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Effect of Feed Rations Based on *Moringa oleifera* Leaf Powder on the Weight Gain of Hens Reared in the Forest Regions of Kisangani, Democratic Republic of Congo

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Abstract

The present study aims to evaluate the effects of food rations based on *Moringa oleifera* leaf powder on the weight growth of hens, was carried out in the province of Tshopo, city of Kisangani in the Democratic Republic of Congo, it covered a period of 6 weeks from August 21 to September 25, 2022. It involved 40 five-week-old Isa Brown chicks, divided into 8 batches of 5 subjects each, corresponding to 4 experimental rations T0, T1, T2 and T3 where *M. oleifera* leaf flour was incorporated at 0, 5, 15 and 30% respectively. The inclusion of *M. oleifera* leaf meal in the ration improved the live weight of poultry from one week to another for all 4 treatments, and this significantly, in particular at the 6th week of age for the T3 (647.5 g) and T2 (581 g) compared to control treatments T0 (520 g) and T1 (537 g). It significantly improved the individual food consumption (CAI) evolved increasingly over time during the experiment (64.9g/d and 64.9g/d) of the subjects of T3 and T2 compared to those (57 .9 g/d, and 62.1 g/d) of T0 and T1 birds respectively. The inclusion had no significant negative effect on the average daily gain (ADG) of poultry, but varied during the experimental period for all treatments (p. value > 0.05), except for treatment T1.

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Nevertheless, from the 6th to the 12th week of age, subjects fed rations based on *M. oleifera* leaf flour showed T0 (0.0587), T1 (0.0143), T2 (0.1121), and T3 (0.3752).

Keywords: Moringa oleifera; hen; Isa Brown breed; weight gain.

1. Introduction

This article is the result of research sanctioning the end of a graduate study in agronomic sciences at the University of Kisangani, valued for this purpose.

Population growth in the forest environment of Kisangani has been noticed in the last decade, influencing food needs. To satisfy these food needs, the population takes refuge in small livestock such as small ruminants, poultry on the one hand, and in agricultural practices, on the other hand. The hen is the poultry that is found in almost all households in the city of Kisangani.

It plays a major role in the survival of households, especially for self-consumption, to meet certain household expenses and for certain customary rites (marriage, bereavement, baptism, etc.) [7].

In the DRC, raising domestic animals is for some people the main activity and for others one of the alternative survival activities in order to cope with the precariousness of social and economic life which continues to worsen following the unsuitable economic and political situation [1].

[8] Estimate that the population of the Democratic Republic of the Congo will exceed 100,000,000 by around 2050. The unsuitable economic and political situation certainly means that the cultures of these animals can come up against thorny problems of food, diseases and the inadequacy of the prophylactic measures which are in vogue in most developing countries in general [3] and in particular in the DR Congo thus resulting in low production of the aforementioned products [2].

In this study, we consider the hen as an animal of poor households, ready to save lives in case of lack of daily ration, lack of funds to resolve disputes, etc.; it can therefore intervene in several situations.

With this in mind, we were interested in the hen raised in the forest environment of Kisangani in order to observe the influence of the use of Moringa in its diet; This is why we asked ourselves the following main question with regard to the hen: What would be the effect of using *Moringa oleifera* leaf powder on the weight growth of the hens?

2. Material and methods

2.1. Location of the study environment

This study was conducted in Kisangani, the capital of the province of Tshopo. This study area is located in the northeast of the Democratic Republic of the Congo at 00° 31' north latitude and 25° 11' east longitude. The city is located on an altitude of 393 meters and its area is 1910 km2 [12]. In general, an average annual temperature

varying between 25° and 28° is recorded in an equatorial type climate orchestrating abundant rains throughout the year. Below is the location of the study area.

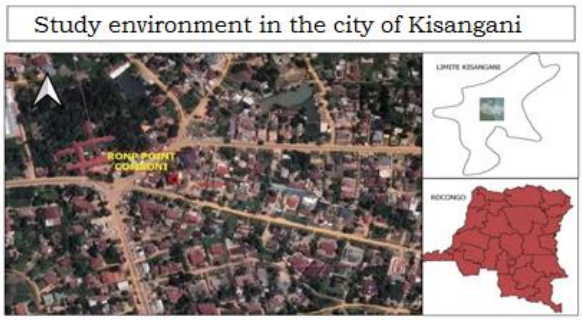

Figure I: Location of the city of Kisangani, studying area.

