Effect of replacing maize with pride of barbados (*Delonix regia*) seed meal on growth performance, carcass, serum and haematological indices of rabbits

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Abstract

Thirty growing rabbits with mean body weight of 516.67g were used in a feeding trial that lasted for 56 days. The animals were randomly distributed into five (5) dietary treatment groups consisting of six (6) animals per group. Each treatment group was replicated six (6) times with individually housed rabbit per replicate. The five dietary treatments contained 0, 25, 50, 75 and 100% replacement levels of *Delonix regia* seed meal (DRSM) for maize in a completely randomized design experiment. The parameters investigated during the study were: feed intake, weight gain, feed conversion ratio and feed cost. At the end of the feeding trial, blood samples were collected from the animals through the ear vein for haematology and serum biochemistry. Fifteen (15) animals at the rate of 3 animals per dietary treatment were stunned and sacrificed for the determination of carcass analysis. Samples of visceral organs and primal parts were collected from the animals for carcass yield evaluation. Data obtained were subjected to one-way analysis of variance. The inclusion of DRSM in rabbit diets did not significantly ($p > 0.05$) influence the daily feed intake, weight gain and feed conversion ratio of the animals. The carcass parameters except the forelegs and all the organ weights were not significantly ($p < 0.05$) affected by the dietary treatments. The highest value (3.85%) of the forelegs was obtained in treatment 4 (75% DRSM). The corresponding values of 3.35, 3.39 and 3.40 respectively for animals in treatments 1, 2 and 5 were similar but lower than that on treatment 4 and higher than 3.19% of treatment 3. Feeding of DRSM to rabbits did not show any significant ($p > 0.05$) variation in both the haematological and biochemical components of the rabbits studied except the globulin. The globulins (g/dl) were 1.50, 3.0, 1.70, 3.30 and 1.75 respectively for animals on treatment 1, 2, 3, 4 and 5. All these haematological and serum biochemical parameters were within the normal physiological ranges for rabbits. Cost per Kg feed and cost of feed per Kg live weight decreased significantly ($p < 0.05$) with increased replacement levels of DRSM for maize in the diets with 100% substitution having the least cost. The results suggest that DRSM could completely replace maize (up to 100%) without any deleterious effect on the growth performance, carcass, haematology and serum biochemistry of rabbits. Therefore DRSM may be a panacea to high cost of maize and can be recommended for rabbit farmers.

Keywords: *Delonix regia* seed meal, growth, carcass yield, organ weights, blood parameters. Anti-stress was administered on the first two days of arrival followed by coccidiostat (Totrazil®).

Introduction

The need to provide sufficient animal protein for the growing human population is of paramount concern to Animal Nutritionist. Acute shortage of animal protein supply is a problem being faced in Nigeria, despite various plans and projections by government and individuals to fight this through improved systems of animal production. Developing livestock industry has been advocated to be the greatest means of bridging the protein gap prevailing in the tropical countries (FAO, 2000). The cost of feed has followed in recent times the upward trend due to increased in the cost of various feed ingredients. The search for alternative sources of feed ingredients which are readily available has been the concern of livestock producers. Studies have focused on sourcing for energy and protein feedstuffs paying less attention to sources of major minerals nutrients (Cheeke, 1987). The increasing cost of conventional feed ingredients such as cereal grains, maize, rice, wheat, sorghum and stiff competition between man and the livestock industry, brewery, the textile industry and other agro-dependent industries have stimulated interest in the use of readily available alternative and cheaper feed substitutes (unconventional feed). Animal feed is an essential part of livestock production. As the world's population increases, the demand for livestock and livestock products is also increasing. Unfortunately, most of the feed resources used in the production of livestock feed such as maize, are also consumed by humans. It is therefore necessary to search for alternative

sources which could be referred to as non-conventional feed resources, compare their nutritive values to the conventional feed resources and incorporate them into the production of animal feed (Adeola and Olukosi, 2008). These feed sources are however not fully and appropriately integrated into livestock feed. This is due to very little knowledge of their potential as feed materials, the presence in some cases of anti-nutritional elements as well as lack of proper knowledge of storage capabilities especially over long periods (Ben *et al.*, 2002).

