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Pride of Barbados (*Delonix regia*) seed meal improved the egg quality parameters of black Harco laying hens

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Abstract

Nutritional evaluation of Delonix regia seed meal (DRSM) as an alternative energy feed ingredient in replacement of maize was carried out using one hundred and thirty-five (135) black Harco laying hens at twenty weeks old. Five experimental diets were formulated with 0 (60% Maize + 0% DRSM), 25 (45% Maize + 15% DRSM), 50 (30% Maize + 30% DRSM), 75 (15% Maize + 45% DRSM) and 100% (0% Maize + 60% DRSM) replacement of maize with DRSM weight for weight, designated as D1, D2, D3, D4 and D5 respectively. The experimental birds were randomly assigned to 5 experimental diets in a Completely Randomized Design. There were 3 replicates of 9 birds each. The feeding trial lasted for 84 days during which data were collected for 70 days with the first 2 weeks to allow the birds to acclimatize. Performance, egg quality and haematology of the experimental birds were monitored. The hen day production (HDP), egg weight, egg mass, feed conversion ratio (FCR), percentage yolk weight, albumen weight and packed cell volume (PCV) differed significantly (P < 0.05) across the dietary treatments. The HDP (%) reduced from 69.67 (D1) to 57.33 (D2), 44.33 (D3), 29.00 (D4), and 17.33 (D5). The egg mass, 38.68g (D1) reduced to 12.80g (D5). The lowest egg weight (55.26g) of the control (D1) increased to 73.94g (D5); and FCR from 2.82 (D1) to 9.23 (D5). The percentage yolk weight reduced while the percentage albumen increased with increasing substitution of DRSM for maize in the diets. Egg yolk colour improved with DRSM inclusion in the diets. The PCV values (%) were 25.20 (D1), 29.58 (D2), 28.33 (D3), 28.67 (D4), and 28.61 (D5). The optimum economic dietary inclusion of DRSM in place of maize for layers is 25% that is 45% Maize + 15% DRSM (D2); with DRSM improving the egg quality (increasing egg weight, percentage albumen and yolk colour score; and reducing the percentage yolk weight) of the experimental birds.

Keywords: Delonix regia seed meal, black Harco laying hens, performance, egg quality, haematology

La farine de grainesde 'Pride of Barbados(Delonixregia) amélioré les paramètres de qualité des œufs de poules pondeuses de 'Harco noires'

Résumé

L'évaluation nutritionnelle de la farine de graines de Delonixregia (le 'DRSM') comme ingrédient d'alimentation énergétique alternative pour le remplacement du maïs a été effectuée à l'aide de cent trente-cinq (135) poules pondeuses harco noires à l'âge de vingt semaines. Cinq régimes expérimentaux ont été formulés avec 0 (60% Maïs + 0% DRSM), 25 (45% Maïs + 15% DRSM), 50 (30% Maïs + 30% DRS 75 (15% Maïs + 45% DRSM) et 100% (0% Maïs + 60% DRSM) remplacement du maïs avec poids DRSM pour le poids, désigné comme D1, D2, D3, D4 et D5 respectivement. Les oiseaux expérimentaux ont été assignés au hasard à 5 régimes expérimentaux dans une conception complètement randomisée. Il y avait 3 répliques de 9 oiseaux chacun. L'essai d'alimentation a duré 84 jours au cours duquel les données ont été recueillies pendant 70 jours avec les 2 premières semaines pour permettre *aux oiseaux de s'acclimater. La performance, la qualité des œufs et l'hématologie des oiseaux expérimentaux ont été surveillées. La production de jour de poule (le 'HDP'), le poids d'oeuf, la masse d'oeuf, le rapport de conversion d'alimentation (le 'FCR'), le poids de jaune de pourcentage, le poids d'albumen et le volume emballé de cellules (PCV) ont différé sensiblement (P < 0.05) entre les traitements diététiques. Le HDP (%) de 69,67 (D1) à 57,33 (D2), 44,33 (D3), 29,00 (D4) et 17,33 (D5). La masse d'œufs, 38,68 g (D1) réduite à 12,80 g (D5). Le poids le plus bas des œufs (55,26 g) du contrôle (D1) est passé à 73,94 g (D5);fcr de 2,82 (D1) à 9,23 (D5). Le pourcentage de poids jaune réduit tandis que le pourcentage albumen a augmenté avec la substitution croissante de DRSM pour le maïs dans les régimes. La couleur du jaune d'œuf s'est améliorée avec l'inclusion du DRSM dans les régimes alimentaires. Les valeurs pcv (%) 25,20 (D1), 29,58 (D2), 28,33 (D3), 28,67 (D4) et 28,61 (D5). L'inclusion alimentaire économique optimale du DRSM à la place du maïs pour les couches est de 25%, soit 45% de maïs + 15% de DRSM (D2); avec DRSM améliorant la qualité des œufs (augmentation du poids des œufs, pourcentage d'albumen et de la couleur du jaune; et réduction du pourcentage de poids jaune) des oiseaux expérimentaux.*

