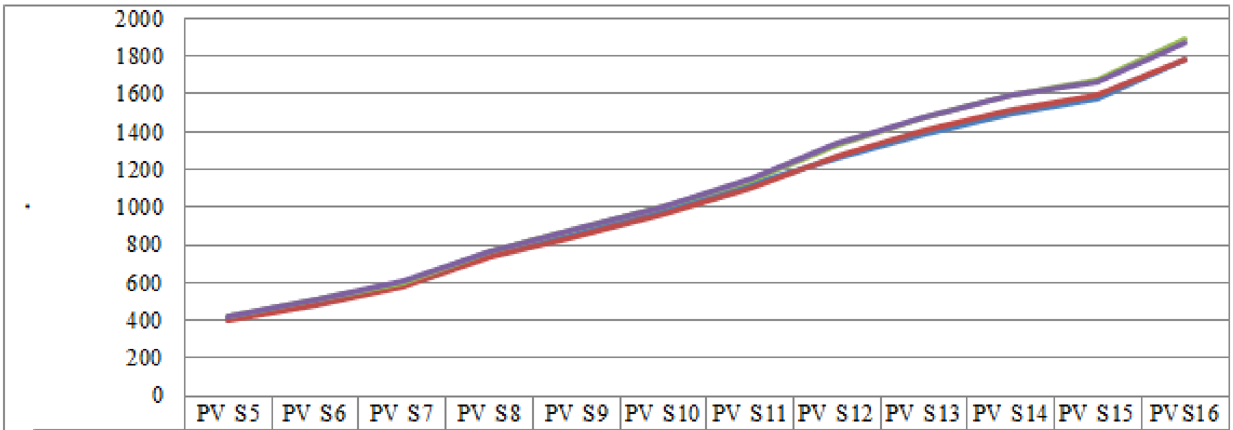
2.2.7. Statistical analysis of data

The analysis of the results obtained and the comparison of the means between the different treatments were carried out by the analysis of variance test (ANOVA) using the Statistical Package for the Social Science (SPSS) software and supplemented by the test of Duncan when the ANOVA test showed a significant difference.

3. Results

3.1. Live weight

Figure 3 illustrates the effect of incorporating *Cajanus cajan* leaf flour into the ration on the weight change of pullets as a function of age. This figure shows that from the 6th week until the end of the experiment, the pullets of all the batches (0%; 5%; 10% and 15%) showed substantially identical live weights with a significant advantage in the subjects of the 10% and 15% treatments compared to the subjects of the 0% and 5% treatments. From the 14th week of age until the end of the experiment, an improvement in weight was observed in chickens treated with leaves. However, no significant difference (P > 0.05) was observed between the weights of the animals of the 10 and 15% treatments as well as the 0 and 5% treatments.



	PV S5	PV S6	PV S7	PV S8	PV S9	PV S10	PV S11	PV S12	PV S13	PV S14	PV S15	PV S16
CC 0%	411.771	494.267	595.722	744.5	856.889	980.056	1122.38	1260.41	1389.54	1496.97	1579.03	1780.99
CC 5%	399.808	482.867	580.869	734.5	847.576	962.202	1103.23	1273.98	1410.2	1520.01	1592.21	1780.9
CC 10%	420.55	505.04	602.563	766.98	882.371	1001.14	1145.52	1333.08	1477.52	1597.91	1675.78	1886.57
CC 15%	418.8	506.508	604.975	767.916	883.285	1005.85	1149.8	1333.26	1476.12	1590.15	1662.97	1871.97

Figure 3: Evolution of the average live weight of pullets by batch.

3.2. Average daily gain

The average daily gains (ADG) obtained by batch or food treatment from the beginning to the end of the experiment are reported in Table 2.

This table shows that the incorporation of *Cajanus cajan* leaf flour in the diet significantly influenced the GDG (P < 0.05) of animals between 6th and 8th week of age. From the 9th week to the end of the experiment, no significant difference was observed (p>0.05). However, a difference in the improvement in weight gain was noted at the 15 and 0% treatment level.

Table 2: Effect of *Cajanus cajan* leaf meal incorporation on average daily gain (ADG).

