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COMPARISON ON THE EFFECTS OF SEVERAL LEAF MEAL KINDS INCLUDED IN DIETS OF LAYING HENS ON EGG YIELD AND QUALITY

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Abstract

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The aim of this experiment is to determine the way to include some kinds of leaf meals in the diets of Luong Phuong parent stock and the effect it will have on egg yield and quality of laying hens. Cassava, leucaena leaf meals (CLM, LLM) and stylosanthes grass meal (SGM) were used in this trial. The experiment employed 630 laying hens, 84 roosters, allocated into 7 groups; each group consisted of 30 hens and 4 roosters in triple replication. The experimental groups were named as: The Control (CG), Experiment 1A, 2A, 3A and 1B, 2B, 3B. The diet offered to the Control was called the basal diet (BD) without inclusion of leaf meals; its ME and CP content complied with requirement standards for colored feather production parent stocks. The diets offered in the A groups were formulated with the edition of 6% CLM (for 1A), 6% LLM (for 2A) and 6% SGM (for 3A) with correction for ME and CP content which was similar to that of the BD (the first method). The diets provided for the B experimental groups were prepared by replacing 6% BD with CLM (for 1B), with LLM (for 2B) and with SGM (for 3B). This replacement without correction of ME and CP content met the requirement standard (the second method). The results showed that there was similar effect of CLM and LLM on egg yield and quality while the effect of SGM was significantly lowered. The effect of the first method of leaf meal inclusion into the diets was better than that of the second method. However, CLM and LLM showed good results in both methods, whereas SGM only had good result in the first method.

Key words: stylosanthes; cassava; leucaena leaf meals; method of inclusion
Abbreviations: BD (Basal diet); CG (Control group); CLM (Cassava leaf meal); CP (Crude protein); FCR (Feed conversion ratio); HP (Hen day); HPA(Hen Presence Average); LLM (*Leucaena leucocephala* leaf meal); ME (Metabolic energy); SGM (*Stylosanthes guianensis* grass meal)

Introduction

The utilization of vegetation leaf meals rich in pigment and protein contents in diets in order to improve farm animal performance, product quality and food safety in general and in poultry production in particular has been extensively focused on and applied in production in Vietnam.

There are various types of forage crops such as cassava, leucaena, stylosanthes, moringa, trichanthera… which have higher biomass yield, carotenoids and protein content in leaves than other forages. Particularly, their leaf meal yield was from 6 to 10 (tons/ha/year) (Hien at el 2017, Hoan et al., 2017, Hien and Trung, 2016, Quang, 2013, Dong et al, 2012); the carotenoids content in the leaf from 250 – 700 mg/kg dry matter (Hoan, 2012, Ngoc, 2012, Hien et al, 2008); and the protein content of the leaf was from 18 to 32% in dry matter (Hoan et al., 2017, Hien and Trung, 2016, Vien, 2015, Hoan, 2012, Quang, 2012).

The first phase of the research on these forages was to work on forage plantation procedures, green biomass yield,

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leaf meal yield, chemical composition, the nutritive value of fresh leaf and that of leaf meal. The second phase was to study the effect of the leaf meal included into diet on productivity, quality of products in farm animal production in general and in poultry nutrition in particular.

This study was done to evaluate and compare the effect of three leaf meal types (cassava, leucaena, stylosanthes) on the fertility (fertilized egg) of laying hens from Luong Phuong parent stock and the way leaf meals should be added into layer diet.

Based on the results of this study, there would be suggestions on the priority of leaf meals utilization in chicken parent stock production in addition, recommendations would be made for poultry raisers on how to effectively formulate the diets in order to achieve optimal production efficiency.

Materials and Methods

Experimental design and diets

The Luong Phuong colored feather parent stock laying hens were used in this experiment. The broilers of this breed grow slowly but give good flavor and tasty meat. They are a popular breed raised in Viet Nam.