This study was conducted on 40 chicks of the ISA Brown breed, with reddish-brown plumage and whose eyes, skin and tarsi are yellow, which should be tested using *Moringa oleifera* leaves collected and prepared locally.

The housing for the hens consisted of a wooden battery-built chicken coop fitted with a 4-millimetre-mesh trellis. The henhouse was partitioned into 8 compartments or boxes which made it possible to have 4 batches of chicks due to 2 sub-batches per treatment. Age-appropriate wooden feeders and siphoid drinkers were also used for chick feeding and watering.

2.2. Data collection

A high-precision electronic scale from 0 to 50 kg was used to weigh the different ingredients and sample the zootechnical variables. Wood shavings to promote the drying out of droppings and the absorption of humidity in the chicken coop, finally to keep it always dry. Four granulated feeds with different incorporation rates (0, 5, 15, and 30%) of *Moringa oleifera* leaf powder were used. The control food (Mor 0) at 0%; Mor 5 treatment foods; Mor 15; and Mor 30 respectively at 5%; 15% and 30% incorporation. The animals were weighed and randomly divided into 4 homogeneous groups of 10 chicks. The distribution of the animals was carried out so that the average weight of each batch was as close as possible. Each batch has two cages (repetitions) of 5 chicks each. The animals were numbered using different colors applied to the wings to facilitate their individual tracking.

Table I: Repetition parameters.

Treatment	Blocks or repetitions
To	Batch 1a and 1b
T1	Batch 2a and 2b
T2	Batch 3a and 3b
T3	Batch 4a and 4b

Legend:

T0: Control food

T1: Food containing 5% *Moringa oleifera* leaves.

T2: Food containing 15% *Moringa oleifera* leaves.

T3: Food containing 30% *Moringa oleifera* leaves.

2.3. Food and ration preparation

Food was also weighed before distribution to quantify consumption. Wastage and rejection were assessed at 20% with the type of feeder we used [11]. Before the pre-mixing of our different rations, we proceeded to the treatment of certain coarse ingredients so that they become easily consumable by the chicks. Corn kernels were purchased already sorted. The soybeans after purchase were roasted, and the bones were purchased already charred.

Harvesting, drying and grinding are the main steps that allowed the preparation of *Moringa oleifera* leaf powder. Drying was done in the shade in a well-ventilated and protected building for 2 days.

The leaves are turned over to allow even drying and exposed to the sun the next day for 15 min. before grinding. After drying the leaves, we pounded them in a mortar to avoid any loss and sifted through a 4mm diameter mesh sieve. The flour obtained after pounding was mixed with other ingredients after their machining while respecting their proportion according to the different treatments.

2.4. Formulation of experimental rations

We proceeded by the trial and error method to compose our different diets used in our experiment according to the protein needs of the first age laying chicks while respecting the incorporation rate margins recommended by the general principles of the establishment food.

We preferred to combine corn flour and rice bran for their higher energy intake and fish flour, *Moringa oleifera* leaf flour, soy also very high in protein allowed us to reduce the rate of incorporation of soy in the 4 aforementioned regimes.

Fishmeal and Moringa leaf meal were protein foods that should provide the ration with essential amino acids that were insufficient in plant-based proteins, especially when the amount of soy is in small proportion. We used bone meal as a source of calcium and phosphorus.

From these different ingredients, we composed the four experimental foods containing the well-balanced ingredients.

2.5. Statistical analysis and data processing

The data collected was subjected to content analysis. They were coded and processed in the Microsoft Excel 2016 spreadsheet to build a database. Some descriptive statistics were carried out in this spreadsheet in order to

present the results in the form of tables and graphs. The comparisons of the means between the different food treatments were carried out using the R software by the analysis of variance test (ANOVA) or by the Kruskal Wallis test at the 5% threshold.

3. Results and discussion

3.1. Effect of incorporating Moringa oleifera powder on the weight growth of hens

The effect of the experimental rations on the evolution of food consumption is presented in Table 2. For all treatments, individual food consumption (ICA) evolved in an increasing manner over time during the experiment. Indeed, this is explained by the fact that the weight growth of hens over time leads to a physiological need to consume more food. The ICA varied very significantly (p-value < 0.05) between weeks for all treatments except the second treatment.

Table V: Effect of the incorporation of *M. oleifera* leaf meal on Individual Food Consumption (IFC) of chickens.