Setting	Age in week	Food treatments			
		CC$_{0\,\%}$	**CC$_{5\,\%}$**	**CC$_{10\,\%}$**	**CC$_{15\,\%}$**
ADG as a function of time	6-8	17,94±0,89b	16,02±1,77ab	14,36±1,14a	12,98±0,31a
	8-10	16,92±1,26a	18,59±1,33a	16,73±1,90a	16,31±1,01a
	10-12	19,67±4,34a	18,93±0,34a	17,57±1,21a	18,43±1,20a
	12-14	16,85±0,41a	14,57±2,44a	15,04±0,45a	16,26±1,05a
	14-16	20,42±1,82a	13,50±1,96a	15,30±4,34a	17,79±1,35a

a, b, c: The means followed by different letters within the same row are significantly different at the 0.05 level.

3.3. Alimentary consommation

The effect of the experimental rations on the evolution of food consumption as a function of time is presented in Table 3. It appears that the daily food consumption was lower in the control batch than in the experimental batches (10% and 15%) and very low in the 5% lot.

In these two batches, food consumption increased steadily from the 6th to the 14th week of age for the 10% treatment and from the 14th week of age to the end of the experiment for the 15% treatment. In general, it appears that the incorporation of *Cajanus cajan* leaf meal in the diet of pullets improved the food consumption of the birds and this significantly ($P < 0.05$) from the beginning to the end. of experimentation.

Table 3: Effect of *Cajanus cajan* leaf meal incorporation on pullet feed consumption (FC).

Setting	Age in week	Food treatments			
		CC$_{0\,\%}$	CC$_{5\,\%}$	CC$_{10\,\%}$	CC$_{15\,\%}$
Average food consumption (g/j)	S6-8	52,16±0,65bc	49,31±0,19ab	53,27±2,04c	46,62±0,56a
	S8-10	63,60±1,16b	63,84±1,48b	65,47±1,86b	58,74±0,13a
	S10-12	73,42±1,78a	74,71±0,41ab	78,48±0,80b	75,26±2,36ab
	S12-14	85,56±2,59ab	79,39±0,75a	86,60±1,90b	84,84±4,25ab
	S14-16	92,27±2,82a	87,66±1,04a	90,12±4,79a	93,63±6,18a

a, b, c: The means followed by different letters within the same row are significantly different at the 0.05 level.

3.4. Consumption index

The effects of the incorporation of *Cajanus cajan* leaf meal on the feed consumption index (CI) of the chickens during the experiment are summarized in Table 4. The results recorded in this table show that the incorporation of *Cajanus cajan* leaf meal had no significant effect on feed conversion between 6-8 weeks for treatments containing 10% and 15% *Cajanus cajan* leaf meal. Similarly, from the 8th to the 16th week of age, the feed conversion index was not influenced with the incorporation of *Cajanus cajan* leaf flour in the diet of the birds compared to the controls. At the end of the experiment, the best consumption index was obtained with the 15% treatment. The study showed an increase in the feed conversion ratio proportionally with the rate of incorporation of *Cajanus cajan* leaf flour in the diet and this in a non-significant way from the 8th week until the end of the study.

Table 4: Effect of the incorporation of *Cajanus cajan* leaf flour on the consumption index (CI).

Setting	**Age in week**	**Food treatments**			
		$CC_{0\%}$	**$CC_{5\%}$**	**$CC_{10\%}$**	**$CC_{15\%}$**
consumption index	IC6_8	2,9437±0,3483a	2,9918±0,2531a	3,7360±0,1815b	3,8826±,1859b
	IC8_10	3,7318±0,097a	3,4972±0,5357a	3,8395±0,1446a	3,6153±0,1011a
	IC10_12	4,1649±0,9954a	4,3335±0,1134a	4,7642±0,2900a	4,3601±0,1134a
	IC12_14	5,5550±0,2121a	6,7263±1,1295a	7,1427±0,9528a	5,4842±0,2283a
	IC14_16	7,4242±1,6699a	7,4444±1,0253a	8,4047±4,0384a	6,2371±0,5355a

a, b, c: The means followed by different letters within the same row are significantly different at the 0.05 level.