The leaf meals of *cassava* (*Manihot esculenta* Crantz*)* variety KM 94, *Leucaena leucocephala* and *Stylosanthes guianensis* CIAT 184 grass, hereinafter referred to as cassava, leucaena and *stylosanthes,* were used for this trial.

The experiment was conducted at the Thai Nguyen University of Agriculture and Forestry's Farm, Vietnam.

Experimental laying hens were cared for and treated in compliance with Vietnamese Regulations for experimental animals.

The study employed 630 hens and 84 roosters from 27 – 52 weeks of age (5 – 30 laying weeks); the experimental duration was 182 days (26 weeks). Birds were allocated into 7 treatment groups; each group consisted of 90 hens and 12 roosters subdivided into 3 subgroups with 30 hens and 4 roosters in each subgroup which was used as triple replication. The experimental groups were named as follows: Control group (CG), 1A, 2A, 3A and 1B, 2B, 3B. In the control group, hens were fed with a basal diet (BD) of 11.55 Mj ME and 17% CP per kg of feed and ME and CP contents complied with nutrient recommendations for colored feather hens.

Diets of A experimental groups (1A, 2A, 3A) were formulated by the 1st method of inclusion, in which 6% *cassava* leaf meal (1A), *leucaena* leaf meal (2A) and *stylosanthes* grass meal (3A) with the adjustment of ME and CP levels met the nutrient requirements for colored feather laying hens so that they were similar to that of the control.

Diets of B experimental groups (1B, 2B, 3B) were formulated by the 2nd method, in which 6% basal diet were replaced by cassava leaf meal (1B), *leucaena* leaf meal (2B) and *stylosanthes* grass meal (3B), respectively, without adjustment of ME and CP content to comply with the standard recommendations.

Experimental diets were formulated with the following ingredients: yellow maize, fish meal, soybean meal, leaf meals and some other feed additives. The nutrient compositions of the experimental diets are presented in Table 1.

Housing and care

All experimental birds were gathered in an open house with a litter floor. The density was 8 hens/m^2. The care program for the laying hens included vaccination and light was carried out in accordance with the Vietnamese Standard for the colored feather laying hens.

Parameters and monitoring procedures

Some parameters of the birds such as survival rate, laying percentage, feed conversion ratio (FCR) per 10 eggs, the feed costs for 10 eggs were monitored and recorded.

Some indicators of hatching egg quality in terms of the fertilized eggs/incubated eggs, the rate of hatched/fertilized

Table 1
Nutrient composition of diets

Items	CG	1A	2A	3A	1B	2B	3B
ME, Mj/kg	11.55	11.53	11.56	11.54	11.31	11.40	11.25
CP, %	17.13	17.13	17.13	17.06	17.34	17.59	17.10
EE, %	3.04	4.54	4.04	4.78	3.28	3.12	2.97
CF, %	2.85	3.34	3.16	4.35	3.42	3.27	4.40
Lysine, %	0.96	0.98	0.96	0.96	0.99	0.97	0.94
Methionine %	0.43	0.44	0.44	0.43	0.43	0.42	0.41
Calcium, %	3.57	3.63	3.64	3.66	3.43	3.44	3.45
P.av., %	0.47	0.47	0.46	0.46	0.47	0.46	0.46
Carotenoids, mg/kg Feed	8,80	37.80	40.05	21.52	38.00	40.10	21.92

eggs, the rate of chicks class1/total hatched chicks and the rate of chicks class1/total incubated eggs were recorded.

Monitoring methods were implemented as follows: the eggs of different groups were marked and stored in different trays before being placed into the incubator. The incubated eggs were candled visually on the 6th day of the incubation period in order to determine the embryonic development of eggs and in order to remove the unfertilized eggs. After hatching, the chicks of different groups were moved to different brooders where healthy chicks were kept and the rest were removed.

Feed and egg chemical compositions including dry matter, crude protein, and lipid content were analysed following the A.O.A.C., 1990 standard. Carotenoid content in egg yolk was analyzed by High Pressure Liquid Chromatography (HPLC). Data was obtained from the mean of 5 times analysis for each parameter (n = 5).

