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Effects of *Desmodium uncinatum* Leaf Meal in the Diet on Lohmann Brown Hens' Laying Performance and Eggs Quality

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Abstract

A cheap, safe and available alternative protein source to soybean is a huge priority for the developing world. This study is aimed at evaluating the effects of *Desmodium uncinatum* leaf meal incorporation levels in the diet on Lohmann Brown hens' laying performances. For this purpose, 60 Lohmann Brown hens aged 33 weeks with an average weight of 1.78 kg were randomly assigned to 3 treatment groups of 20 birds each with 4 replicates. The experimental treatments consisted of $DULM_0$, $DULM_5$, and $DULM_{10}$ containing 0, 5 and 10 kg of *D. uncinatum* leaf meal (DULM) per 100 kg of feed respectively. The results reveal that except for the weights of hens, laying performances were significantly affected ($p < 0.05$) by DULM in the diet. Daily feed intake was lower with 10% incorporation of DULM in the diet as compared to a diet with 5% DULM which recorded the highest value for this parameter. Moreover, the highest value for the egg weight, egg mass, yolk index, albumen index and egg production were recorded with diet $DULM_5$. On the other hand, the diet with 10% of DULM ($DULM_{10}$) recorded the highest relative shell weight, feed conversion ratio and egg price. Nevertheless, the mortality rate found in this study was 0% for all treatments confirming the good quality of DULM as protein feedstuff for layer. It was concluded that incorporation levels of *D. uncinatum* leaves at 5% in the diet improved the laying performances of Lohmann Brown hens.

Keywords

Desmodium uncinatum, Laying Hens, Egg Production, Egg Quality

1. Introduction

The importance of chicken production in developing countries is widely recognized [1] [2]. Scanes [3] stated that chicken production is increasing due to high demand for eggs and chicken meat and more people invest into chicken projects. Cameroon is not an exception to such an increase within the past decades. However, this sector faces feed shortages which have led to an increase in the cost of production [4]. In poultry farming, the production of layers faces so many challenges amongst which feed cost stands as the major challenge. In fact, feed represents more than 60% of the cost of the production of layers [5] [6]. Nowadays, there is a great need to have an environmentally friendly poultry production system that is cost-efficient by using available and cheap non-conventional plant materials. Considerable attention has therefore been placed on the search for non-conventional foodstuff such as *D. uncinatum* which is available and cheap to substitute the conventional resources (soya beans) in the formulation of poultry diet. For decades, laying hens were commonly fed soybean meal, which is very costly and often genetically modified [7]. Previous research has shown that leguminous leaves such as *Moringa oleifera*, *Cassia taro*, *Manihot esculenta* and *Leucaena leucocephala* can be incorporated into chicken diets without detrimental effects on growth and laying performances [8]. The leaves of *Chronomolaena odorata* [9] and *Moringa oleifera* [10] were used in the laying diet without adverse effects. Therefore, *D. uncinatum* which is an excellent feed due to its good adaptability, long cultivation history, mature planting technique, high leaf yield and which has many active substances for healthcare can be explored. It is an important source of supplementary protein, vitamins and minerals for livestock [11] and is also rich in condensed tannin [12] [13]. The high nitrogen content of these leguminous species contributes to improving the nutritional quality of grazing ruminants' diets [14]. It has a dry matter yield of 4.670 kg/ha/year and its nutritional benefits enhance nutrient availability since it is a potential source of protein. Despite these advantages, *Desmodium* as a feed ingredient in poultry production has not been investigated. This study aims at evaluating the effects of *D. uncinatum* leaves incorporation levels on Lohmann Brown hens' laying performances.

2. Material and Methods

2.1. Study Area

The study was conducted at the Lobeng family farm situated at Mile Three Nkwen (Bamenda) in the North West Region of Cameroon. Bamenda is situated at 5˚56'0'' North and 10˚10'0'' East. His population of about 1.3 million inhabitants with the main economic activity being agriculture. It is situated at an altitude of 1200 m above sea level. The mean temperature is 27˚C, the relative humidity of 60% and the mean annual rainfall of about 1500 mm.