In achieving this goal of searching for alternatives, researchers have explored the utility of industrial by-products and agricultural waste products such as maize offal, wheat offal, rice bran, rice husk, brewer's dried grains, maize cobs, cassava peels, etc. There is paucity of reports on the use of Pride of Barbados seed (*Delonix regia* seed meal, DRSM) as dietary source of energy in rabbit nutrition. There is also no competition between man and animals for Pride of Barbados seed. This study therefore investigated the effect of graded levels of DRSM as substitutes for maize in rabbits' diets.

Materials and methods

Site of the experiment

The experiment was carried out at the Rabbit Unit of the Teaching and Research Farm, Joseph Ayo Babalola University Ikeji-Arakeji, Osun State, Nigeria. The location lies between 7°16' and 7°18' North and longitude 5°09' and 5°11' in the rain forest belt of the tropics. The annual rainfall ranges from 1405-2400 mm and the

average monthly temperature of 26.5°C). *Collection and preparation of the test ingredient*

Matured and dried pods of *Delonix regia* were plucked from the trees around Igboora, Ibarapa Central Local Government Area of Oyo State, Nigeria. The pods were further dried in the open air. Seeds were collected and ground with hammer mill.

Experimental diets

Five (5) experimental diets were compounded arising from the replacement of maize with 0, 25, 50, 75 and 100% DRSM. The substitution was weight for weight. The gross composition of the diets and calculated analysis are presented in Table 2. Diets were presented in pelletized form.

Management of the experimental animals

A total of thirty Chinchilla x New Zealand White cross-bred weaner rabbits of about six weeks old and of mixed sexes with average weight of 516.67g were purchased from Osogbo in Osun State, Nigeria. These were randomly assigned into five treatments with six replicates each balanced for the group average weights. Prior to the arrival of the rabbits, the house and hutches were repaired and thoroughly washed, cleaned and disinfected. The hutches were provided with suitable clay pot drinkers and feeders. The rabbits were housed one in a unit of the hutch measuring 40 x 60 x 54 cm in dimension. The hutches were raised from the floor and provided with wire screen floor to allow faeces and urine to drop to the cemented floor. Anti-stress was administered on the first two days of arrival followed by coccidiostat (Totrazil®) which was given for two days and dewormer (Piperazine®) was also given. Ivomec® super was administered in the second week at the rate of 0.1ml/5kg against ectoparasites. The animals were fed *ad libitum* with the pelletized feed and clean drinking water provided free choice.

Growth performance and cost analysis

The rabbits were weighed at the beginning of the experiment and thereafter on weekly basis. Weekly feed intake per animal was recorded from which the feed to gain ratio (FCR) was calculated. Weekly weight gain and feed intake of all the experimental animals were taken using five goat pan table scale, calibrated in 0.1kg with a maximum carrying capacity of 20 kg. The costs of the five diets were computed from the prevailing cost of the ingredients at the time of the study. These were then used to calculate the cost of feed consumed per kg live weight gain of the experimental animal.

Carcass and organ evaluation ($P < 0.05$)

Fifteen rabbits (three rabbits per treatment) were randomly taken at the end of the feeding trial based on the group average weight for carcass analysis. The rabbits were fasted for 12 hours and their live weights recorded. Each of the animals was stunned before slaughtering by cutting the jugular vein with a sharp knife. Carcass weight was taken. The tail, head, pelt, feet and internal organs were removed. The dressing weight recorded. The head, liver, kidneys, heart, lungs, intestine, feet, spleen, and all other parts were obtained and weighed. The dressed weight was expressed as percentage of carcass weight and organ weight as percentage of live weight of the animals.

Haematology and serological parameters

Blood samples were collected from three animals per treatment for haematological and biochemical analyses at the end of the feeding trial. Blood was collected from each animal into labelled sterile universal bottle containing anti-coagulant ethylenediamine-tetraacetic acid (EDTA) for the determination of haematological components and into another labelled sterile bottle without EDTA for the determination of serum biochemical 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 hemacytometer method, and haemoglobin (Hb) using the cyanomethemoglobin method described by Kelly, (1979). Serum from the coagulated blood samples was used for the measurement of total protein, albumins, globulins and glucose.