The yolk color darkness was measured by using Roche color fan (Roche, 1988).

Sampling and sample analysis were carried out at the Institute of Life Sciences – Thai Nguyen University, Vietnam.

Data analysis

Collected data was analyzed with excel 2007 and ANOVA statistical analysis was performed by using IRRISTAT 5.0 and SPSS 16.0.

Results and Discussions

The effect of leaf meals inclusion into diets on the survival of birds

In egg production, two figures are used to judge production performances, namely Hen Day (HD) and Hen Presence Average (HPA). For example, this experiment was carried out in 182 days, when a bird was alive from day 1 to day 182, its HD was 182; another bird died at day 150, so its HD was 149. The total HD of 90 hens/group would be the sum HD of the group. Take the sum HD of the group divided by 182 to get the so-called Hen Presence Average (HPA) of the group.

The sum total of the hen day and the hen presence average were used in this experiment to estimate the effect of leaf meals on bird livability. The sum HD and HPA of the experimental birds are presented in Table 2.

Data in Table 2 showed that only 2 – 3 birds died during entire experiment period. The death of the birds occurred on different experimental day in the different groups so there was a difference in sum Hen Days and equivalently the variance of HPA among the treatments. However, the highest HPA of the 2A was just higer than that of the lowest HPA of the 1B by 0.82 birds. This difference was not significant. This proved that the different leaf meals and how they were added into diet had no negative effect on bird health. These sum Hen Days and Hen Presence Average parameters are the fundamental element to estimate the egg production yield of group and egg productivity per HPA of each treatment group.

Laying percentage and egg productivity

Laid eggs from each group were collected twice daily and graded screening for incubation. The laying percentage, egg yield, breeding egg per HPA were calculated based on the number of laid eggs and the actual graded breeding eggs obtained during 182 days of experiment. The results are shown in Table 3.

Data presented in Table 3 showed that birds fed with diets containing leaf meals (Except for those in the 3B group) had the higher laying percentage compared to those in the Control ($p < 0.001$). This proved that the leaf meals in general, carotenoids in particular, had the positive effect on the laying percentage of the chickens. The laying percentage of birds in 3B treatment was similar to that of those in the Controls because the diet offered in this group had lower ME content than the diets offered in the Control and in the other groups.

The laying percentage among the treatment groups was different for the different leaf meals added into diets. The highest laying percentage was seen in birds fed with diet containing leucaena, followed by those fed with diet containing cassava, and the lowest laying percentage was observed in birds fed with diets containing stylosanthes. This might be due to because the carotenoid content of the leaf meals was different, which led to the different carotenoid content in the diets offered to the birds. This content could be ranked as from the highest to the lowest as follow 2A > 1A > 3A

Table 2
The sum Hen Day and Hen Presence Average of experimental groups

Items	Unit	CG	1A	2A	3A	1B	2B	3B
Number of hen at the begining	Bird	90	90	90	90	90	90	90
Number of hen at day 182	Bird	87	87	88	88	87	87	88
Sum HD /group(1)	Day	16.224	16.220	16.256	16.215	16.107	16.204	16.123
HPA/group(2)	Bird	89.14	89.12	89.32	89.09	88.50	89.03	88.59