2.2. Management of Birds

A total of 60 Lohmann Brown hens with mean age and weight of 33 weeks and

1.9 kg respectively were used. These hens were purchased in a poultry farm in Bafut village situated in the North-West region of Cameroon. After the purchase of the hens, the animals were housed in deep litter for a 10 days adaptation period. During this period, the hens were dewormed using an anthelmintic and multivitamin administered to them in order to release them from stress [15]. At the end of the adaptation period, the animals were weighed and assigned to three experimental diets in a completely randomized design with 20 birds per treatment. Each group was further divided into 4 subgroups of 5 hens and housed in plank cages of 50 cm × 50 cm in size. Feed and water were provided *ad libitum* in recommended equipment. The experiment lasted for a period of 4 months.

2.3. Experimental Diet

D. uncinatum leaves were harvested around the poultry house before flowering, dried, crushed and 100 g sample was taken, dried at 60˚C in an oven until a constant weight was obtained, crushed and stored in plastic bags for evaluation of chemical composition [16]. The proximate composition of *D. uncinatum* leaves (DULM) was performed in the Laboratory of animal nutrition of the University of Dschang. Three experimental diets were formulated to meet the nutritional requirements of the birds as prescribed by the National Research Council (NRC 1992). Then, from a control diet containing 0% of *Desmodium uncinatum* leaf meal ($DULM_0$) two others were obtained by incorporating DULM at 5 and 10% ($DULM_5$ and $DULM_{10}$) respectively which represent the substitution of soybean cake at 50% and 100% (**Table 1**).

2.4. Data Collection

During the experimental period, the followings parameters were collected: Hens' body weights (kg), body weight gain (g), feed intake (g/bird), egg production (% hen-day), egg mass (g/hen/day) and feed conversion ratio (g feed/g egg). Egg production was recorded daily and the results were expressed as percentages of the number of eggs per hen house. Eggs were weighed on a 0.01 g precision scale. One day per week, all the eggs collected were used to evaluate egg qualities which included: egg weight, egg length, egg width, shell weight, shell yolk weight, yolk diameter, yolk height, yolk index, yolk ratio, albumen weight and albumen height.

Egg shells were weighed using a 0.01 g precision scale balance. The yolk length (cm) and yolk width (cm) were measured using a Vermier Caliper Guage® and the yolk index was calculated. Albumen length (cm) and albumen width (cm) were also measured using the same Vermier Caliper and the albumen index was calculated.

Prices per kilogram of feed were obtained based on the price of ingredients at the time of the study. The cost of production of an egg was calculated by multiplying the cost of the kilogram of the feed by the feed conversion ratio.

2.5. Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) in a

Table 1. Composition of experimental diets.

Ingredients (kg)	$DULM_0$	$DULM_5$	$DULM_{10}$
Maize	56	58	57.5
Wheat bran	20	15.5	14
DULM	0	5	10
Soya beans	10	5	0
Fish meal	1.5	4	6
Oyster shell	6.5	6.5	6.5
Bone meal	1	1	1
*Premix 5%	5	5	5
Price (FCFA/kg)	168.8	145.10	140.08
Total (kg)	**100**	**100**	**100**
Chemicals composition of experimental diets			
Crude protein (%)	15.72	15.52	15.20
Metabolizable Energy (kcal/kg)	2883.04	2874.82	2863.98
Calcium (%)	3.27	3.52	3.75
Phosphorus (%)	0.58	0.62	0.67
Lysine (%)	0.86	0.88	0.88
Methionine (%)	0.35	0.38	0.40

*Premix 5%: Crude protein = 40%; Metabolizable energy (ME) = 2078 kcal/kg; Calcium = 8%; Phosphorous = 2.05%; Lysine = 3.30%; Méthionine = 2.40%. DULM: *Desmodium uncinatum* leave meal.

completely randomized design. The Duncan Multiple Range Test was used to separate the means when there were significant differences at a 0.05 significance level.

