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Partial replacement of maize by root and leaf meal of cassava in diets of laying hens

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Abstract

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A mixture of 65% cassava root meal and 35% cassava leaf meal which is abbreviated as CRLM (cassava root – leaf meal) was used to partially replace maize in diets of Luong Phuong (LP) parent stock. The experiment was carried out with 450 hens and 60 roosters of LP breed from 35 to 54 weeks of age, divided equally into 5 treatments; each treatment had 30 hens and 4 roosters with triple repetition. All treatments were coded as T1, T2a, T2b, T3a and T3b; T1 served as control (no replacement was made) and metabolic energy (ME) of the diet met the feed ME standards of LP laying hens; T2a and T2b diets were replaced 30%, the T3a and T3b diets were replaced 40% grounded maize by CRLM; vegetable oils were added to T2b and T3b diets in order to achieve ME value similar to that of the control (T1), and vegetable oils were not added to T2a and T3a diets. The result showed that laying rate and egg productivity of T2b and T3b treatments were higher than that of the control (T1); T2a and T3a treatments were lower than T1. The replacement of grounded maize by 30 – 40% CRLM in the diets of laying hens would not affect the quality of incubated eggs. The cost for egg and chick production of T2a, T2b, T3a, T3b treatment was lower than that of T1, in which the cost of T2b was the lowest. Therefore, maize can be replaced with CRLM at 30 – 40% in the diet of LP laying hens with or without vegetable oil supplement, but 30% with added vegetable oil is optimal.

Keywords: Cassava root meal; Cassava leaf meal; maize; laying hens; replacement

Introduction

Using locally available animal feed ingredients to reduce the import of feed ingredients is a prior strategy of many countries. Vietnam has a large production of cassava roots and cassava leaves, so using cassava in livestock would reduce remarkably maize import. Although cassava root meal is rich in energy content (3260 Kcal ME/kg), it is low in protein (2.58%) (NIAS, 2001). Therefore, the inclusion of cassava root powder in the diet at a high rate will adversely affect the production performance of livestock. In contrast, cassava leaf meal is low in energy content (1978 Kcal ME/kg) but rich in protein content (21.64%) (Hien et al., 2017). The majority of amino acids contents of cassava leaf meal protein is higher than that of maize (NIAS, 2001). On the other hand, cassava leaf meal is rich in carotenoids (476 – 625 mg/ kg DM), (Hoan, 2012), which was proved to have a positive effect on laying rate, egg productivity, the fertilized egg/ incubated eggs, the rate of hatched/ fertilized eggs (Hoan, 2012; Hien et al., 2016; Trung, 2017; Hien et al., 2018). The mixture of cassava root meal and cassava leaf meal would be balanced between energy and protein. Therefore, the inclusion of the mixture (root and leaf meals of cassava) in order to partially replace grounded maize in layer parents stock diet is feasible, which would contribute to the domestic availability of animal feed ingredients and less dependency on the importation of animal feed materials.