Proximate analyses of DRSM and experimental diets

The proximate analyses of DRSM and the experimental diets were according to method of AOAC (1990). The metabolizable energy was calculated according to the procedure of Ponzenga, (1985) as $ME \text{ (kcal/kg DM)} = 37 \times \% \text{ protein} + 81.8 \times \% \text{ fat} + 35.5 \times \% \text{ NFE}$.

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.

Results and Discussion

The proximate composition of *Delonix regia* seed meal indicated a crude protein content of 23.9%, crude fibre of 6.81%, ether extract of 3.96%, ash of 4.64%, dry matter of 90.64% and metabolizable energy of 3030.54kcal/kg. The values obtained in this study compares favourably with 96.26% DM, 23.42% CP, 4.60% EE and 8.79% Ash reported by Kagya-Agyemang *et al.*, (2008).

The gross composition of experimental diets is shown in Table 1. The calculated crude protein for the experimental diets ranged from 15.23 to 19.66 % and the calculated metabolizable energy (kcal/kg DM) were 2539.51 (0%DRSM), 2555.31 (25%DRSM), 2544.60 (50%DRSM), 2533.49 (75%DRSM) and 2522.38 (100%DRSM) respectively.

The calculated crude protein and metabolizable energy values for the treatment diets were similar to 15.84-16.85% and 2520.08-2528.90 kcal/kg fed to growing rabbits (Abegunde *et al.*, 2014). The performance characteristics of rabbits fed the various diets are shown in Table 2. The animals had the same average body weights at the start of the experiment. There were no significant ($P>0.05$) differences in the final body weights of the animal fed with 0% DRSM - based diet (control) compared with those fed with 25%, 50%, 75% and 100% DRSM -based diets. The average daily feed intake, daily weight gain and feed conversion ratio were also not significantly ($P>0.05$) affected by the dietary treatments. The non significant

Table 1: Gross compositions of the experimental diets

Ingredients	Treatments				
	T1 (0% DRSM)	T2 (25% DRSM)	T3 (50% DRSM)	T4 (75% DRSM)	T5 (100% DRSM)
Maize	39.00	29.25	19.50	9.75	0.00
DRSM	0.00	9.75	19.5	29.25	39.00
Groundnut cake	2.70	0.00	0.00	0.00	0.00
Brewer dry grain	33.00	33.00	33.00	33.00	33.00
Soybean	1.10	0.00	0.00	0.00	0.00
Palm kernel cake	20.50	24.30	24.30	24.30	24.30
Bone	1.90	1.90	1.90	1.90	1.90
Limestone	0.50	0.50	0.50	0.50	0.50
Salt	0.20	0.20	0.20	0.20	0.20
Lysine	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15
Premix	0.25	0.25	0.25	0.25	0.25
Palm oil	0.55	0.55	0.55	0.55	0.55
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Energy(ME, kcal/kg)	2539.51	2555.31	2544.60	2533.49	2522.38
Crude protein (%)	15.23	15.57	16.94	18.30	19.66
Ether Extract (%)	5.46	5.57	5.50	5.48	5.53
Crude fibre (%)	10.03	10.77	11.23	11.70	12.17

DRSM: *Delonix regia* seed meal

dietary treatments effects on these parameters may suggest that the control diet and those formulated on graded levels of DRSM were similarly acceptable and utilized by these animals.

The cost per kg feed and cost of feed per kg live weight gain differed significantly ($P<0.05$) among the dietary treatments. The control diet (0% DRSM) recorded the highest ($P<0.05$) cost (N65.66) per kilogramme feed compared with N 57.08 (25% DRSM), N52.69 (50% DRSM), N48.30 (75% DRSM) and N43.92 (100% DRSM) respectively. Cost of feed per kg live weight also reduced significantly ($P<0.05$) with increasing levels of substitution of DRSM for maize in the diets.

The highest cost (N106.02) of feed per kg live weight gain was obtained in rabbits fed the control diet (0%DRSM). This significantly ($P<0.05$) reduced to N89.09 (25%DRSM), N85.45 (50%DRSM), N80.18 (75%DRSM) and N77.77 (100%DRSM) respectively.