3. Results

3.1. Laying Performances

The effects of *D. uncinatum* leaf meal incorporation levels on the laying performances of Lohmann Brown hens are presented in **Table 2**. Except for the weights of hens, all laying performances collected were significantly affected ($p < 0.05$) by DULM. Furthermore, increasing DULM from 5% to 10% in the diet tended to decrease hens' laying performances.

3.2. Feed Intake

Feed intake was significantly affected ($p < 0.05$) by DULM in the diet. Hens who received a 5% DULM diet recorded the highest feed intake compared to diets with 10% DULM and 0% DULM. The regression curve between DULM and feed consumption is presented in **Figure 1**. It can be seen that the curve showed a

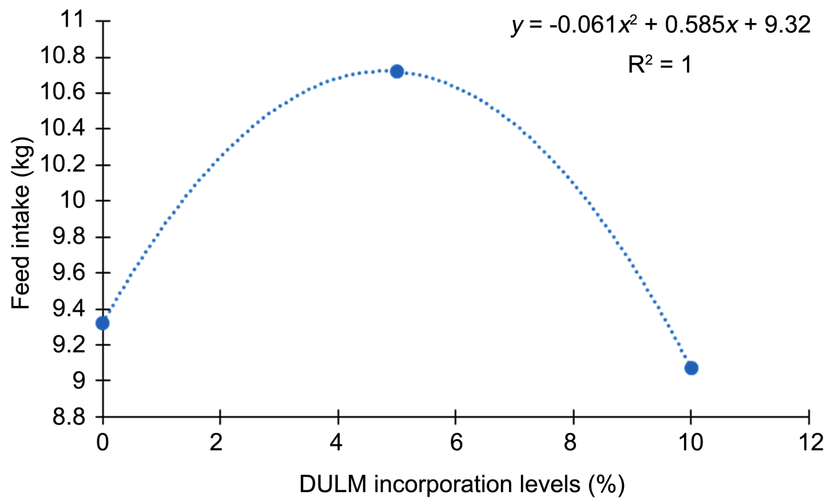

Figure 1. Regression curve between DULM incorporation levels and feed intake of Lohmann Brown hens.

Table 2. Laying performances and egg prices of Lohmann Brown hens as affected by graded levels of DULM in the diet.

Parameters	Experimental diets			SEM	p	Sig
	$DULM_0$	$DULM_5$	$DULM_{10}$			
Hens' weights (kg)	2.13^a	2.26^a	2.17^a	0.11	0.116	Ns
Total feed intake (g/hen/day)	110.95^{ab}	127.62^b	107.98^a	1.023	0.081	*
Egg weight (g)	66.51^b	67.37^b	63.71^a	1.78	0.003	*
Eggs mass (kg)	5.18^b	5.22^b	2.72^a	1.26	0.000	*
Egg/hen/day	0.92^b	0.93^b	0.51^a	0.21	0.000	*
Feed conversion ratio (g feed/g egg)	1.81^a	2.06^a	3.36^b	0.77	0.002	*
Number of egg/hens	77.53^b	77.93^b	42.67^a	17.92	0.000	*
Egg price (FCFA)	30.42^a	29.89^a	47.07^b	9.37	0.008	*

a, b: means with the same superscript letter are not significantly different ($p < 0.05$). SEM: standard error of the mean, DULM: D. uncinatum leaf meal; p: probability; Sig: significance.

bell-like shape materializing the fact that, when DULM reached 5% there is a maximum feed intake and after this point, there is a decrease in feed consumption at 10% DULM incorporation. On the other hand, the relationship between these two parameters is very high with a regression coefficient of 1. This implies that 100% of variations in feed intake are linked to DULM level in hen's diet.

3.3. Egg Production

The incorporation of 10% of DULM in the diet of Lohmann Brown layers tends to decrease egg production (**Table 2**). Hence, the highest egg production was recorded with hens receiving diet $DULM_5$ containing 5% of as compared to diets with 0% of ($DULM_0$) and 10% of DULM ($DULM_{10}$). Moreover, the increase of DULM in the diet from 0% to 5% led to a 45% increase in the number of eggs laid per hen per day (**Figure 2**).

