

## Effects of Some Raw Tropical Legume Seeds on Egg Quality and Laying Performance of Exotic Hens

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**Abstract:** Raw Jack beans, bambara groundnuts and benne seeds were fed to exotic hens in a six-week experimental study to assess their toxicological effects on egg quality and laying performance. The raw legumes were used to replace soy bean meal at 25 and 50% levels. Egg weight and hen-day production were more significantly ( $p < 0.05$ ) reduced in birds fed 25 and 50% raw benne seed-based diets. Feed conversion ratio was conspicuously ( $p < 0.05$ ) increased in birds fed 50% raw benne seeds. Egg yolk index and haugh unit were significantly ( $p < 0.05$ ) reduced across the groups. The reductions were however more pronounced in birds fed 50% raw jack beans and 50% raw benne seeds respectively. The whole egg protein was similar in all the groups. The yolk protein and albumen protein were however significantly ( $p < 0.05$ ) reduced across the groups. The fat contents of the whole eggs and yolk were more significantly ( $p < 0.05$ ) reduced in birds fed 50% raw jack beans and 50% bambara groundnuts respectively. Regression analysis revealed significant ( $p < 0.05$ ) correlations between egg weight and haemagglutinin ( $r = -0.47$ ), tannin, ( $r = -0.55$ ), Yolk index and haemagglutinin ( $r = -0.54$ ), trypsin inhibitor ( $r = -0.51$ ); Haugh unit and tannin ( $r = -0.68$ ), oxalate ( $r = -0.51$ ); Yolk protein and haemagglutinin ( $r = -0.51$ ), trypsin inhibitor ( $r = -0.48$ ).

**Key words:** Raw legumes · hens · eggs

### INTRODUCTION

The presence of artificial or natural toxic compounds in diets of livestock animals constitutes a great danger to their health and optimum performance [1]. Several toxic compounds are known to have caused one negative effect or the other on growth, reproduction, blood biochemical composition, nutrient utilization and general well being of livestock animals. For example, the inclusion of dimethoate and dehtamethrin (two toxic compounds) in diets of male rabbits reduced their sperm concentration [2]. Likewise, Yousef *et al.*, [3] reported direct cytotoxic effects on spermatogenesis and/or an indirect effect via hypothalamic-pituitary-testis axis controlling the reproductive efficiency of male rabbits fed with two toxic compounds (Carbofuran and glyphosate).

Moreover, apart from the artificial toxic compounds, certain plants also contain some natural toxic compounds which cause adverse effects on performance of livestock animals consuming them. An example of such plants are the raw grain legumes. This group of plant grains are a

source of protein and energy. However, their nutritive elements are masked with the occurrence of anti-nutrients such as lectins (haemagglutinins), trypsin inhibitors, canavanine, tannin, oxalate and phytate. Extensive work has been done on the effects of these toxic elements in conventional raw grain legumes on growth and histopathology of organs of poultry birds and rats. Lorenzson and Olsen [4] reported shedding of brush border membranes and decreased villus length and subsequent reduction in the surface area for absorption of nutrients in the small intestine of rats when haemagglutinin isolated from a raw legume was injected into the intestinal loop. Diets rich in trypsin inhibitor activities have also been reported to lead to inhibition in growth and endogenous excretion of essential amino acids as a result of a hyperactive pancreas [5]. Oxalate, tannin and phytate have also been reported to form complexes with dietary protein and minerals like calcium, iron, magnesium and sodium, thereby making them unavailable for growth.

However, available literature does not show that much attention has been paid to the effects of anti-

nutrients in many under-utilized grain legumes on egg production and quality of exotic laying hens.

This present study was therefore designed to look at the effects of the anti-nutrients in raw jack beans, bambara groundnuts and benne seeds on egg laying performance and physico-chemical characteristics of eggs laid by exotic hens.