3.5. Entry into laying of the hens

Table 5 illustrates the start of laying of hens according to the treatments. It appears that the incorporation of *Cajanus cajan* leaf flour did not influence the laying of hens in general. Nevertheless, a delay in the onset of lay was observed with the 15% batch. The 0%, 5%, and 10% batches started spawning in the 15th week.

The total number of eggs harvested per batch was 60; 85; 70 and 15 respectively for the 0%, 5%, 10% and 15% treatments during the 7 weeks of production. It emerges from this analysis that the 5% batch recorded the best laying results, followed by the 10% and 0% batches. The 15% lot showed the lowest rate.

Table 5: Ages of entry into lay of hens according to treatments.

Treatments	**The age of entry into lay**
Lot CC 0%	15weeks ±2days
Lot CC 5%	15weeks ±2days
Lot CC 10%	15weeks ±2days
Lot CC 15%	18weeks ±2days

3.6. Egg weight

The evolution of the average egg weights of the different treatments are given in Table 6. It appears from this table that the experimental rations (5%, 10% and 15%) recorded eggs of satisfactory sizes compared to the control. Weights at week 21 were 62.77±0.8g; 62.14±1.3g; 61.25±2.9g; and 58.55±1.7g respectively at 10% batches; 5%; 15% and 0%. The control batch recorded the lowest weight at the end of the experiment.

Table 6: Evolution of egg weight according to weeks and treatments.

Weeks	Batch CC 0%	Batch CC 5%	Batch CC 10%	Batch CC 15%
W15	31,05±2,5a	32,09±1,4ab	34,32±0,9b	33,52±1,1b
W16	35,47±3,1a	35,17±0,8a	37,52±2,1b	36,36±1,6ab
W17	41,85±1,5a	43,98±0,6b	44,85±0,8b	42,72±2,1ab
W18	43,47±0,5a	45,65±2,1b	47,54±1,5bc	45,45±0,9b
W19	47,00±3,1a	52,23±2,3b	51,45±3,4b	50,44±2,4b
W20	55,17±2,0a	57,87±1,2b	59,95±5,1b	56,87±3,0ab
W21	58,55±1,7a	62,14±1,3b	62,77±0,8b	61,25±2,9ab

a, b, c: The means followed by different letters within the same row are significantly different at the 0.05 level.

3.7. Effect on egg production and coloring

Figure 4 shows the effect of experimental rations on the evolution of egg laying as a function of time. Overall, the incorporation of *Cajanus cajan* leaf meal did not negatively influence egg laying as shown in the figure below. The 5% batch stood out from the other batches with a clear pace from the beginning to the end of the experiment, followed by the 10% batch. The control showed more fluctuation throughout the experiment.

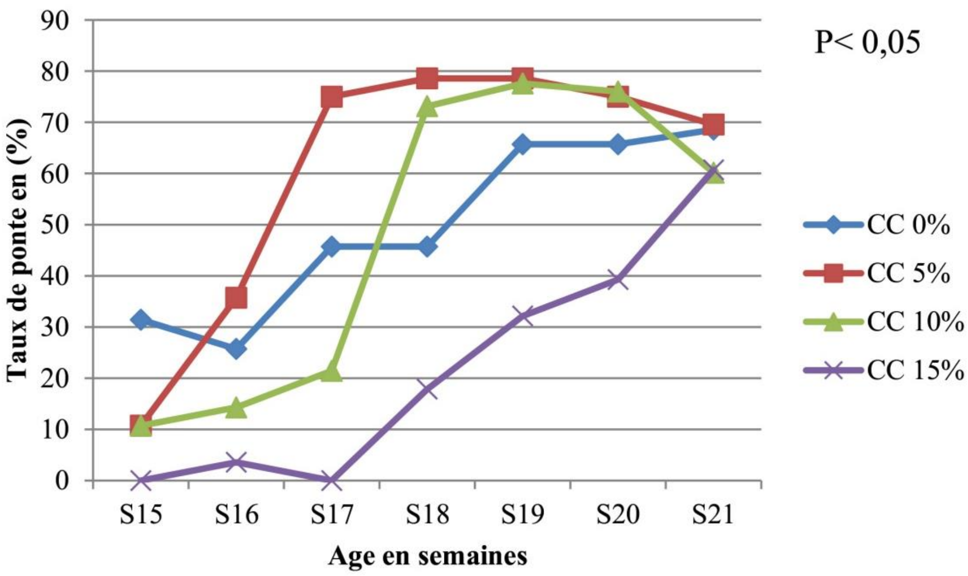


Figure 4: Effect of the incorporation of *Cajanus cajan* leaf meal in the ration on the evolution of laying.