Reductions in the cost per kilogramme feed makes it relatively cheaper to produce a kilogramme of live weight gain when rabbits were fed 25%, 50%, 75% and 100% DRSM based diets respectively. Similar reductions in the cost per kg feed and cost of feed per kg live weight gain were obtained by Adeyemi *et al.*, (2011) with growing rabbits fed graded levels of fermented and unfermented pineapple peel. However, in

Table 2: Performance of weaner Rabbit fed graded level of *Delonix regia* seed meal based-diets

Parameters	Treatments					SEM
	T1(0% DRSM)	T2 (25% DRSM)	T3 (50% DRSM)	T4 (75% DRSM)	T5 (100% DRSM)	
Average initial weight (g)	516.67	516.67	516.67	516.67	516.67	30.00
Average final weight (g)	1167	1190	1166.67	1190	1150	60.50
Average final weight gain(g)	650.33	673.33	650.00	673.33	633.33	16.00
Average daily feed intake (g)	21.43	21.43	21.43	22.86	22.86	2.29
Average daily weight gain (g)	13.27	13.74	13.27	13.74	12.92	1.31
Feed conversion ratio	1.61	1.56	1.61	1.66	1.77	0.04
Cost per Kg feed (₦)	65.66 ^a	57.08 ^b	52.69 ^c	48.30 ^d	43.92 ^e	3.50
Cost of feed/Kg rabbit live weight (₦)	106.02 ^a	89.09 ^b	85.45 ^c	80.18 ^d	77.77 ^e	2.00

a, b, c, d and e Means in the same row bearing different superscripts are significantly different at ($P < 0.05$).

SEM (standard error of the means)

DRSM: *Delonix regia* seed meal

another study reported by Abegunde *et al.*, (2014) while the cost per kg of feed formulated with *Garcinia kola* leaves as substitutes for maize in growing rabbits' diets reduced with the levels of substitution, the cost of feed per kg weight gain did not reduce with the substitution.

The carcass characteristics and organ weights of rabbits fed *Delonix regia* seed meal-based diets are shown in Table 3. All the carcass parameters investigated except the forelegs were not significantly ($P > 0.05$) affected by the dietary treatments. The average treatment values of the forelegs were 3.35, 3.39, 3.19, 3.85 and 3.40% respectively for rabbits fed 0, 25, 50, 75 and 100% DRSM-based diets. However, there have not been any anatomical bases for the increase, since it did not follow any particular trend to be associated with dietary treatments. The differences noticed may be due to individual differences. Also, inclusion of *Delonix regia* seed meal in the diets did not have any significant ($P > 0.05$) effects on all the organs of the animals. This

indicates that the inclusion of DRSM in rabbit diets up to 100% had no negative effects on these organs. Onyeyilli *et al.*, (1998) have identified kidney and liver as the primary organs of biotransformation involved in handling metabolic wastes and toxins from the body. Hypertrophy and hypotrophy of these organs have also been linked to presence of toxin (Ewuola *et al.*, 2003). The dressing percentage values obtained in this study were close to 51.0-57.39% reported for rabbits by Abegunde *et al.*, (2014) but lower than 68.0-70.34% and 61.69-66.66% respectively reported by Adeyemi *et al.*, (2011) and Togun *et al.*, (2006). The differences noticed could be linked to different diets, breeds, age and location of the studies. The organs (heart, liver, kidney, lungs, spleen and stomach) were within the ranges obtained by these authors.

Table 4 shows the serum metabolites and haematological parameters of rabbits fed graded levels of *Delonix regia* seed meal based diets. There were no significant ($p > 0.05$) variations in all the parameters

Table 3: Carcass characteristics and organ weights of Rabbits fed *Delonix regia* seed meal based diets