### MATERIALS AND METHODS

Samples of raw jack bean (*Canavalia ensiformis* (L.) DC), (*Vigna subterranean* (L.) Venc.) and benni seed (*Sesamum indicum* L.) were acquired from the Department of Agronomy, University of Ibadan, South Western, Nigeria and open markets in Maiduguri, North Eastern Nigeria.

**Chemical analysis:** Proximate compositions of the raw legumes were determined by the procedures outlined by the Association of Official Analytical Chemists [6]. Trypsin inhibitor, haemagglutinin and canavanine contents were determined by the methods described by of Kakade *et al.*, [7], Valdebouze *et al.*, [8] and Natelson and Bratton [9] respectively. Tannin, oxalate and phytate contents were determined by methods described by Hoff and Singleton [10] Wheeler and Ferrell [11] and Dye [12] respectively.

**Diet formulation:** Diets of equal energy and nitrogen contents Table 1 were formulated by incorporating raw jack beans, bambara groundnuts and benne seeds into the basal diet at the expense of soybean meal at 25 and

50% replacement levels respectively. All diets were supplemented with 3 g kg<sup>-1</sup> DL methionine and 2 g kg<sup>-1</sup> lysine to ensure these amino acids were not limiting for egg production and quality.

**Experimental birds:** A total of 210 exotic laying hens (Nera brown) of 40 weeks old were randomly allocated into 7 dietary treatment groups at thirty (30) birds per group. Each group was further subdivided into ten (10) birds per replicate group. The birds were raised in individual battery cages and adequately dewormed in the first week of the experiment. The birds were stabilized for the first two weeks by feeding them with commercial layers mash, after which they were fed with the experimental diets for another six weeks. Food and water were served ad-libitum and light was provided for 24 h daily. At the end of the sixth week, the experiment was terminated. The daily feed intake, egg weight and hen-day production were taken.

**Physical and chemical analysis of eggs:** The physical characteristics of the eggs were taken using the methods described by Card and Neshiem [13]. Eggs were collected for analysis for 4 days in the sixth week of the experiment. For physical analysis, the weights of whole egg, yolk, albumen and shell were taken using a sensitive chemical balance. The yolk index was calculated by dividing the yolk height with the yolk width. The haugh unit was calculated using the formula  $100\log(H+7.57-1.7W^{0.37})$ , where H is the albumen height and W is the egg weight. The yolk, albumen and shell weights were expressed as percentages of the egg weight.

Table 1: Gross composition of diets (g/kg Dm)

	Control	25% RJB	50% RJB	25% RBG	50% RBG	25% RBS	50% RBS
Maize	480.0	480.0	480.0	480.0	480.0	480.0	480.0
Soy bean	180.0	135.0	90.0	135.0	90.0	135.0	90.0
Jack bean	-	45.0	90.0	-	-	-	-
Bambara	-	-	-	45.0	90.0	-	-
Benne	-	-	-	-	-	45.0	90.0
Fish meal	15.0	25.0	25.0	25.0	25.0	25.0	25.0
Wheat bran	115.0	110.0	115.0	110.0	105.0	110.0	110.0
Palm kernel meal	95.0	90.0	85.0	90.0	95.0	90.0	90.0
Bone meal	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Oyster shell	75.0	75.0	75.0	75.0	75.0	75.0	75.0
Salt	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Premix	3.0	3.0	3.0	3.0	3.0	3.0	3.0
DL-methionine	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lysine	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Determined crude protein (%)	17.1	17.0	16.8	16.7	16.5	16.8	16.6
Calculated metabolizable energy (Kcal g <sup>-1</sup> )	2.64	2.63	2.62	2.61	2.61	2.64	2.63

RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

The chemical characteristics of the eggs (whole egg protein, yolk protein, albumen protein, whole egg fat, yolk fat and albumen fat) were determined according to the analytical methods of AOAC [14].

**Statistical analyses:** The data were analyzed by analysis of variance. When analysis of variance indicated a significant treatment effect, means were compared using the Duncan multiple range test [15] and test of linearity was applied to assess the relationship between the anti-nutrients and the response indices respectively.