The regression curve between egg production and DULM level in the diet confirmed the fact that the incorporation of DULM at 10% in the diet reduced egg production (**Figure 3**). In fact, the downward trend of the curve showed that when DULM incorporation increased, egg production decreased. The relationships between these parameters were positive and high with a regression coefficient of 0.74, showing that 74% of variations in egg production are linked to DULM in the diet.

3.4. Feed Conversion Ratio (FCR) and Egg Price

Same as for feed intake, a diet containing the highest level of DULM in the diet ($DULM_{10}$) recorded the highest feed conversion ratio ($p < 0.05$) as compared to the rest. Furthermore, there was a 39% increase in the feed conversion ratio when the incorporation of *D. uncinatum* in the diet changed from 5% to 10%.

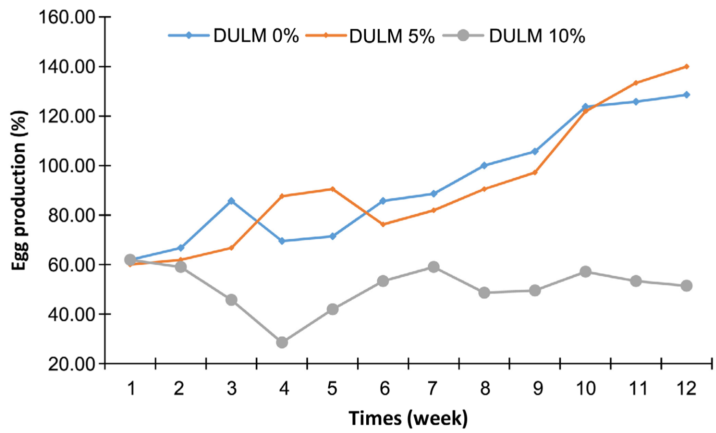

Figure 2. Weekly evolution curves of laying performances of Lohmann Brown hens receiving graded levels of DULM.

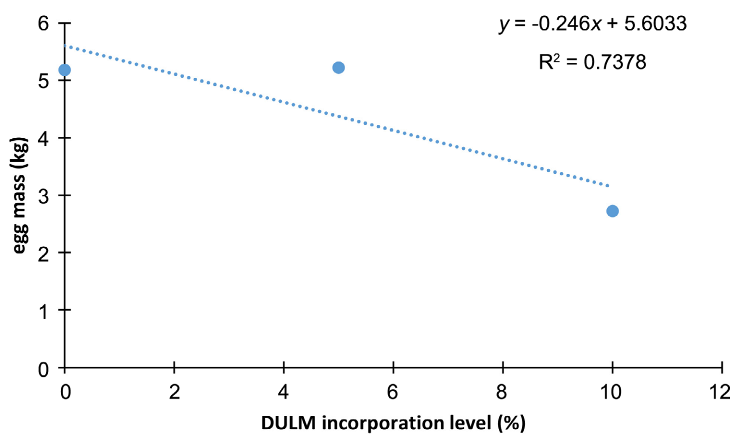

Figure 3. Regression curve between egg mass and dietary levels of DULM in Lohmann Brown hens.

Egg price was significantly affected ($p < 0.05$) by DULM inclusion in hens' diets (**Table 2**). Diet receiving 10% DULM recorded the highest ($p < 0.05$) egg price (47.06 CFA) as compared to the 5% DULM diet and 0% DULM diet. It appears therefore that the incorporation of DULM at 5% in the diet led to a decrease in egg prices as illustrated by **Figure 2**. Furthermore, the inclusion of 10% DULM led to a 57% increase in egg prices as compared to the 0% DULM diet. On the contrary at 5% DULM in the diet, egg prices were reduced by 57% as compared to 10% DULM diet incorporation (**Figure 4**).

3.5. Egg Characteristics

Apart from the yolk index and shell weight which did not show any significant difference ($p > 0.05$); all other egg characteristics were significantly affected ($p < 0.05$) by DULM incorporation in the laying diet (**Table 3**). Eggs of hens fed on a 5% DULM diet (DULM) were heavier (67.25 g) as compared to those receiving 10% of DULM in the diet (DULM10) which recorded the lowest value (63.76 g) for this characteristic.