Mots-clés: Farine de graines Delonixregia, poules pondeuses Harco noires, performance, qualité des œufs, hématologie

Introduction

The major constraint to expansion of the poultry industry in Nigeria and indeed other African Countries is the ever-increasing cost of feeds. This is as a result of the escalating price of the conventional feed ingredients brought about by intense competition for the same ingredients by man, industry and livestock. The discovery of grains as biofuel does not help the matter. The use of agro-industrial by-products such as brewers dried grain (Olajide *et al.,* 2007; Olajide *et al.,* 2013), maize offals (Onifade *et al.,* 1999), wheat offals (Ogunleye *et al.,* 2019), sorghum sprout waste (Kwari *et al.,* 1999), palm kernel cake (Afolabi *et al.,* 2007), root and tubers including corms of cocoyam (Olajide, 2008; Olajide *et al.,* 2011) as substitutes for maize in layers have been investigated with a moderate level of success. There is the need for concerted research effort in the use of other agro-industrial by-products and unconventional ingredients as viable alternatives to grains in layers' production. Discovery of such viable unconventional feed ingredients will likely lessen the pressure on demand for the conventional feed ingredients and thus force the latter down. Because of the critical nature of energy ingredients in poultry diets, any successful breakthrough in discovering alternative unconventional energy ingredients will further lower the cost of eggs and meat. Adeola and Olukosi, (2008) recommended searching for alternative, non-conventional feed resources, comparing their nutritive values to the conventional feed resources and incorporate them into the production of animal feed. Ben *et al.,* (2002) have identified that very little knowledge of the potential of such unconventional feed ingredients as feed materials, the presence in some cases of anti-nutritional elements as well as lack of proper knowledge of storage capabilities over long periods as constraints against the use of many alternative feed resources. There is also the need to understand how such alternatives affect the quality of the final product so that the consumers' acceptability is guaranteed (Olajide *et al.,* 2007). Olajide and Adeniyi, (2015) reported that pride of Barbados seed (*Delonix regia* seed meal, DRSM) could replace 100% maize (39% DRSM) in rabbits nutrition. There is, however, a dearth of research information on the use of DRSM as a dietary source of energy in layers diets. The intense competition among the various alternative users of maize does not exist for

DRSM. This study therefore monitored the effect of graded levels of DRSM as a viable energy substitute for maize in layers' diets through the performance, egg quality and haematological variables.

Materials and methods

Site of the experiment

This study was carried out at the Poultry Unit of the Teaching and Research Farm, Joseph Ayo Babalola University, Ikeji-Arakeji, Osun State, Nigeria. Ikeji -Arakeji is situated on 350.52m above sea level at latitude 7^0 25'N and at longitude 5^0 19'E. The vegetation of the area is that of the rainforest characterized by the hot and humid climate. The mean annual rainfall is 1500mm and the rain period is bimodal with a short break in August with a mean annual relative humidity of 75% and mean temperature of 26 – 28^0 C (Ajibefun, 2011).

Collection and preparation of the test ingredient

Matured and dried pods of *Delonix regia* were plucked from the trees within and around the Joseph Ayo Babalola University, Ikeji-Arakeji in Osun State, Nigeria. The pods were further dried in the open air. Seeds were collected and ground with hammer mill. The composition of the DRSM is as presented in Table 1.

Experimental diets

Five (5) experimental diets were compounded arising from the percentage replacement of maize with 0 (60% Maize + 0% DRSM), 25 (45% Maize + 15% DRSM), 50 (30% Maize + 30% DRSM), 75 (15% Maize + 45% DRSM) and 100% (0% Maize + 60% DRSM), designated as D1, D2, D3, D4 and D5 respectively. The substitution was weight for weight. The gross composition of the diets and calculated analysis are presented in Table 2.