**RESULTS**

The proximate compositions of the raw jack beans, bambara groundnuts and benne seeds used in this are presented in Table 2.

Higher values of crude protein and fiber were obtained in raw jack beans. The fat content was 25 times and 8 times higher in raw benne seeds than raw jack beans and bambara groundnuts respectively.

Data on the anti-nutrients in the legumes are shown in Table 3. Haemagglutinin and trypsin inhibitor activities were higher in raw jack beans than in bambara groundnuts and benne seeds respectively. Raw benne seeds however contained higher values of tannin, oxalate and phytate, marginal level of haemagglutinin and none of trypsin inhibitor activities. Canavanine was only detected in raw jack beans.

Performance characteristics of the laying hens are presented in Table 4. Feed intake was significantly ( $p<0.05$ ) increased in the group fed with 50% raw benne seed than other groups. The lowest feed intake was however obtained in birds fed 50% raw jack beans.

Egg weight was more significantly ( $p<0.05$ ) reduced in groups fed 25 and 50% raw benne seeds than those fed with raw jack beans and bambara groundnuts respectively. The hen-day production was however more reduced ( $p<0.05$ ) in birds fed 50% raw jack beans and 50% raw benne seeds respectively. Feed conversion ratio as revealed by gram feed intake per gram egg weight was more significantly ( $p<0.05$ ) increased in birds fed 50% raw benne seeds.

Data on the physical characteristics of eggs are shown in Table 5. The yolk index values were more significantly ( $p<0.05$ ) reduced in birds fed 25 and 50% raw jack beans-based diets respectively. Marginal reductions were however obtained in the yolk index of eggs of other groups.

Reduction in haugh unit was more pronounced ( $p<0.05$ ) in eggs of birds fed 50% raw bambara groundnuts and 50% raw jack beans respectively. Moreover, the haugh units of eggs of birds fed 25% raw jack beans, 25% bambara groundnuts and 25% raw benne seeds were low, but statistically ( $p>0.05$ ) similar to one another.

Table 2: Proximate composition of raw jack beans, bambara groundnut and benne seeds

	Raw jack beans (%)	Raw bambara groundnut (%)	Raw benne seeds (%)
Dry matter	96.0	97.7	98.1
Crude protein	27.7	20.3	25.2
Crude fibre	9.5	3.2	4.0
Ether extract	2.5	6.7	52.8
Ash	3.5	3.5	5.3
Nitrogen free extract	52.8	64.0	10.8

RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Table 3: Anti-nutrients of raw jack beans, bambara groundnut and benne seeds

	Raw jack beans	Raw bambara groundnut	Raw benne seeds
Haemagglutinin (Hu mg <sup>-1</sup> protein)	71.6	5.0	1.3
Trypsin inhibitor (Tiu mg <sup>-1</sup> protein)	41.4	9.4	-
Tannin (g/100 g Dm)	0.4	0.4	2.4
Phytate (g/100 g Dm)	0.7	0.3	5.2
Oxalate (g/100 g Dm)	0.4	0.2	2.3

RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds; Hu = Haemagglutinin units; Tiu = Trypsin inhibitor units

Table 4: Performance characteristics of exotic hens fed raw jack beans, bambara groundnut and benne seeds