Similarly, a diet containing 5% of DULM recorded the highest ($p > 0.05$) albumen length and width as well as yolk length (4.34 cm) and width (4.02 cm) as compared to the rest of the diets. The monthly evolution curve of egg weight is presented in **Figure 5**. Throughout the study period, the egg weight curve of hens containing 5% of DULM in their diet was above the others. Meanwhile, with 10% of DULM was below.

The regression curve between egg weight and DULM incorporation levels in the diet is presented in **Figure 6**. The Descending trend of this curve confirms the fact that when the DULM level increased in the diet, egg weight decreased.

Table 3. Egg characteristics of Lohmann Brown laying hens as affected by graded levels of DULM.

Characteristics	DULM level (%)			SEM	p	Sig
	0	5	10			
Egg weight (g)	66.51^{b}	67.37^{b}	63.71^{a}	1.78	0.003	*
Yolk length (cm)	4.03^{a}	4.34^{b}	4.09^{a}	0.12	0.012	*
Yolk width (cm)	3.82^{a}	4.02^{b}	3.81^{a}	0.23	0.000	*
Yolk index	0.95^{a}	0.93^{a}	0.93^{a}	0.04	0.120	Ns
Albumen length (cm)	9.66^{b}	10.55^{c}	8.64^{a}	1.72	0.000	*
Albumen width (cm)	6.78^{a}	7.69^{b}	6.47^{a}	1.02	0.000	*
Albumen index	0.70^{a}	0.75^{ab}	0.98^{b}	0.55	0.038	*
Shell weight (g)	8.40^{a}	8.18^{a}	8.25^{a}	0.93	0.595	Ns
Relative shell weight	12.64^{a}	12.18^{a}	12.94^{a}	1.50	0.132	Ns

a, b and c: Means and means with the same superscript letters are not significantly different ($p > 0.05$). SEM: standard error of the mean, DULM: D. uncinatum leaf meal; P: probability; Sig: signification; ns: no significant difference. *: a significant difference.

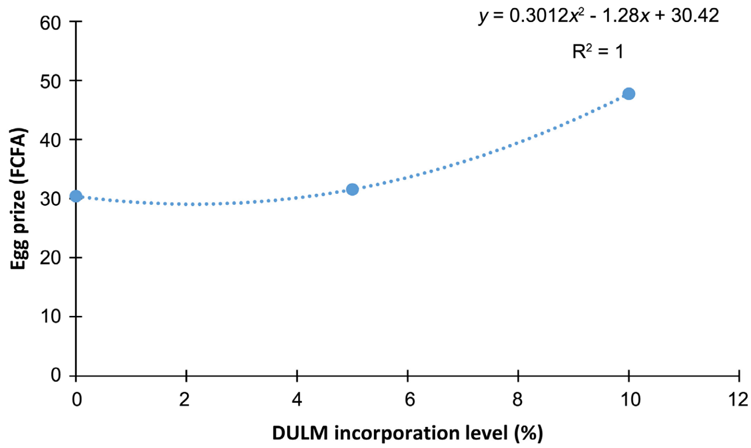

Figure 4. Regression curve between DULM incorporation levels and egg price of Lohmann Brown hens.