Note: (2) = (1): 182

Table 3
The laying percentage of the experimental birds

Items	Unit	CG	1A	2A	3A	1B	2B	3B	SEM	P
Laying percentage	%	66.74^{d}	72.66^{a}	73.14^{a}	71.10^{c}	71.08^{c}	71.82^{b}	66.45^{d}	0.194	< 0.001
Egg yield/group	Egg	10828	11785	11890	11529	11449	11638	10714		
Productivity/HPA	Egg	121.5^{e}	132.2^{b}	133.1^{a}	129.4^{d}	129.4^{d}	130.7^{c}	120.9^{f}	0.151	< 0.001
Comparison	%	100	108.81	109.55	106.50	106.50	107.60	99.50		
Fertilized egg rate	%	96.70	97.39	97.07	97.03	97.18	97.16	96.75		
Fertilized egg/group	Egg	10471	11477	11542	11187	11126	11307	10366		
Fertilized egg/HPA	Egg	117.5^{d}	128.8^{a}	129.2^{a}	125.6^{c}	125.7^{c}	127.0^{b}	117.0^{e}	0.167	< 0.001
Comparison	%	100	109.62	110.0	106.89	106.97	108.09	99.57		

Note: HPA is Hen Presence Average

and 2B > 1B > 3B so the laying percentage of the hens also followed this trend. However, there was only significant difference found between birds in 1A, 2A compared to those in 3A (in group A) and birds in 2B compared to those in 1B and birds in 1B, 2B compared to 3B (in group B) with $p < 0.001$.

The method of leaf meal addition into diets also had significant effect on the laying percentage of laying hens. This laying percentage was found to be higher in birds fed diets prepared by the 1st method compared to that of those fed with diets prepared by the 2nd method (1A > 1B, 2A > 2B, 3A > 3B) with $p < 0.001$. This might be explained by the fact that the carotenoid content of diets offered by the 1st method was similar to that by the 2nd method (1A ~ 1B, 2A ~ 2B, 3A ~ 3B) but the energy content of diets offered by the 1st method was higher than that of the diets offered by the 2nd method, this led to the higher laying percentage observed in groups A (diets prepared by the 1st method).

The egg productivity was determined by the laying percentage; the higher laying percentage, the higher egg productivity and vice versa. Thus, the egg productivity of birds also showed the similar trend to birds laying percentage. Accordingly, the egg productivity per HPA of birds fed with diets containing leaf meal was higher than that of those fed with the control diet (diet without inclusion of leaf meal) with $p < 0.001$; the egg productivity of birds fed with diet containing leucaena leaf meal was higher than that of those fed with diet including cassava leaf meal and higher than that of those fed with diet containing stylosanthes leaf meal (2A > 1A > 3A and 2B > 1B > 3B).

The egg productivity per HPA of birds fed with diet prepared by the 1st method was higher than that of birds fed with diets prepared by the 2nd method (1A > 1B, 2A > 2B, 3A > 3B) with $p < 0.001$.

The laying percentage, egg productivity and fertility from the 1B and 2B were similar or higher than those from 3A. It can be seen that the leaf meal with average ME content, higher protein content and low fiber content (such as cassava and leucaena leaf meals) that were added into diet either followed by the 1st or 2nd method would result in positive effect on laying percentage and productivity. Whereas, the leaf meals which have low ME content, lower protein level, higher fiber content (such as stylosanthes grass meal) can only be added into diet followed by the 1st method in order to achieve better performance of laying hens. If this leaf meal is added into diet according to the 2nd method, the negative effect on laying percentage and productivity will occur.

The physiological characteristics of eggs

Several physiological characteristics of eggs such as egg weight, egg yolk, albumin, shell weight were measured. The results are presented in Table 4.

Data present in Table 4 showed that the egg weight and yolk, albumin weight in egg from birds offered with diets containing leaf meals were higher than that from birds fed with the control diet; however, this difference was not significant ($p > 0.05$). This result was similar to the finding from Bai Changjun et al. (2004).

Two parameters differing significantly among the treatments were the albumin index and the color score of yolk.

The albumin index of eggs collected from birds fed with diet containing leaf meal was higher than that of eggs from birds fed with the control diet ($p < 0.05$). This characteristics was not found to be similar among birds fed with diets containing different types of leaf meals ($p > 0.05$).

The yolk fan score in eggs from birds fed with diets containing leaf meals was significantly higher than that from birds fed with the control diet from 3.7-6.1 points ($p < 0.001$). This score of the groups 2A, 2B were higher than that of the groups 1A, 1B and that of groups 1A, 1B were higher that of the groups 3A, 3B but there were insignificant difference between them ($p > 0.05$).