	Control	25% RJB	50% RJB	25% RBG	50% RBG	25% RBS	50% RBS	Mean±SE
Feed intake (g/day)	125.7 <sup>b</sup>	122.3 <sup>c</sup>	120.8 <sup>c</sup>	122.4 <sup>c</sup>	122.8 <sup>c</sup>	127.3 <sup>b</sup>	130.2 <sup>a</sup>	±1.97
Egg Weight (g/day)	63.1 <sup>a</sup>	60.9 <sup>b</sup>	59.2 <sup>c</sup>	58.8 <sup>c</sup>	57.7 <sup>d</sup>	57.4 <sup>d</sup>	56.4 <sup>d</sup>	±0.94
Feed conversion Ratio	2.01 <sup>d</sup>	2.06 <sup>d</sup>	2.08 <sup>d</sup>	2.12 <sup>e</sup>	2.14 <sup>e</sup>	2.21 <sup>b</sup>	2.33 <sup>a</sup>	±0.08
Hen Day Production	71.3 <sup>a</sup>	61.2 <sup>c</sup>	58.1 <sup>c</sup>	66.8 <sup>b</sup>	59.9 <sup>c</sup>	59.7 <sup>c</sup>	59.6 <sup>c</sup>	±1.02

a, b, c, d, e, - Means with different superscript are significantly different ( $p<0.05$ ). RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Table 5: Physical characteristics of eggs of exotic hens fed raw jack beans, bambara groundnut and benne seeds

	Control	25% RJB	50% RJB	25% RBG	50% RBG	25% RBS	50% RBS	±SE
Yolk index	0.42 <sup>a</sup>	0.35 <sup>d</sup>	0.34 <sup>d</sup>	0.37 <sup>c</sup>	0.36 <sup>c</sup>	0.40 <sup>b</sup>	0.39 <sup>b</sup>	±0.04
Haugh unit	71.01 <sup>a</sup>	61.43 <sup>b</sup>	58.64 <sup>d</sup>	60.75 <sup>c</sup>	57.09 <sup>d</sup>	61.47 <sup>b</sup>	59.33 <sup>c</sup>	±1.76
Yolk weight as percentage of egg weight	30.53 <sup>a</sup>	25.23 <sup>c</sup>	24.61 <sup>c</sup>	26.92 <sup>b</sup>	27.25 <sup>b</sup>	27.80 <sup>b</sup>	26.60 <sup>b</sup>	±0.57
Albumen weight as percentage of egg weight	59.36 <sup>d</sup>	64.43 <sup>a</sup>	64.08 <sup>a</sup>	61.70 <sup>c</sup>	61.00 <sup>d</sup>	62.20 <sup>c</sup>	63.35 <sup>b</sup>	±1.35
Shell weight as percentage of egg weight	10.11	10.34	11.31	11.38	11.75	10.00	10.05	±0.53

a, b, c, d, e, - Means with different superscript are significantly different (p<0.05). RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Table 6: Chemical characteristics of eggs of exotic hens fed raw jack beans, bambara groundnut and benne seeds

	Control	25% RJB	50% RJB	25% RBG	50% RBG	25% RBS	50% RBS	±SE
Whole egg protein (g dl <sup>-1</sup> )	12.02	11.87	11.81	12.01	11.98	11.96	11.87	±0.14
Yolk protein (g dl <sup>-1</sup> )	16.70 <sup>a</sup>	16.21 <sup>b</sup>	15.46 <sup>c</sup>	16.41 <sup>b</sup>	16.18 <sup>b</sup>	16.21 <sup>b</sup>	16.03 <sup>b</sup>	±0.26
Albumen protein (g dl <sup>-1</sup> )	11.67 <sup>a</sup>	10.32 <sup>c</sup>	10.02 <sup>c</sup>	11.23 <sup>b</sup>	11.13 <sup>b</sup>	11.36 <sup>b</sup>	11.21 <sup>b</sup>	±0.15
Whole egg fat (g dl <sup>-1</sup> )	11.50 <sup>a</sup>	10.78 <sup>c</sup>	10.67 <sup>c</sup>	11.24 <sup>b</sup>	11.04 <sup>b</sup>	10.82 <sup>b</sup>	10.26 <sup>c</sup>	±0.18
Yolk fat (g dl <sup>-1</sup> )	33.01 <sup>a</sup>	32.06 <sup>b</sup>	30.32 <sup>d</sup>	32.14 <sup>b</sup>	31.13 <sup>c</sup>	32.49 <sup>b</sup>	31.04 <sup>c</sup>	±0.52
Albumen fat (g dl <sup>-1</sup> )	0.33	0.30	0.29	0.31	0.30	0.32	0.30	±0.04

a, b, c, d - Means with different superscript are significantly different (p<0.05). RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Table 7: Regression analysis of response indices of adult cockerels fed raw jack beans, bambara groundnut and benne seeds