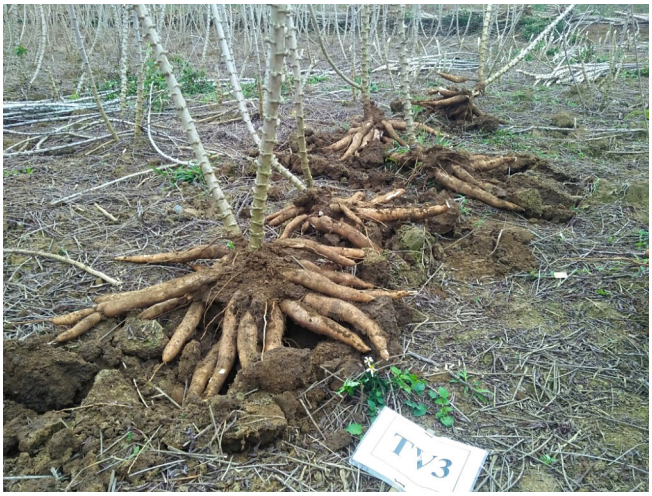

Fig. 1. Cassava roots

Fig. 2. Cassava leaves

Materials and Methods

Experimental Design

Laying parent stock of Luong Phuong (LP) breed was used in this experiment. Cassava root meal and cassava leaf meal were obtained from the KM94 variety, which was locally produced. Cassava roots were peeled, sliced, dried and grounded into powder. Cassava leaves were dried and grounded into powder. The cassava root meal and cassava leaf meal were mixed at the ratio of 65% and 35%, which is hereinafter referred to as CRLM (cassava root – leaf meal), because with this ratio the mixture had the same protein ratio as grounded maize. The feeding trials were conducted at Thai Nguyen University of Agriculture and Forestry, Vietnam in 2021.

The experiment was carried out with 450 hens and 60 roosters of LP breed from 35 to 54 weeks of age, divided equally into 5 treatments; each treatment consisted of 30 hens and 4 roosters with triple repetition. All treatments were coded as T1, T2a, T2b, T3a and T3b; T1 served as control (no replacement was made) and metabolic energy (ME) of the diet met the feed energy standards of LP laying hens; T2a and T2b diets were replaced 30%, the T3a and T3b diets were replaced 40% grounded maize by CRLM, the only difference was that vegetable oils were added to T2b and T3b diets in order to achieve ME value similar to that of control (T1), and vegetable oil were not added to T2a and T3a diets. The ME content in 1 kg of feed of T2a and T3a diets was 76 and 102 kcal (0.32 and 0.43 MJ) lower than that of T1, respectively.

The experimental diets were formulated from maize, rice bran, soybean meal, fish meal, vegetable oil, CRLM and other additives; all ingredients were chemically analyzed prior to diets mixing. The chemical composition of all diets is shown in Table 1.

Laying hens were accessed to feed *libitum*, other laying hen management program were performed similarly in all treatments.

Parameters and Monitoring procedures

Some parameters of birds such as survival rate, laying percentage, egg productivity and yield, feed intake, feed conversion ratio (FCR) and the feed production cost for 10 eggs and 10 first grade hatch chicks were monitored and recorded. The number of incubated eggs was 2100 eggs/ treatment. Some indicators of hatching egg quality in terms of the fertilized egg/ incubated eggs, the rate of hatched/ fertilized eggs, the rate of chicks grade I/ total incubated eggs were recorded.

The above parameters were monitored by using the method reported by Doan et al. (2011). Feed chemical compositions were analyzed following A.O.A.C. (1990). Statistical analysis was performed after Dzung et al. (2018) using Minitab software version 18.1.

Result and Discussion

Survival rate

At the end of the experiment, the survival rate of all treatments reached 100%, which proved that experimental feed has a good effect on the health of laying hens. The laying hens fed the diet containing root and leaf meal of cassava were more agile, lustrous feathers, bright red crests compared to laying hens of the control. This was thanks to the positive effect of the carotenoids in the leaf meal on lay-

Table 1. Ingredient composition and nutritive value of all diet treatments

Ingredients	Unit	T1	T2a	T2b	T3a	T3b
Maize,	%	50.00	35.00	35.00	30.00	30.00
CRLM (1)	%	–	15.00	15.00	20.00	20.00
Rice bran,	%	17.00	17.00	15.70	17.00	15.00
Fish meal,	%	1.00	1.00	1.00	1.00	1.00
Soybean meal,	%	22.50	22.50	22.60	22.50	22.90
Vegetable oils,	%	–	–	1.20	–	1.60
Additives(2),	%	9.50	9.50	9.50	9.50	9.50
Total ,	%	100.0	100.0	100.0	100.0	100.0
Nutritive value						
ME,	Kcal	2754	2678	2752	2652	2753
	Mj	11.53	11.21	11.52	11.11	11.53
CP,	%	17.09	17.13	17.01	17.15	17.08
EE,	%	4.59	4.48	5.52	4.45	5.80
CF,	%	4.21	4.64	4.53	4.79	4.64
Lysine,	%	0.92	0.94	0.93	0.95	0.95
Methionine,	%	0.38	0.38	0.38	0.39	0.38
Ca,	%	3.28	3.31	3.31	3.34	3.34
Pav.,	%	0.36	0.37	0.36	0.38	0.37
Carotenoids,	mg/kg	8.26	41.4	41.4	52.5	52.5
CPF[3]	%	100	96.9	102.6	95.9	103.6