The effect of the experimental rations on eggshell and yolk coloring is shown in Figures 5 and 6. The incorporation of ***Cajanus cajan*** leaf meal into the hens' ration up to 15% n has not changed the color of the shell in general. It did, however, improve egg yolk color in the 10% and 15% treatments.

Figure 5: coloring of eggs from laying hens fed rations containing respectively 0, 5.10 and 15% of *Cajanus cajan* leaf flour.

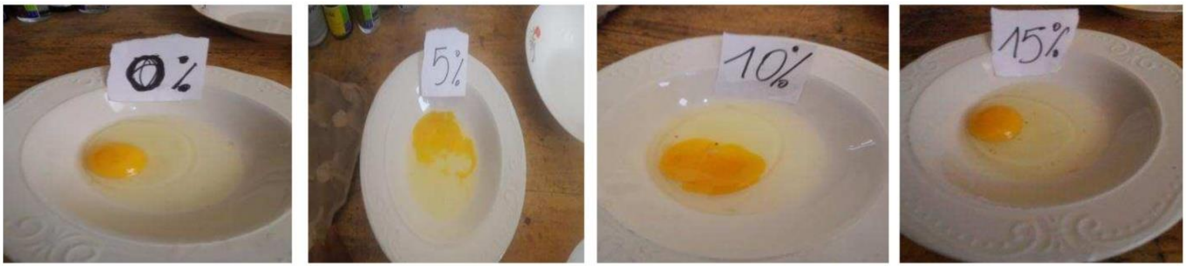


Figure 6: Staining of egg yolk of laying hens fed rations containing 0, 5, 10 and 15% *Cajanus cajan* leaf meal respectively.

3.8. Effect on the health status and mortality of subjects

In general, the incorporation of *Cajanus cajan* leaf meal in the ration of chickens did not cause any adverse effects on the health status of the animals. Indeed, no mortality was observed during the entire period of the experiment. The 0% mortality rate suggests that the gradual incorporation of *cajanus cajan* leaf flour into chicken feed remains an alternative to overcome the feed problem in the poultry sector.

4. Discussion

At the end of the study conducted on the effect of incorporating *Cajanus cajan* leaf flour on growth performance, carcass weight and organ characteristics of pullets. The discussion of the results is based on the following points: average live weight, average daily gain, feed consumption, feed conversion, carcass weight, carcass and organ characteristics, health status and mortality pullets.

The incorporation of *Cajanus cajan* leaf meal in the ration improved the average live weight of the pullets in a non-significant way p>0.05 in the subjects of the CC5% (1803 g) and CC10% (1904.5 g) treatments.) from the 14th week of age compared to the control treatments CC0% (1769.65 g) and 10% (1904.5g). The increase in live weight was of the order of 1.67% and 6.74% respectively in the pullets of the CC5% and CC10% batches compared to the pullets of the control batch. The live weights observed in the control and CC15% treatments were similar and lower while those of the other leaf meal treatments were the highest. These results are similar to those obtained by [18], of 0% (1985.6g), 3% (1962.8g), 6% (1851.8g), 9% (1917.2g) and 12% (1737.6 g), on the other hand, these results are higher than those obtained by [19], T1 (1566g), T2 (1485.9g), T3 (1506.0), with those obtained by [10] where average live weights in the batches 5% (880.41g), and 10% (763.14g), compared to the control 0% (694.36g) and 15% (708.64g), as well as those obtained by [20].