Management of the experimental birds

One hundred and thirty-five (135) twenty-week old black Harco layers used for this study were purchased from a reputable poultry farm in Ibadan, Oyo State, Nigeria. The birds were raised in a three-tier California type colony cages (43×41 cm). Each diet was offered to 3 replicates comprising 9 birds each (27 birds per treatment) in a completely randomized design (CRD) experiment. The birds were weighed individually both at the beginning and the completion of the study. All other daily routine management practices required were provided. Feed and water were supplied ad libitum. The feed remaining at the end of the week were subtracted from the feed supplied at the beginning of the week to determine the weekly feed intake from which average daily feed intake was calculated.

Data collection and cost estimates

Birds were allowed 2 weeks of feeding (acclimatization) during which no data was collected. Data were collected on performance indices such as feed intake, hen day production, HDP (egg/day) and egg weight thereafter for 10 weeks. The HDP (egg/day) and egg weight were used to calculate the egg mass as Number of eggs (HDP) multiply by egg weight. The FCR was computed as average daily feed intake divided by egg mass. Cost per kg feed for each of the diets was calculated from the prevailing cost of feed ingredients at the time of purchase, and this was subsequently used to compute the cost of feed per unit (mass) of an egg. Egg quality parameters monitored include egg weight, egg length, egg width, egg shape index, yolk weight, albumen weight, shell weight, and shell thickness. A total of 30 eggs per treatment per week were taken for egg quality determination. The egg yolk was separated using yolk separator. The weights of egg, shell, albumen and the yolk were measured with a sensitive scale calibrated in grammes. Yolk colour was determined with the aid of DSM® Yolk colour fan. The width and the length of the egg were measured with the aid of the Vernier Caliper calibrated *in centimeters. Egg width (maximum) was divided by the maximum egg length to get the egg shape index. Shell thickness was measured with micrometer screw gauge. The eggs were carefully broken, the contents were removed, and the shells were air-dried at room temperature for 2 days. To ensure accuracy, the mean of the measurement was taken from 3 regions (the broad, narrow and equatorial region).*

Haematological parameters of the experimental laying birds

Blood samples were collected from the wing vein of the experimental birds (six birds per dietary treatment) for haematological analysis at the end of the tenth week of the feeding trial. Blood was collected from each bird into the labelled sterile universal bottle containing anti-coagulant ethylene-diamine-tetraacetic acid (EDTA) for the determination of haematological components. The samples were taken to the Laboratory for analysis. The packed cell volume (PCV) was determined using the micro-hematocrit technique, the red blood cells (RBC) and white blood cells (WBC) counts using the improved Neubauer hematocytometer method, and haemoglobin (Hb) using the cyanomethemoglobin method described by Kelly, (1979).

Proximate analyses of DRSM and experimental diets

The chemical composition of DRSM and the experimental diets for proximate composition was according to the method of Association of Official Analytical Chemist (2005) vis-a-vis AOAC Official Methods 988.05, 2003.06, 942.05, 958.06, 967.08 respectively for the determination of crude protein, crude fat, ash, crude fibre, dry matter and moisture, NFE by difference; and energy value according to the procedure of Pauzenga (1985) as Metabolisable energy (kcal/kg DM) = 37 x % protein + 81.8 x % fat + 35.5 x %NFE.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using the procedure of SAS, (1999). The means were separated using the Duncan Multiple Range Test of the same package.

Table 1: Proximate composition of *Delonix regia seed meal (*DRSM*)*

Nutrient	Value
Crude protein (%)	19.98
Ether extract (%)	3.92
Crude fibre (%)	7.02
Ash (%)	4.72
Dry matter (%)	90.44
Nitrogen Free Extract (%)	54.80
ME (MJ/kg DM)	12.57

Results and discussion

The proximate composition including the calculated ME of the DRSM is presented in Table 1. The values were 19.98% CP, 3.92% EE, 7.02% CF, 4.72% ash, and 54.80% NFE. The calculated ME was 12.57 MJ. Previous studies on the composition showed that DRSM contained 23.90% CP, 6.81% CF, 3.96% EE, 4.64% ash, 90.64% DM, and 12.68 MJ (Olajide and Adeniyi, 2015). The variations in the values of the different constituents could be as a result of the differences in location, soil type, environmental factors etc. Table 2 shows the gross composition of the experimental diets. The crude protein (CP) and crude fibre (CF) increased; and metabolizable energy (ME) decreased with increasing contents of DRSM in the diets**.** The NRC, (1994) recommended 11.92 MJ ME /kg diet