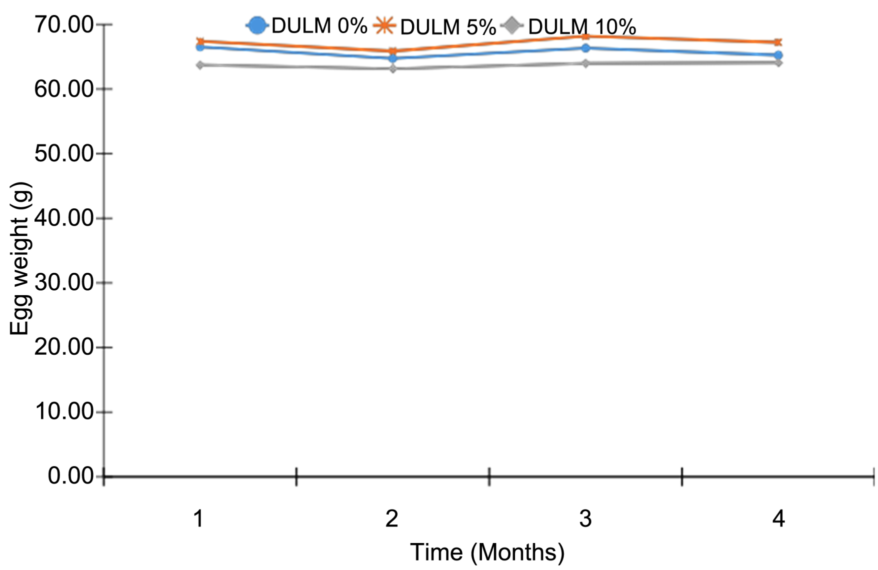

Figure 5. Monthly evolution curves of egg weight as affected by DULM levels.

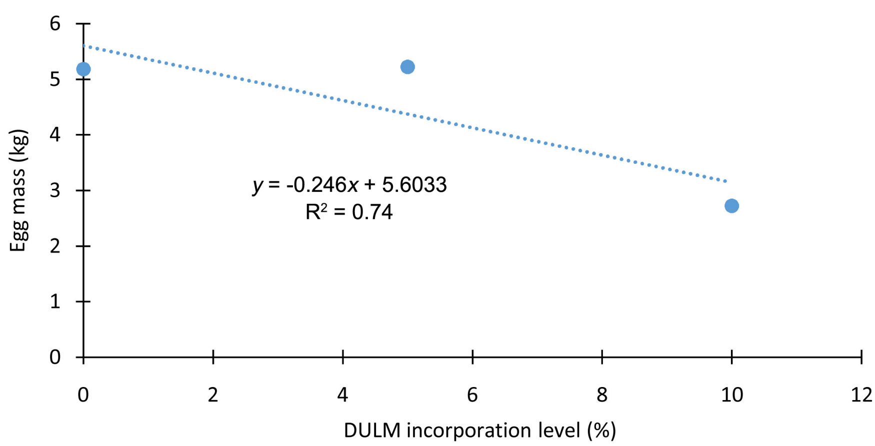

Figure 6. Regression curve between egg weight and dietary levels of DULM in Lohmann Brown hens.

Moreover, 74% of the variation in egg weight is related to the DULM incorporation level in the diet ($R^2 = 0.74$).

4. Discussion

The results of this study showed that the feed intake of laying hens decreased in response to the increase of dietary DULM at 10%, but hens' weight was not affected. This decrease is in conformity with the research of Chimvuramahwe *et al.* [17] in which the incorporation levels of dried *Adansonia digita* (baobab leaves) at 5%, 10%, and 15% in hens' diet led to a decrease in feed intake. The detrimental effect of DULM on feed intake might have contributed to the low availability of energy and protein when supplementary *D. uncinatum* was high in the diets. This was probably due to the low digestibility of the fiber component of leaves. The decrease in feed intake could be explained by the impaired palatability due to the existence of a higher amount of saponins when DULM was supplemented above 5% [18]. On the contrary, Lu *et al.* [19] observed an increase in feed intake in layers when 5% Moringa leaf was used in the diet whereas Das *et al.* [20] reported that the Indian runner hens' intake was not affected by DULM in their diet. The discrepancy in feed intake could be explained by the digestibility of the diet relative to the dietary components used in different studies.

DULM significantly affected ($p < 0.05$) hens feed conversion ratio. Hens fed on a diet containing 10% of DULM had a higher FCR as compared to the others. Similar results were reported by Houndonougbo *et al.* [21] who recorded an increase in FCR due to the incorporation of 10% and 15% of *Cassava* leaves into the poultry diet. This can be explained by the lower digestibility of nutrients in this diet in relation to saponins and condensed tannin present in *D. uncinatum*. In fact, Voemesse *et al.* [22] pointed out the cumulative effect of a high level of tannins and saponins in moringa leaves to reduced intake in laying hens at a 3% incorporation level. Indeed, the tannin content of DULM can therefore have reduced the absorption of vitamin B12 [22] which is important in erythropoiesis and then decrease weight gain. Moreover, saponins possess lytic action on the erythrocyte cell membrane which will lead to the reduction of red blood cells and growth. The hemolytic action of saponins is due to their affinity for the membrane cholesterol during which they form non-dissolvable complexes leading to their destruction [23]. In addition, it was proven that tannins, saponins or other active components in leguminous specie leaves would have inhibited the release of erythropoietin, which is the humoral regulator of RBC production.