There was no difference observed in fan score of yolk in eggs from 1A compared to 1B; 2A compared to 2B; and also 3A compared to 3B. This proved that the way leaf meals were added into diet did not affect the egg yolk color because

Table 4
The physiological characteristics of the egg

Items	Unit	CG	1A	2A	3A	1B	2B	3B	SEM	P
Egg weight	gam	55.99	56.67	56.50	56.22	56.53	56.37	56.18	–	–
Morphological index	%	1.32	1.33	1.34	1.33	1.32	1.31	1.32	–	–
Albumin weight	gam	32.18	32.60	32.43	32.31	32.37	32.44	32.25	–	–
Yolk weight	gam	17.24	17.49	17.55	17.45	17.58	17.42	17.39	–	–
Shell weight	gam	6.57	6.58	6.52	6.46	6.58	6.51	6.54	–	–
Albumin percentage	%	57.47	57.53	57.40	57.47	57.26	57.55	57.40	–	–
Yolk percentage	%	30.79	30.86	31.06	31.04	31.10	30.90	30.95	–	–
Shell percentage	%	11.73	11.61	11.54	11.49	11.64	11.55	11.64	–	–
Albumin index	%	0.152^{b}	0.173^{a}	0.170^{a}	0.180^{a}	0.181^{a}	0.183^{a}	0.177^{a}	0.005	0.010
Yolk index	%	0.554	0.547	0.558	0.554	0.560	0.551	0.549	–	–
Yolk fan score	unit	7.3^{b}	12.8^{a}	13.4^{a}	11.2^{a}	12.6^{a}	13.1^{a}	11.0^{a}	0.19	0.000

the carotenoid content in the diets was similar in A and B groups (1A~1B; 2A~2B; 3A~3B).

The difference of the yolk fan score among the groups was because of the difference in carotenoid content in the diets. The diet having more carotenoid content would result in more carotenoid accumulated in the yolk, thus the higher yolk fan score was obtained.

The chemical composition of the eggs

Several chemical contents of the eggs such as dry matter, crude protein, lipid, albumin and carotenoid content of the yolk were analyzed. The data is presented in Table 5.

Data presented in Table 5 showed that, the lipid content in the yolk and the dry matter, crude protein, lipid content in the albumin were insignificantly different between eggs of the experiment groups and of the control group.

There were only 3 parameters showing difference, namely dry matter, crude protein and carotenoid contents of the egg yolk.

The dry matter content of eggs given by birds fed with diets containing leaf meal was higher than those consumed the control diet with $p < 0.01$. This parameter was not significantly different among the treatments except for those in 1B compared to 3B.

The crude protein content in egg yolk also followed the similar trend. However, the difference was only observed significantly between 2A, 2B, 1B compared to the control $p < 0.01$.

The carotenoid content in the egg yolk from the groups fed with diets containing leaf meal was higher than that from those fed the control diet by 7.88 – 26.45mg/kg DM with the significant level of $p < 0.01$. Among the treatments, the carotenoid content in egg yolk only observed to have significant difference in 1A, 2A, 1B, 2B compared to 3A, 3B with $p<0.01$. In other words the carotenoid content in the egg yolk from birds fed with diet containing cassava and leucaena leaf meals was remarkably higher than that from birds fed with the diet containing stylosanthes grass meal. The reason was that, the carotenoid content in the diets offered to birds in 1A, 2A, 1B, 2B was higher than that of the diets offered to birds in 3B, 3A from 16 – 18mg/kg feed.

The difference in dry matter, crude protein and carotenoid contents in egg yolk among the treatments is the explanative base for the difference in the fertility, hatchability and the percentage of the hatched chicks class1 among the groups.