Parameters	Treatments					SEM
	T1 (0% DRSM)	T2 (25% DRSM)	T3 (50% DRSM)	T4 (75% DRSM)	T5 (100%DRSM)	
Live weight (g)	1350	1025	1265	1225	1225	65.25
Carcass weight (g)	1310	1005	1200	1175	1175	0.62
Dressed weight (%)	51.45	43.76	47.61	46.39	46.18	1.55
Heart (% of carcass)	0.27	0.25	0.25	0.29	0.26	0.01
Lung(%)	0.89	0.54	0.63	0.85	0.78	0.08
Liver(%)	0.32	0.31	0.28	0.34	0.29	0.11
Kidney(%)	0.61	0.65	0.56	0.60	0.54	0.12
Stomach(%)	2.16	2.69	2.87	2.43	2.51	0.16
Head(%)	10.08	10.39	11.30	9.61	9.46	0.38
Skin(%)	7.72	6.67	7.60	7.01	7.34	0.25
Feet(%)	2.42	2.98	2.37	2.99	2.64	0.12
Tail(%)	0.45	0.45	0.36	0.35	0.61	0.14
Shoulder(%)	4.57	3.44	4.20	3.62	3.54	0.20
Loin(%)	11.08	8.87	10.91	10.04	10.53	0.58
Thigh(%)	16.22	13.94	15.39	15.18	14.93	0.55
Forelegs(%)	3.35 ^{ab}	3.39 ^{ab}	3.19 ^b	3.85 ^a	3.40 ^{ab}	0.91
Hind legs (%)	3.43	2.80	2.90	3.36	3.50	0.15
Rib(%)	10.64	10.03	9.82	10.18	9.93	0.24
Spleen(%)	0.10	0.08	0.06	0.05	0.06	0.01

^{a, b} Means in the same row bearing different superscripts are significantly different at ($p < 0.05$).

DRSM: *Delonixregiaseed* meal; SEM (standard error of the means)

except the globulin. The globulin values (g/dl) were 1.50 (0% DRSM), 3.0 (25% DRSM), 1.70 (50% DRSM), 3.30 (75% DRSM) and 1.75% (100% DRSM). The differences may not be as a result of the inclusion of DRSM because it shows no effects on the physiological performance of the animal; it did not follow any particular trend as well. It is similar to 15-27g/l reported for rabbits by Jenkins, (1993). The haematological components measured were within the normal physiological ranges reported for rabbits: haemoglobin (8.0-17.5 g /dl), packed cell volume (30 -

50%), red blood cell ($4.0-8.0 \times 10^6 /\mu\text{l}$), white blood cell ($5.0-12.0 \times 10^3/\text{dl}$) (Jenkins, 1993; Hillyer, 1994; Nuhu, 2010). Also, there were no significant ($p > 0.05$) dietary treatment effects on the biochemical components of the rabbits fed *Delonix regia* seed meal. The values of biochemical components fell within the normal physiological ranges for rabbits: total serum protein (5.4-7.5 g/dl), albumin (2.5-5.5 g/dl), globulin (1.9-3.5 g/dl) (Jenkins, 1993; Hillyer, 1994; Nuhu, 2010). The results show that the nutrients in the different treatment diets fed to the rabbits

were balanced. The diets supported normal performance, carcass, haematology and biochemical components of the experimental animals.

Conclusion

Similar performance, carcass, serum and haematology of the rabbits fed the control and DRSM-based diets may point to good utilization of nutrients. The fact that there was no mortality or health related problems recorded during the study coupled with the lowest cost per kg feed and cost per kg live weight gain obtained at 100% replacement level of DRSM for maize indicate that *Delonix regia* seed meal can safely and economically replace maize (up to 100%) if good hygiene and sanitation practices are maintained.

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Table 4: Serum biochemistry and haematological parameters of Rabbits fed *Delonix regia* seed meal- based diets

Parameters	Treatments					SEM
	T1 (0% DRSM)	T2 (25% DRSM)	T3 (50% DRSM)	T4 (75% DRSM)	T5 (100% DRSM)	
Haemoglobin (g/dl)	12.00	10.55	11.90	10.80	11.15	1.14
Packed Cell Volume (%)	36.00	31.5	35.50	35.50	33.50	3.42
White Blood Cell (10 ³ dl)	4300	3250	3675	4100	3675	411.38
Red Blood Cell (10 ⁶ µl)	4.05	3.55	3.95	3.68	3.75	0.38
Glucose (g/dl)	91.00	102.50	97.50	103.00	98.00	10.26
Total protein (g/dl)	5.30	5.75	6.75	6.30	5.70	0.68
Albumin (g/dl)	3.80	2.85	5.05	3.00	3.95	0.47
Globulin (g/dl)	1.50 ^b	3.00 ^a	1.70 ^{ab}	3.30 ^a	1.75 ^{ab}	0.33

^{a, b, ab} Means in the same row bearing different superscripts are significantly different at (P<0.05).

SEM: standard error of the means; DRSM – *Delonix regia* seed meal

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