Table 2: Gross composition of the laying hens diets with graded levels of Delonix regia seed meal in place of maize

Ingredients	Diets (% replacement levels of maize by DRSM)				
	D1 60% Maize + 0% DRSM	D2 45% Maize + 15% DRSM	D3 30% Maize + 30% DRSM	D4 15% Maize + 45% DRSM	D5 0% Maize + 60% DRSM
Maize	60.00	45.00	30.00	15.00	0.00
Delonix regia seed meal	0.00	15.00	30.00	45.00	60.00
Soybean Meal	10.50	10.50	10.50	10.00	10.00
Wheat Offals	10.03	10.03	10.03	10.03	10.03
Groundnut Cake	7.52	7.52	7.52	7.52	7.52
Fish Meal (%)	1.50	1.50	1.50	1.50	1.50
Oyster Shell	7.80	7.80	7.80	7.80	7.80
Dicalcium Phosphate	1.80	1.80	1.80	1.80	1.80
*Premix (layers)	0.15	0.15	0.15	0.15	0.15
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15
Methionine	0.10	0.10	0.10	0.10	0.10
Vegetable Oil	0.20	0.20	0.20	1.20	1.20
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Crude Protein (%)	16.50	18.00	19.49	20.78	22.28
Crude Fiber (%)	3.13	3.88	4.64	5.35	6.10
Metabolisable Energy (MJ/kg)	11.68	11.42	11.14	10.88	10.60

*Premix contains: Vit A, $4x10^{6,}$ I.U; Vit $D_{3,}$, $8x10^{5,}$ I.U; Tocopherols. , $4x10^{3,}$ I.U; Vit $K_{3,}$ 800mg; folacin, 200mg; Thiamine, 600mg; Riboflavin, 1,800mg; Niacin, 600mg; Calcium panthothenate, 2g; Pyridoxine, 600mg; Cyonocobalamin, 4mg; Biotin, 8mg; Manganese, 30g; Zinc, 20g; Iron, 8g; Choline chloride, 80g; Copper, 2g; Iodine, 480mg; cobalt, 80mg; selenium, 40mg; BHT, 25g; Anti-caking agent, 6g.

and CP of 16% for brown egg laying birds from 18 weeks of age to first egg. Olajide *et al.,* (2008) fed diets containing 10.70 – 11.02 MJ, 16.90 – 17.30% CP, 3.8 – 4.20% CF; and with enzyme supplementation Olajide *et al.,* (2013) fed diets containing 10.47 – 11.62 MJ, 17.16 – 17.52% CP, and 3.99 – 7.54% CF. The performance indices of the experimental laying birds are presented in Table 3. The egg/day (HDP), egg weight, egg mass and FCR differed significantly ($p< 0.05$) across the dietary treatments. The highest HDP (69.67%) and egg mass (38.68 g); and the lowest egg weight (55.26 g) and FCR (2.82) were obtained in layers fed D1 compared to those fed the remaining diets. The egg weight and FCR increased while the HDP and egg mass decreased with DRSM inclusion levels. The lowest HDP of 17.33%, egg mass (12.80 g); and highest egg weight (73.94 g) and FCR (9.23) were obtained in laying birds fed D5 (0% Maize + 60% DRSM-based diets). Meanwhile, the average initial live weight, average final live weight, average body weight gain and average daily feed intake were similar ($p> 0.05$) across the dietary treatments. The decreasing HDP and increasing FCR with increasing DRSM in the diets may further suggest that the nutrients were poorly digested, utilized and absorbed by the experimental birds. The decreasing ME with the dietary inclusion of DRSM have caused non-significant increase in average daily feed intake. This is in line with the submissions that the energy content of the feed affects the feed intake in birds (Oluyemi and Roberts, 2013). It is expected that the increase in feed intake could have resulted in higher HDP, egg weight and eventually egg mass. However, this did not translate to production of more eggs. Harms *et al.,* (2000) reported that egg production was not affected by dietary energy level. The increased egg weight should have resulted in increasing egg mass, but contrary is the case due to low HDP; more so the HDP of DRSM-based diets beyond D2 level did not cause a reduction in cost of feed to produce the particular egg mass. This was despite the fact that the cost per kg feed consistently reduced with DRSM inclusion in the diets. The increasing CP with DRSM inclusion level in the diets did not translate to increased HDP, although bigger eggs; probably due to increasing CF and reducing ME. The CF would have limited the digestibility, availability and utilization of other nutrients in the diets which is in line with past submissions (King *et al.,* 2000; Baidoo *et al.,* 2003; Safari *et al.,* 2005; Longe 2006; Olajide *et al.,* 2009). The coarse nature of the seed coat would have contributed to the further impairments of digestibility, absorption and utilization of other nutrients in the diets. While the body weight gain, average daily feed intake and egg weight in the present study were higher than 0.15 – 0.18 kg, 101.52 – 107.71g/b/d, and 57.35 – 58.39g respectively; the HDP were lower than 75.24 – 84.76% reported by Olajide *et al.,* (2010). In another study involving the use of enzyme to bio-degrade brewers' dried grain in Isa-brown laying hens conducted by Olajide *et al.* (2013), the values were average daily feed intake (81.88 – 95.06g/b/d), weight gain (0.33 – 0.35kg), egg weight (49.42 – 50.79g) and HDP (56.97 – 73.04%). Black laying birds are practically known to be bigger, laying bigger but fewer number of eggs than the brown. This probably further explains the results obtained in these parameters.