Table 5
The chemical compositions of the eggs

Items	Unit	CG	1A	2A	3A	1B	2B	3B	SEM	P
Yolk										
Dry matter	%	50.62^{c}	51.48^{ab}	51.42^{ab}	51.43^{ab}	51.67^{a}	51.46^{ab}	51.11^{b}	0.183	0.004
Protein	% DM	16.25^{b}	16.74^{ab}	16.77^{a}	16.66^{ab}	16.88^{a}	16.78^{a}	16.42^{ab}	0.104	0.007
Lipid	% DM	32.51	32.87	32.74	32.87	32.91	32.84	32.81	0.221	0.674
Carotenoids	mg/kg DM	13.68^{c}	38.52^{a}	40.13^{a}	22.64^{b}	37.50^{a}	39.65^{a}	21.56^{b}	1.986	0.001
Albumin										
Dry matter	%	13.10	13.16	13.10	13.03	13.32	13.04	12.77	0.124	0.090
Protein	% DM	11.35	11.41	11.43	11.35	11.57	11.34	11.07	0.106	0.202
Lipid	% DM	0.225	0.227	0.226	0.222	0.233	0.225	0.223	0.004	0.772

The quality of the eggs

Eggs collected from each group were incubated in 6 batches; each batch had 330 eggs; so the total number of incubated eggs was 1980 eggs per group (330x6). The incubation data are presented in Table 6.

Data presented in Table 6 showed that the fertility, hatchabilty/fertilized egg and the chick class1 percentage tended to have a similar trend as follows: these parameters were higher for eggs from birds fed with diets containing leaf meal than those from birds fed with control diet with $p<0.01$. This can be explained that the carotenoids, the dry matter, crude protein contents in the egg yolk from birds fed with diets containing leaf meal were significantly higher than that of the control diet. These were the main factors making a great contribution to the improvement of the egg fertility, hatchabilty and chick class1 percentage in the treatments.

The percentage of the fertilized eggs from birds fed with diet containing leaf meal tended to be the highest from the 1A, 1B groups, followed by 2A, 2B and the lowest was observed in the 3A, 3B groups.

The percentage of hatchability/fertilized eggs and of chicks class1/total incubated eggs in 1A, 1B, 2A, 2B compared to 3A, 3B was significantly different with $p < 0.01$.

The carotenoid content in the egg yolk was the main factor contributing to the above mentioned observation because Hien et al. (2016) stated that the carotenoid content and the fertility, hatchability were positively correlated. This content in diet offered to birds in 1A, 1B, 2A, 2B was 1.5 times higher than that of diet offered to 3A, 3B.

There was no significant difference observed for these parameters between birds fed with diets produced with different formulation of leaf meals because the carotenoid content in the diets as well as this content in the egg yolk was similar between groups A and groups B.

The egg productivity per HPA of birds fed with the diet containing leucaena leaf meal was higher than that of birds fed with the diet having cassava leaf meal, but this comparative relation was not similar to the fertility, hatchability, and chick class1 percentage. This might be because the leucaena leaf meal had mimosine content; this toxin element had the negative effect of the embryonic formation and development. According to Tang and Ling (1975), mimosine had the negative effect on the synthenis of collagen in chicken embryonic cartilage due to the inhibition of hydroxyl-prolin synthesis. The depletion of collagen resulted in the fragile embryonic cartilage, led to capillary hemorrhage and resulted in the retardation of embryonic development and fetal death.

The feed utilization efficiency

The data of feed conversion ratio (FCR) for 10 eggs, 10 fertilized eggs and feed cost for each chick class1 are presented in Table 7.

Data presented in Table 7 showed that the FCR for 10 eggs, 10 fertilized eggs and feed cost for each hatched chick class1 from birds fed with diet containing leaf meals (except for the 3B) were significantly lowered than that from the control (consumed the diet without leaf meal inclusion) with $P < 0.001$.