Period (in weeks)	T0	T1	T2	T3
P1	40,9	38,6	37,4	38,1
P2	40,4	44,1	43,1	43,4
P3	47,6	49,7	48,4	48,7
P4	52,9	55,1	53,9	54,1
P5	55,7	60,6	59,7	59,6
P6	57,9	66,1	64,9	64,9
Total	**49,2**	**52,4**	**51,2**	**51,5**
p-value	1,956^{e}-11	1,961^{e}-10	0,4159	1,972^{e}-8

Table VI: Effect of incorporating *M. oleifera* leaf flour on the Consumption Index (CI) of chickens (mean ± standard deviation).

Period (In week)	T0	T1	T2	T3
P1	1,3 ±0,6	1,4 ±0,4	1,0 ±0,3	0,9 ±0,2
P2	0,9 ±0,2	1,0 ±0,4	1,0 ±0,3	0,7 ±0,1
P3	1,0 ±0,4	1,6 ±1,2	1,0 ±0,4	1,0 ±0,3
P4	2,3 ±3,0	1,3 ±0,6	1,2 ±0,6	0,8 ±0,1
P5	1,5 ±0,8	1,6 ±0,6	1,1 ±0,4	1,0 ±0,2
P6	1,5 ±0,5	1,7 ±1,1	1,4 ±0,4	0,9 ±0,1
Total	**1,4 ±1,4**	**1,4 ±0,8**	**1,1 ±0,4**	**0,9 ±0,2**
p-value	0,01591	0,1917	0,1086	0,04277

Figures 3 and 4 respectively show the evolution of the mean live weight of the chickens according to the four treatments and according to the repetitions. It shows that overall, weekly weight varied from week to week for all 4 treatments. Nevertheless, the treatment consisting of a ration with the highest concentration of *Moringa oleifera* powder (T3) presented individuals with better weight growth, followed by those of the T2 treatment. On the other hand, the chickens submitted to the T1 treatment rations presented the lowest average live weight, close to the control treatment chickens (T0), which attests that the T1 treatment did not make it possible to identify the effect of *Moringa oleifera* in chicken feed.

Our results are better than those obtained by [6] who found a decrease in the final live weight of layers by including 20% of *Leucaena leucocephala* and cassava leaf meal, respectively. These authors attributed this decrease in live weight to the high rate (20%) of flour in the ration, to the drop in the energy level and the possible presence of antinutritional and toxic factors in the leaves. Moreover, our results are lower than those found by [5] respectively after 8 and 17 weeks of age in the Fayoumi breed from Egypt (469 g) and the Kabylia hen in Algeria (1531 g). In the rows below, Figure 2 shows the evolution of the average live weight of chickens according to the four treatments.

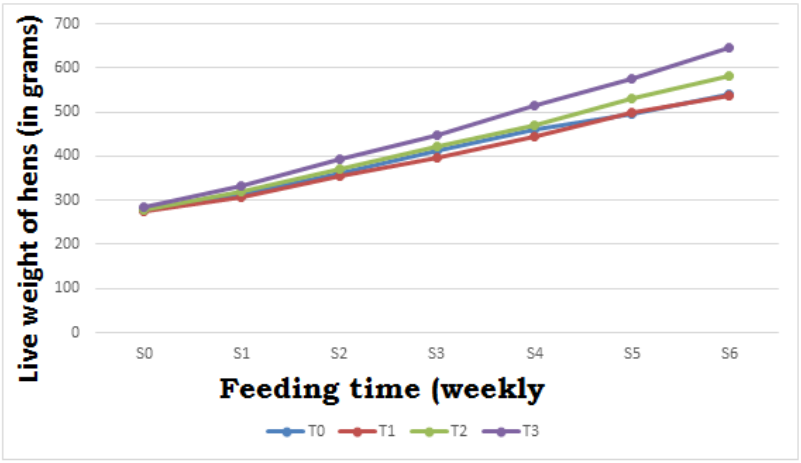

Figure II: Evolution of the average live weight of chickens according to the four treatments.