Table 3: Performance of laying hens fed graded levels of DRSM-based diets

Parameters	Treatments					SEM
	D1 60% Maize + 0% DRSM	D2 45% Maize + 15% DRSM	D3 30% Maize + 30% DRSM	D4 15% Maize + 45% DRSM	D5 0% Maize + 60% DRSM	
AIW (g/b)	1667.88	1663.83	1666.18	1667.60	1668.88	10.56
AFBW (g/b)	2007.88	1998.16	2006.26	2008.33	2017.86	16.08
ABWG (g/b)	340.00	334.33	340.08	340.73	348.98	14.58
ADFI (g/d)	109.23	112.43	112.13	115.50	116.66	5.92
Egg/day	0.70[a]	0.57[b]	0.44[c]	0.29[d]	0.17[e]	0.03
Egg weight (g)	55.26[c]	60.02[b]	60.97[b]	67.49[ab]	73.94[a]	2.26
Egg mass (g)	38.68[a]	34.21[ab]	26.83[b]	19.57[c]	12.57[d]	1.40
HDP (%)	69.67[a]	57.33[b]	44.33[c]	29.00[d]	17.33[e]	1.49
FCR	2.82[d]	3.29[cd]	4.18[c]	5.89[b]	9.23[a]	0.26
Cost/kg feed	128.20	109.45	86.95	64.45	41.95	NA
(° /€)	0.28	0.24	0.19	0.14	0.09	
Cost of feed/unit	361.52	360.09	363.45	380.26	389.30	NA
of egg (° /€)	0.80	0.80	0.81	0.84	0.86	

DRSM = *Delonix regia* seed meal; SEM = standard error of the means; NA = not analysed, AIW average initial weight, AFBW average final body weight, ABWG average body weight gain, ADFI average daily feed intake

[a,b,c,d]Means in the same row with different superscripts differ significantly($P < 0.05$).