Table 6
The incubation and hatchability of the eggs

Items	Unit	CG	1A	2A	3A	1B	2B	3B	SEM	P
Total incubation	Egg	1.980	1.980	1.980	1.980	1.980	1.980	1.980	–	–
Fertilized egg	%	90.86^{c}	95.05^{a}	94.24^{ab}	93.59^{b}	94.70^{ab}	93.84^{ab}	93.33^{b}	0.597	0.009
Hatchibility	%	93.16^{d}	97.24^{ab}	96.73^{ab}	95.41^{c}	97.28^{a}	96.61^{b}	95.29^{c}	0.505	0.009
Chicks class1/fertilized egg	%	98.57	98.81	98.56	99.04	98.63	98.16	99.09	0.227	0.469
Chicks class1/incubation egg	%	83.43^{d}	91.41^{a}	89.95^{ab}	88.43^{c}	90.86^{a}	88.99^{bc}	88.13^{c}	1.004	0.007

Table 7
The FCR and feed cost for 10 eggs and each chick class1

Items	Unit	CG	1A	2A	3A	1B	2B	3B	SEM	P
Feed intake/ group	kg	2433.6	2433.0	2438.4	2432.3	2416.1	2430.6	2418.5	–	–
FCR for 10 eggs	kg	2.248^{a}	2.064^{b}	2.051^{b}	2.110^{b}	2.110^{b}	2.089^{b}	2.257^{a}	0.003	< 0.001
Comparison	%	100	91.8	91.2	93.9	93.9	92.9	100.4	–	–
FCR for 10 fertilized egg	kg	2.324^{a}	2.120^{b}	2.113^{b}	2.174^{b}	2.172^{b}	2.150^{b}	2.333^{a}	0.004	< 0.001
Comparison	%	100	91.2	90.9	93.6	93.5	92.5	100.4	–	–
FCR for each chick class1	kg	0.279^{a}	0.232^{b}	0.235^{b}	0.246^{b}	0.239^{b}	0.242^{b}	0.265^{a}	0.002	< 0.001
Comparison	%	100	83.2	84.2	88.2	85.7	86.7	95.0	–	–
Feed cost for 1 chick class1	%	100^{a}	81.8^{e}	81.1^{e}	89.3^{c}	84.1^{d}	85.6^{d}	94.4^{b}	0.548	0.006

The feed conversion ratio (FCR) for 10 eggs was the lowest in birds in 2A and 2B followed by those in 1A and 1B and the highest was found in 3A and 3B. However for each hatched chick class1, this parameter was observed lower in 1A and 1B than that in 2A and 2B. This was because the fertility, hatchability and hatched chick class1 percentage in 1A, 1B was higher than that in 2A, 2B.

The feed cost for each hatched chick class1 in all treatments was lower than that of the control from 5.6 – 18.9%. The expense in birds fed with the diets containing cassava and leucaena leaf meals was similar, but those fed with diet containing stylosanthes was significantly higher with $p < 0.01$.

Conclusions

The inclusion of leaf meal into the diets of laying hens from the parent stock improved the productivity, egg quality and reduced feed cost for each hatched chick class1, compared to those fed diet without leaf meal inclusion.

Among the 3 leaf meal kinds tested, the effect of cassava and leucaena leaf meals on egg productivity and quality was similar, but that effect of stylosanthes grass meal was significantly lower.

For the method of leaf meal inclusion into diet, the correction of ME and CP contents after inclusion (the first method) was seen to have better effect than the 2nd method, which was done without correction for ME and CP contents. However, leaf meal which has moderate ME content, high CP content (cassava and leucaena leaf meals) can be added into diet by both ways and still bring the best bird production performance. For the leaf meal which has lower ME content, moderate CP content, higher fiber content (such as stylosanthes) can only be added into diet by the 1st method; otherwise, it would deplete bird performance.

Therefore, in the nutrition and feeding for laying hens of the parent stocks, the priority should be given to the utilization of cassava and leucaena leaf meals to formulate the layer diet and they can be added in either way. In case stylosanthes grass meal is to be used, the 1st method of inclusion is highly recommended.

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