Note: (1) CRLM: cassava root – leaf meal; (2) Additives: Methionine 0.1%, $CaCO_3$ 7.9%, NaCl 0.5%, Vitamin premix 0.5%, Mineral premix 0.5% for each treatment; (3) CPF: Compare the Price of 1 kg of mixed Feed. 1 Mj = 238.8 kcal

ing hens. Hoan (2012), Hien et al. (2014b), Trung (2017), Hien et al. (2018), Nhung et al. (2021) when studying the addition of leaf meal to the diet of laying hens, reported the same.

Laying rate

The average laying rate in different stages is presented in Table 2.

Data in Table 2 showed that the average laying rate of different stages had similar trend to that in the whole experimental period (35 – 54 weeks old). The laying rate of T2b, T3b was higher with a significant difference compared to the other treatments, and that of treatment T1 was higher than that of T3a with a significant difference ($P < 0.001$), that of T1 compared with T2a and that of T2a compared with T3a did not differ significantly ($P > 0.05$).

With the replacement of maize by 30 – 40% CRLM, the ratio of cassava leaf meal in the diet was 5.25 and 7.00%, respectively. Previous studies have shown that the ratio of leaf meal in the diet of laying hens from 5 to 8% was the most appropriate; with this ratio of leaf meal, the laying rate of the hens was often significantly higher than that of control (Abou-Elezz et al., 2011; Hoan, 2012; Ngoc, 2012; Ebenebe et al., 2013; Hien et al., 2014a; Trung, 2017; Nhung et al., 2021). However, leaf meal has low energy if it is added to the diet without adding vegetable oil to compensate for the shortage of energy, the results are often not as expected. Hoan et al. (2015), Hien et al. (2017), Hien et al. (2018) reported that the laying rate of the hens fed diets containing leaf meal without adding vegetable oil was 1.30 – 4.63% lower than that of the hens fed diets adding vegetable oil with $P < 0.05$.

Laying rates tended to be lower when maize was replaced by 40% CRLM with added vegetable oil (T3b) compared to 30% with added vegetable oil (T2b). The reason may be that when the ratio of CRLM in the diet increased, the cyanhydric

Table 2. The average laying rate in different stages, %

Week old	T1 0%	T2a 30%	T2b 30% + oil	T3a 40%	T3b 40% + oil	SE M	P
35 – 38	71.67	70.95	72.26	70.83	72.02	0.664	0.088
39 – 42	69.05^{bc}	68.21^{c}	70.83^{a}	67.50^{c}	70.71^{ab}	0,626	0.000
43 – 46	65.71^{b}	64.52^{bc}	69.17^{a}	63.81^{c}	68.45^{a}	0.572	0.000
47 – 50	62.26^{b}	60.71^{bc}	67.14^{a}	59.40^{c}	66.31^{a}	0.581	0.000
51 – 54	58.33^{b}	56.19^{c}	64.64^{a}	54.29^{d}	63.81^{a}	0.563	0.000
35 – 54	65.40^{b}	64.12^{bc}	68.81^{a}	63.17^{c}	68.26^{a}	0.579	0.000

Note: Number with different subscription letter in the same row are significant different ($p < 0.001$)

acid content (HCN) which has a negative effect on laying hens also increased. The HCN content was 0.95 mg/kg in cassava root powder (Hien et al., 2012), and 30.9 mg/ kg DM in cassava leaf meal (Hoan et al., 2018). In addition, the ratio of CRLM in the diet increased; the ratio of fiber also increased. The increased ratio of fiber in the diet had a negative effect on the use of feed of laying hens.