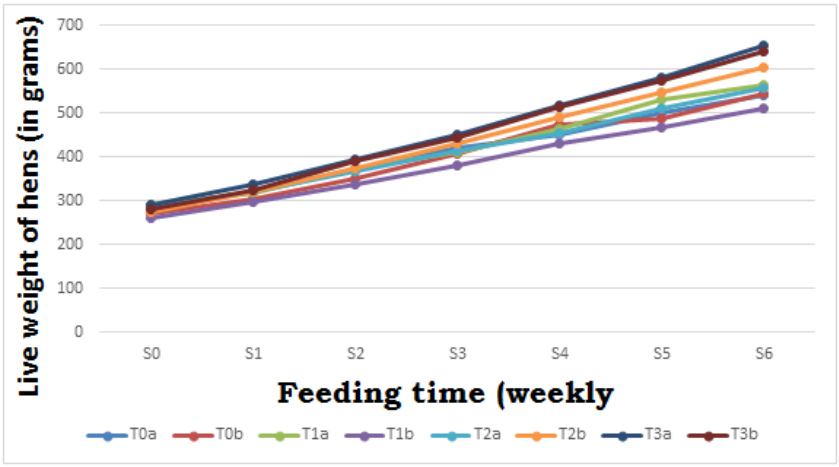

Figure III: Evolution of the average live weight of chickens according to the treatments and the repetitions.

A figure 5 presents the weight gain of the chickens according to the treatments at the beginning and at the end of the experiment. As a result, the chickens had almost the same average live weight at the start of the experiment. An almost similar weight gain can be observed for treatments T0 and T1, with the same average live weights at the end of the experiment. Moreover, the live weight of the hens at the end of the experiment is higher as the quantities of *M. oleifera* increase in the feed ration (T2 and T3).

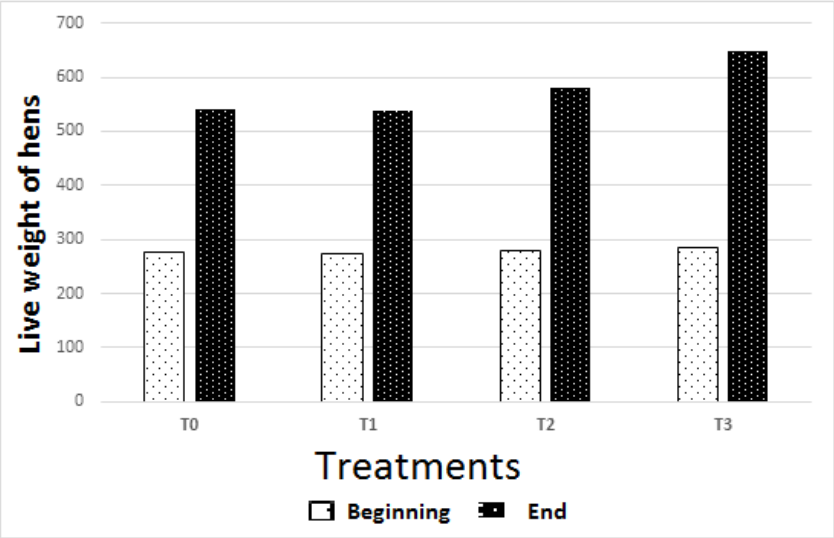

Figure IV: Weight gain of chickens according to the treatments at the start and at the end of the experiment.

3.2. Optimum quantity of Moringa oleifera powder to incorporate into the hens' feed ration

Table 4 presents the evolution of the mean live weights of the chickens during the experiment for each treatment and repetition. The results show a regular growth, but different between batches. The incorporation of *Moringa oleifera* leaf meal in the ration improved the average live weight of chickens at the 5th and 6th week. However, the highest average is observed in the subjects of T3 block I (460.57) and T1 block II represents the lowest average (382,85). This suggests that T3 is the treatment with the optimal amount of *Moringa oleifera* powder for the constitution of chicken feed rations because it gives better weight growth in subjects.

Table 4: Evolution of the mean live weights of the chickens during the experiment.

Treatments	**T0**		**T1**		**T2**		**T3**	
Blocks	I	II	I	II	I	II	I	II
Original weight	285	270	289	261	284	273	291	279
Week 1	321,2	305	317	296	321	321,4	338	325
Week 2	372	352	373	338	367	375	394	391
Week 3	422	406	411	381	414	431	451	444
Week 4	455	464	463	429	454	489	517	514
Week 5	500	506	510	466	512	548	580	574
Week 6	544	550	565	509	558	604	653	642
Sum	**2899,2**	**2853**	**2928**	**2680**	**2910**	**3041,4**	**3224**	**3169**
Mean	**414,17**	**407,57**	**418,28**	**382,85**	**415,71**	**434,48**	**460,57**	**452,71**
Standard deviation	**94,03**	**104,63**	**100,84**	**90,70**	**99,73**	**120,42**	**130,88**	**132,07**
CV	**22,71**	**25,67**	**24,11**	**23,69**	**23,99**	**27,71**	**28,41**	**29,17**

Table 5 presents the effect of the incorporation of *M. oleifera* leaf meal in the ration on the average daily gain (ADG) of chickens. It appears from the latter that the ADG was relatively higher towards the last weeks of the experiment in comparison with the values at the start for all the treatments. This is because hens grow relatively slowly at first and gain more weight as they eat a lot of feed. The ADG did not vary significantly during the experimental period for all treatments (p.value >0.05), except for treatment T1.