The results obtained show that the incorporation of *Cajanus cajan* leaf meal in the diet significantly influenced the ADG ($P < 0.05$) of animals between 6th and 8th week of age in all batches. The 15% batch with an ADG of 17.79g/d, followed by the 10% batch with an ADG of 15.30g/d, followed by the 5% batch with an ADG of 13.50g/d. These GMQ are higher than those obtained by [9], obtained a GMQ of 8.7g/d at 18 weeks of breeding and those found by [21] a GMQ of the order of 3.57g/d at 12 weeks. These results are much higher than those obtained by [22], at 24 weeks with 9.46 to 11g/d, as well as those found by [10], at 18 weeks the ADG respectively of CT at 5% (7.805g /d), CT 10 (6.395g/d, CT at (5.73g/d). These same results are superior to those obtained by [19], at 20 weeks the following ADG: R1 (10.0g/d) , R2 (9.0g/d) and R3 (9.0).

Daily feed consumption is lower in the control batch than in the experimental batches (10% and 15%) and very low in the 5% batch. In these two groups, food consumption increased steadily from the 6th to the 14th week of age for the 10% treatment and from the 16th week of age to the end of the experiment for the 15% treatment. In general, it appears that the incorporation of *Cajanus cajan* leaf flour in the diet of chickens improves the food consumption of birds and this significantly ($P < 0.05$) from the beginning to the 16th week of the litter. experimentation which are respectively 0% (92.27g), 5% (87.66g), 10% (90.12), 15% (93.63). These results can be comparable to those obtained by [23, 24] who incorporated up to 15-20% of Leucaena leaf flour and [25] with 10% of sweet potato leaf flour, observed an improvement growth performance in broilers. These results are also similar to those of [26, 27] who with high rates (20 and 15% respectively) found a significant improvement in productivity and feed consumption in laying hens.

The effects of *Cajanus cajan* leaf meal on the feed conversion index (FI) to increase with age. However, the best consumption index was obtained with the 15% treatment. This study shows an increase in the feed conversion ratio proportionally with the rate of inclusion of *Cajanus cajan* leaf flour in the diet and this in a non-significant way from the 8th week. At 16 weeks of breeding, they are very high and of the order of: 0% (7.42), 5% (7.44), 10% (8.40) and 15% (6.23). These results are similar to those of [8, 28, 9] who found 7.2 respectively; 7.86; 7.37 in adult subjects. As for the production and coloring of eggs, the incorporation of up to 15% of *Cajanus cajan* leaf meal in the diet of layers improved the production and coloring of egg yolk and this in treatments 10 and 15%. This effect could be due to the presence of pigments (ß-carotenes) in the leaves of *Cajanus cajan*. These results are similar to those found by [29, 30, 31, 32] who found improved egg production, feed conversion, egg size and egg color by including 5-15% leaf meal Azolla pinnata and neem (Azadirichta indica) in the diet of laying hens. Our results are similar to those of [26, 27] who, by incorporating up to 20% of M. oleifera leaves in the ration of layers, observed a significant improvement in the yellow coloration of the egg yolk, productivity and feed consumption in laying hens. These authors attributed this egg yolk coloration to the existence of pigments in the leaves of M. oleifera.

The mortality rate of 0% throughout the period of the experiment and a very remarkable improvement in the health status of the pullets. These results are similar to those obtained by [33] on safou cake incorporated into chicken feed. This same mortality rate is better with that obtained by [34], who recorded a mortality rate of 20.77% and [10], respectively 0% (40.9%), 5% (22.72), 10 % (9.08%), and 15% (18.18). This mortality rate is better than that recorded by [35] with a rate of (4.3%).

5. Conclusion

In conclusion, the incorporation of *Cajanus cajan* leaf flour up to 15% in the feed ration of laying hens of the Lohmann Brown strain in Congo Brazzaville did not cause any negative effect on weight growth, food consumption, mortality, production and egg color in subjects fed experimental food compared to controls. From the beginning to the end of the experiment, all the zootechnical parameters were better in the subjects having consumed the rations based on the leaves compared to the control.

In view of these results, the incorporation of *Cajanus cajan* leaves in the feed of laying hens can be done up to 15% in substitution for soybean meal. It is a real opportunity for Congolese poultry farmers to not only improve their income (given the high cost of conventional raw materials) but also to contribute to the reduction of massive imports into Congo.

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