The egg quality characteristics of the black Harco laying hens fed graded levels of DRSM-based diets are shown in Table 4. The percentage yolk weight, average albumen weight and percentage albumen weight differed significantly ($p< 0.05$) across the dietary treatments. The egg weight 55.26g (D1), increased to 60.02g (D2), 60.97g (D3), 67.49g (D4) and 73.94g (D5). The highest percentage yolk weight, 24.43 (D1) compared with 23.84 (D2). The percentage albumen weight increased with contents of DRSM in the diets. The percentage albumen weight of egg from birds fed control diet (D1) was 64.75 which increased to 65.31 (D2), 67.57 (D3), 67.12 (D4) and 68.30 (D5). The average egg length, egg width, egg shape index, absolute egg yolk weight, shell weight and shell thickness were similar ($p > 0.05$) across the dietary treatments. Yolk colour improved with DRSM inclusion levels (Plates 1 – 5). This is very desirable for egg processors. The increasing egg weight and percentage albumen weight; and decreasing percentage yolk weight with increasing levels of DRSM in the diets are desirable.This is because bigger eggs command higher prices in the market, the albumen is rich in protein which is of nutritional importance; and the cholesterol scare always associated with the consumption of eggs is in the yolk (Olajide *et al.,* 2013). Longe, (1984) associated low yolk constituents to increased fibres in the diets, and Olajide *et al.,* (2013) linked the reduced egg lipids to contents of saponin in the diets. The egg weight in this study were bigger than standard (50 – 60 g) recommended for the tropics (Oluyemi and Roberts, 2013). Narushin and Romanov, (2002) listed egg weight and shape index (maximum breadth to length ratio) as influential egg physical parameters in the processes of embryo development and successful hatching. The shell thickness is important in egg handling and transportation. The fact that bigger eggs from DRSM-based diets did not possess inferior shell quality (thickness) is a plus and may suggest non-negative effect on handling quality and profit to farmers (Olajide *et al.,* 2010). Mekki *et al.,* (2005) reported a negative correlation between shell thickness and laying rate in different Sudanese indigenous chicken types. Inclusion of DRSM improved the egg yolk colour. The difference observed in the yolk colour of the experimental birds could be attributed to DRSM which was the only ingredient varied in the diets. El Boushy and Raterink (1987) reported that the degree of pigmentation of egg yolk depends on the Xanthophyll concentration in the feed, the composition of the feed and health of the birds. There was no incidence of meat spots, blood stain, double yolks, mottled yolks, yolkless egg, shell-less egg and wrinkled shell in all the eggs analysed. These were considered abnormalities in egg (Oluyemi and Roberts, 2013).

Table 4: Egg quality characteristics of laying hens fed graded levels of DRSM-based diets

Parameters	Treatments					SEM
	D1 60% Maize + 0% DRSM	D2 45% Maize + 15% DRSM	D3 30% Maize + 30% DRSM	D4 15% Maize + 45% DRSM	D5 0% Maize + 60% DRSM	
Egg weight (g)	55.26^{d}	60.02^{c}	60.97^{b}	67.49^{ab}	73.94^{a}	2.26
Egg length (cm)	5.40	5.58	5.55	5.59	5.59	0.05
Egg width (cm)	4.00	4.60	4.10	4.10	4.30	0.12
Egg shape index	0.74	0.82	0.74	0.73	0.77	0.02
Yolk weight (g)	13.50	14.31	12.64	14.25	15.33	1.01
Yolk weight (%)	24.43^{a}	23.84^{ab}	20.73^{d}	21.11^{c}	20.73^{d}	2.11
Alb. weight (%)	64.75^{d}	65.31^{c}	67.57^{ab}	67.12^{ab}	68.30^{a}	2.02
Shell weight (g)	5.50	6.09	6.60	7.40	7.60	0.52
Shell weight (%)	10.13	10.15	10.82	10.96	10.28	0.64
Shell thickness (mm)	0.34	0.34	0.35	0.34	0.35	0.001

DRSM = *Delonix regia* seed meal, SEM = standard error of the means, Alb. = albumen

^{a,b,c,d}Means in the same row with different superscripts differ significantly($p<0.05$).

Plates 1-5: Varying yolk colours of the black Harco laying hens fed diets with graded levels of DRSM in place of maize.

Plate 1: Yellow yolk (RYCFs 1) (60% Maize + 0% DRSM).

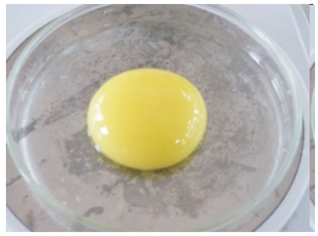

Plate 2: Yellow yolk (RYCFs 2) (45% Maize + 15% DRSM)

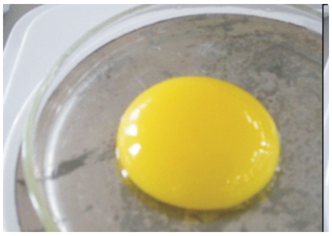

Plate 3: Yellow yolk (RYCFs 4) (30% Maize + 30% DRSM).