Egg productivity

Egg productivity (number of eggs/ hen/ 20 weeks) and egg yield (number of eggs/ treatment/ 20 weeks) was presented in Table 3.

Data in Table 3 showed that egg yield had the similar trend as laying rate. Because the rate of laying had an effect on the egg yield, the higher the laying rate was, the higher the egg yield reached and vice versa. Egg yield of treatments T2b and T3b was higher than that of the other treatments ($P < 0.001$); this indicator of T1 compared with T2a and of T2a compared with T3a did not differ significantly ($P > 0.05$). Eggs of laying hens fed the CRLM – containing diet were larger, more uniform and had fewer small, abnormal eggs than the control (T1), so the rate of hatching eggs was higher than that of T1. Hoan (2012), Ebenebe et al. (2013), Trung (2017), Hien et al. (2018) and Nhung et al. (2021) adding leaf meal to the diet of laying hens also had the similar results. Hatching egg has also tended to be similar to egg yield. Thus, replacing maize with CRLM in the laying hen diets supplemented with vegetable oil, the egg and hatching egg yield were both higher than the control with significant difference.

However, if replacing at 30% without adding vegetable oil (T2a), the results were only equivalent to the control and if replacing at 40% without adding vegetable oil (T3a), the results were lower than the control.

Hatching egg quality

The results of some parameters of hatching eggs were presented in Table 4.

Data in Table 4 showed that the ratio and number of embryonic eggs of the treatments which replaced maize with CRLM supplemented with vegetable oil were higher than that of the control (T1) with significant difference ($P < 0.05$) but if no vegetable oil was added, it was only equivalent to T1 ($P > 0.05$). Hoan et al. (2015), Hien et al. (2017), and Hien et al. (2018) had the similar result when supplementing leaf meal in laying hen diets with and without adding vegetable oil. The remaining parameters tended to be higher in the treatments that replaced maize with CRLM, but there was no significant difference between treatments ($P > 0.05$). Thus, replacing maize with CRLM with or without adding vegetable oil to the diet did not affect the quality of incubated eggs.

Table 3. Egg productivity and egg yield

Indicators	Unit	T1 0%	T2a 30%	T2b 30% + oil	T3a 40%	T3b 40% + oil	SEM	P
Egg yield	eggs/ T	8241^{b}	8079^{bc}	8670^{a}	7959^{c}	8601^{a}	24.116	0.000
Egg productivity	eggs/ hen	91.6^{b}	89.8^{bc}	96.3^{a}	88.4^{c}	95.6^{a}	0.804	0.000
Compare	%	100	98.0	105.1	96.5	104.4	–	–
Hatching egg yield	eggs/ T	7958^{b}	7849^{bc}	8460^{a}	7716^{c}	8381^{a}	27.989	0.000
Hatching egg ratio	%	96.56^{c}	97.15^{ab}	97.58^{a}	96.94^{bc}	97.44^{a}	0.173	0.000
H. egg productivity	eggs/ hen	88.4^{b}	87.2^{bc}	94.0^{a}	85.7^{c}	93.1^{a}	0.932	0.000
Compare	%	100	98.6	106.3	96.9	105.3	–	–

Note: Number with different subscription letter in the same row are significant different ($p < 0.001$). H.eggs is Hatching eggs; T. is Treatment