It shows that overall, weekly weight varied from week to week for all 4 treatments. Nevertheless, the treatment consisting of a ration with the highest concentration of *Moringa oleifera* powder (T3) presented individuals with better weight growth, followed by those of the T2 treatment. On the other hand, the chickens submitted to the T1 treatment rations showed the lowest average live weight, close to the control treatment chickens (T0).

The reasons for this feed efficiency can be explained by the digestibility produced by the vitamins contained in the natural additive provided. For example, vitamin D is involved in the regulation of intestinal absorption and calcium metabolism [4].

In the case of Moringa, it should be noted that its high nutritional quality has already been demonstrated in humans, particularly in sick and malnourished children. Moringa leaves contain a very high concentration of vitamins A and C, a complex of B vitamins, iron, calcium, proteins, zinc, and selenium. Moringa has the 10 essential amino acids for humans. According to the work of [9].

Table V: Effect of the incorporation of *M. oleifera* leaf meal in the ration on the average daily gain (ADG) of chickens.

Period (in weeks)	T0	T1	T2	T3	Total
W1	5,08 ±2,1	4,5 ±1,7	6,1 ± 2,0	6,6 ±1,8	**5,5 ± 2,0**
W2	6,9 ±1,5	7,0 ±2,9	7,1 ± 2,1	8,7 ± 1,5	**7,4 ± 2,1**
W3	7,4 ±2,1	5,7 ± 2,2	7,3 ± 1,9	7,8 ± 2,4	**7,1 ±2,2**
W4	6,5 ±3,8	7,1 ± 2,4	7,0 ± 2,0	9,7 ± 1,2	**7,5 ± 2,7**
W5	6,2 ±1,9	6,0 ±2,1	8,3 ± 2,5	8,7 ± 1,8	**7,3 ± 2,3**
W6	6,2 ± 2,3	7,0 ± 2,8	7,2 ± 2,1	10,0 ± 1,4	**7,6 ± 2,6**
p-value	0,0587	0,0143	0,1121	0,3752	

W = Weight

The supplementation of chicken feed with *M. oleifera* leaf powder has led to a significant increase in the average daily gain (ADG) of chickens during growth periods, this increase in weight would thus reflect a good assimilation of the feed due to the presence of an optimal amount of protein in the rations of 2% and 5% *M. oleifera* leaf powder (Djitie and colleagues 2015).

They corroborate those obtained by [10] who, by incorporating *M. oleifera* leaf flour up to 6% as a substitute for soybean meal in the finishing ration of broiler chickens, did not observe any harmful effect on the live weight of chickens.

4.Conclusion

The aim of our investigation was to contribute to the improvement of poultry farming productivity by promoting unconventional local ingredients to reduce the cost of feeding hens and promoting unconventional feed with very low competition with the male. In view, At the end of the observations, it turns out that the *Moringa*

oleifera leaf meal had no significant negative effect on the average daily gain (ADG) of the birds, but varied during the experimental period for all the treatments (p. value >0.05), except for treatment T1. Nevertheless, from the 6th to the 12th week of age, subjects fed rations based on *M. oleifera* leaf flour presented T0 (0.0587), T1 (0.0143), T2 (0.1121) , and T3 (0.3752); The inclusion of *M. oleifera* leaf meal in the ration improved the weekly live weight varied from one week to another for all 4 treatments, and this significantly especially at 6th weeks of age for the T3 (647.5 g) and T2 (581 g) compared to control treatments To (520 g) and T1 (537 g). It significantly improved the individual food consumption (CAI) evolved increasingly over time during the experiment (64.9g/d and 64.9g/d) of the subjects of T3 and T2 compared to those (57 .9 g/d, and 62.1 g/d) of T0 and T1 birds respectively. It is important to underline that the improvements in the quality of the products necessarily come after the essential questions which often prevent the success of the activities of production in Congo in particular the lack of hygiene, a bad application of the techniques... It is necessary that these problems must first be resolved through extensive training and awareness campaigns.

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