Hens fed with diet $DULM_5$ recorded the highest egg production performances as compared to the others. These results indicate that birds fed DULM at the 5% level might have an increase in protein retention, which would improve laying performance and egg quality as stipulated by Lu *et al.* [19]. On the contrary, the laying performances decrease when DULM was used at 10% in the laying diet. This can be related to the deteriorating effect of anti-nutrient factors present in *Desmodium* at high rates. In fact, supplementation of vegetable leaves in laying hens at high rates seems to have a negative effect on liver and kidney function

[24]. Moreover, Lu *et al.* [19] reveals that the incorporation of 15% of moringa leaf meal in laying hens' diet leads to deterioration of liver and kidney function as compared to the control group.

Egg price was lowest with diet DULM5 containing *D. uncinatum* at 5% in the diet. This can be explained by the high intake of this diet associated with high digestibility. Moreover, these results show that utilization of leguminous herbs such as *Desmodium* has a link with a reduction in production cost. However, a diet containing 10% of DULM recorded the highest egg price and this led to a 57% increase in egg prices as compared to a 0% DULM diet. A 57% increase in price might have been due to the low quantity of feed intake and egg weight. This suggested that *D. Uncinatum* shouldn't exceed 5% in hens' diet.

Egg weight was significantly affected by DULM incorporation level in the diet of Lohmann Brown hens. In our study, the highest weights of eggs were recorded with a diet containing 5% DULM in the diet meanwhile 10% of DULM in the diet decreased the weights of eggs. This study had similar results to those of Kakengi *et al.* [25] who reported a decrease in egg weight with a high level of *Moringa oleifera* leaves in hens' diet. This result can be explained by an increase in dietary bulkiness inducing a reduction in FI values when leguminous trees were used [24]. Generally, the increased dietary bulkiness accompanying the high levels of leaf meals might have made it difficult for the hens to increase their FI in order to compensate for any deficiency in their nutrient requirements. In addition, the hen's digestive system is simple, has a limited capacity to digest high-fibrous ingredients efficiently and lacks the enzymes necessary for utilizing high-fibrous ingredients [26]. Therefore, using high dietary levels of the leaf meals could result in inadequate nutrient availability for the hens, which could be responsible for the negative effect on the egg mass [7] [23] [24].

The egg yolks and albumen lengths and widths were higher with diet DULM 5 containing 5% of *D. uncinatum* leaf meal as compared to other diets. These results are in agreement with Lu *et al.* [19] who recorded an increase in egg quality with the addition of 10% of Moringa leaf meal in laying hens. It can be suggested that DULM at 5% improved egg quality.

Eggshell characteristics were not affected by the inclusion of DULM in the diet independent of the level used. These results are in close agreement with Elwy *et al.* [27] who did not record any significant difference in the weight of egg shell of the quail subjected to the Moringa leaves meal. This result suggests that *D. uncinatum* did not impair mineral absorption in laying hens. However, a slight increase in shell weight was recorded with the high level of DULM. This may indicate a beneficial effect of this ingredient on calcium absorption [28] [29]. In fact, increased absorption of Calcium in serum boost weight.

5. Conclusion

The incorporation of 5% of DULM in the diet did not impair the growth, laying performances, and egg characteristics of hens. DULM at this level led to a reduction in egg price while improving egg production and quality. Therefore, it is concluded that DULM can advantageously replace soybean by up to 50% in poultry diet, especially in rural areas where this grass is available and free.

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In love memory of **Lobeng Josiane** who collected the data but pass away before publication.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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