Table 4. Some parameters of hatching eggs

Indicators	Unit	T1 0%	T2a 30%	T2b 30% + oil	T3a 40%	T3b 40% + oil	SEM	P
Number of H. E.	eggs/ T	2100	2100	2100	2100	2100	–	–
Number of E, E.	eggs/ T	1947^{b}	1988^{ab}	1998^{a}	1978^{ab}	2001^{a}	5.190	0.011
Rate of E.E./ H..E.	%	92.71^{b}	94.67^{ab}	95.14^{a}	94.19^{ab}	95.28^{a}	0.743	0.011
Number of chicks	chicks/ T	1871	1917	1935	1902	1940	8.598	0.051
Rate of chicks/ E. E.	%	96.09	96.43	96.84	96.16	96.95	0.548	0.276
Chicks class I	chicks/ T	1833	1876	1897	1862	1903	11.317	0.158
Chicks class I/Chicks	%	97.97	97.86	98.03	97.90	98.09	0.465	0.970
Chicks class I/ H. E.	%	87.28	89.33	90.33	88.67	90.62	1.617	0.158
Compare	%	100	102.3	103.5	101.6	103.8	–	–

Note: H.E.: Hatching eggs, E.E: Eggs with Embryos, T: Treatment

Number with different subscription letter in the same row are significant different ($p < 0.005$)

Table 5. Some parameters of feed for the production of eggs and DOCs

Indicators	Unit	T1 0%	T2a 30%	T2b 30% + oil	T3a 40%	T3b 40% + oil	SEM	P
Feed intake	kg/ T	1857	1857	1857	1857	1857	–	–
Eggs / T(1)	eggs/ T	8241	8079	8670	7959	8601	–	–
Hatching eggs	eggs/ T	7958	7849	8460	7716	8381	–	–
Chicks class I	chicks/ T	6946^{b}	7012^{b}	7642^{a}	6842^{b}	7595^{a}	24.899	0.000
Feed/ 10 eggs	kg	2.25^{b}	2.30^{ab}	2.14^{c}	2.33^{a}	2.16^{c}	0.021	0.000
Feed/ 10 H.E. (2)	kg	2.33^{b}	2.37^{ab}	2.20^{c}	2.41^{a}	2.22^{c}	0.023	0.000
Feed/ 10 C.C. I (3)	kg	2.67^{a}	2.65^{a}	2.43^{b}	2.71^{a}	2.45^{b}	0.027	0.000
Feed cost/ 10 eggs	%	100^{a}	98.7^{c}	97.5^{d}	98.9^{b}	99.0^{bc}	0.246	0.000
Feed cost/ 10 C.C. I	%	100^{a}	95.8^{c}	93.3^{f}	97.3^{b}	95.0^{d}	0.169	0.000

Note: (1) T: Treatment; (2) H.E; Hatching egg; (3) C.C. I: Chick class I
Number with different subscription letter in the same row are significantly different ($p < 0.001$)

The feed and feed costs for the production of eggs and 1-day old chicks

The feed conversion ratio and feed costs for the production of eggs and 1-day old chicks (DOC) were presented in Table 5.

Data in Table 5 showed that the feed conversion ratio (FCR) for production of 10 eggs and 10 hatching eggs was ranked in order from the lowest to the highest as follows: T2b, T3b, T1, T2a and T3a. T2b and T3b were significantly lower than T1, while T3a was significantly higher than T1 ($P < 0.001$). The feed conversion ratio (FCR) for production of 10 DOCs class I of T2b and T3b was significantly lower than T1 ($P < 0.001$), there was no significant difference between the remaining treatments. Thus, with partial replacement of maize by CRLM in addition to adding vegetable oil, the FCR for egg production and type I chicks were lower than the control.

However, the price of the diets without adding vegetable oil (T2a and T3a) was lower by 96.9% and 95.9% compared with the control, respectively. Therefore, feed costs for the production of eggs or DOCs class I were ranked in order from the lowest to the highest as follows: T2b, T3b, T2a, T3a, T1. Thus, when replacing maize with 30 and 40% CRLM with or without the addition of vegetable oil, the cost of feed for production of eggs and DOCs class I was lower than that of control, in which the lowest was replacing maize with CRLM at 30% with the addition of vegetable oil.

Conclusion

It can be concluded that maize can be replaced with CRLM at 30 – 40% in the diet of Luong Phuong laying hens with or without vegetable oil supplement, but 30% with added vegetable oil is optimal in bird's performance.

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