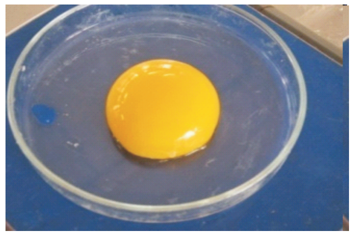

Plate 4: Yellow yolk (RYCFs 6) (15% Maize + 45% DRSM).

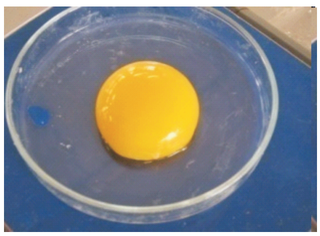

Plate 5: Deep yellow yolk (RYCFs 7) (0% Maize+ 60% DRSM).

The haematological indices of the experimental birds fed diets containing varying levels of DRSM in place of maize in the diets are shown in Table 5. There were no significant (*p>0.05*) differences in all the parameters observed except the packed cell volume (PCV) values which ranged from 25.20% (D1) to 29.58% (D2), 28.33% (D3), 28.67% (D4) and 28.61% (D5). The experimental birds fed diets containing 45% Maize + 15% DRSM (D2) had the highest (*p<0.05*) among the treatments and those fed control diet (D1) had the lowest value. Data obtained in the other haematological variables (ESR, RBC, Hb, lymphocytes, neutrophils, monocytes, basophils, eosinophils, MCV, MCH and MCHC) were similar (*p>0.05*) across the dietary treatments. The fact that the PCV increased with DRSM in the diets still within the recommended range values of 24.90 – 45.20% (Mitruka and Rawnsley, 1977) is a plus for the test ingredient. Saka *et al.,* (2019) identified PCV as an index of toxicity reduction in the blood. The fact that the PCV values were within the normal physiological range for chickens suggests DRSM was tolerated across the treatment groups. Normal PCV values were also reported to be indicators of adequate nutritional status (Saka *et al.,* 2019 citing Ahamefule *et al.,* 2005). Other haematological parameters especially RBC and Hb were similar and within 7.40 – 13.10 g/dl and 1.58 – 4.10 (mm^3 x 10^6) respectively recommended for normal chicken (Mitruka and Rawnsley, 1977). This may suggest normal oxygen carrying capacity for all the experimental birds.

Table 5: Haematological variables of laying hens fed diets in which graded levels of DRSM replaced maize

Parameters	Diets					SEM
	D1 60% Maize + 0% DRSM	D2 45% Maize + 15% DRSM	D3 30% Maize + 30% DRSM	D4 15% Maize + 45% DRSM	D5 0% Maize + 60% DRSM	
ESR (mm/hr)	4.10	5.00	4.10	4.20	5.11	0.52
PCV (%)	25.20^c	29.58^a	28.33^b	28.67^{ab}	28.61^{ab}	1.20
RBC (mm^3 x 10^6)	2.41	2.23	2.30	2.49	2.24	0.42
Hb (g/dl))	9.80	10.10	10.33	9.80	10.90	0.98
Lymph (%)	59.67	60.00	59.33	60.00	60.67	2.33
Neutrop (%)	25.33	23.00	24.67	25.33	23.67	1.58
Mono (%)	11.67	13.33	12.99	11.67	13.33	1.02
Basoph (%)	2.33	2.67	2.50	2.50	2.58	0.07
Eosinophils (mm^3 x 10^3)	1.00	1.50	0.67	1.50	1.00	0.003
MCV (μ^3)	81.50	81.40	81.50	81.60	81.60	2.50
MCH (μμg)	31.70	32.01	32.10	32.00	32.00	1.10
MCHC (%)	31.30	30.80	30.80	30.00	30.99	1.30

DRSM = *Delonix regia* seed meal, SEM = standard error of the means; ESR erythrocyte sedimentation rate; PCV packed cell volume; RBC red blood cells; Hbc haemoglobin concentration; Lymph lymphocytes; Neutrop neutrophils; Mono monocytes ; Basoph basophils; MCV mean cell volume; MCH mean cell/corpuscular haemoglobin; MCHC mean corpuscular haemoglobi concentration

[a,b,c,]Means in the same row with different superscripts differ significantly(P <0.05).

Conclusion

It was concluded that maize could economically be replaced with 25% DRSM (45% Maize + 15% DRSM) in layers diets despite superior HDP, egg mass and FCR of the control; and egg quality (increased albumen, reduced yolk and increased yolk colour) improved with DRSM inclusion in the diets.

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