Anti-nutrients	Response Indices	Prediction equation	r	SE. b	S. L
TI	FI	122.3-0.02 X	-0.47	0.091	x
	EW	60.2-0.002 X	-0.34	0.074	ns
	YI	0.36-0.0008 X	-0.45	0.006	x
	HU	58.69-0.003X	-0.32	0.035	ns
	YP	16.01-0.005X	-0.48	0.002	x
Hg	FI	123.1-0.04 X	-0.53	0.085	x
	EW	59.57-0.02 X	-0.47	0.069	x
	YI	0.37-0.0003X	-0.54	0.008	x
	HU	59.02-0.006X	-0.52	0.042	x
	YP	16.04-0.001X	-0.48	0.003	x
Tannin	FI	127.1-0.01 X	-0.32	0.088	x
	EW	58.24-0.02 X	-0.55	0.093	x
	YI	0.36-0.02X	-0.22	0.008	ns
	HU	60.12-0.03X	-0.68	0.047	x
	YP	16.11-0.004X	-0.23	0.002	ns
Phytate	FI	126.7-0.2 X	-0.34	0.073	ns
	EW	59.02-0.01 X	-0.48	0.059	x
	YI	0.37-0.009X	-0.33	0.005	ns
	HU	58.97-0.02X	-0.48	0.038	x
	YP	16.03-0.008X	-0.39	0.004	ns
Oxalate	FI	128.2-0.4 X	-0.32	0.101	ns
	EW	57.01-0.02 X	-0.68	0.073	x
	YI	0.35-0.02X	-0.46	0.006	x
	HU	60.09-0.04X	-0.51	0.042	x
	YP	16.02-0.004X	-0.35	0.007	ns

X = Anti-nutrients; SE. b = Standard error of b; S.L = Significance of linearity; r = coefficient of linearity; x = Significant (p<0.05); ns = Non -significant (p > 0.05) FI = Feed intake; EW = Egg weight; YI = Yolk index; HU = Haugh unit; YP = Yolk protein; TI = Trypsin inhibitor; Hg = Haemagglutinin

The yolk weight as percentage of egg (YWPEW) differs significantly (p<0.05) between the groups. Conspicuous (p<0.05) reduction was obtained in the YWPEW of group fed 50% raw jack beans. Significant (p<0.05) elevation was however obtained in the YWPEW of group fed 25% raw benne seeds over all other groups. The Albumen Weight as Percentage of Egg Weight (AWPEW) was significantly (p<0.05) elevated in groups red 25 and 50% raw jack beans than that of control group. All other groups gave lower amounts of AWPEW respectively. Marginal differences (p>0.05) were also obtained in the shell weight as percentage of egg weight across the groups.

Results on biochemical composition of the eggs are shown in Table 6. Significant (p<0.05) reductions in both yolk protein and albumen protein were obtained across the groups, but more pronounced in eggs of birds fed 50% raw jack beans. The whole egg protein was however statistically similar (p>0.05) among the eggs of all the groups.

The fat contents of the whole eggs and the yolk were more significantly (p<0.05) reduced in eggs of birds fed 50% raw benne seeds, 50% raw jack beans and 50% bambara groundnuts respectively. The fat contents of the albumen across the groups were significantly (p>0.05) not different.

Linear regression analysis between some of the response indices and the anti-nutrients are shown in

Table 7. Significant ( $p < 0.05$ ) correlations were obtained between feed intake and haemagglutinin ( $r = -0.53$ ), trypsin inhibitor ( $r = -0.47$ ); egg weight and oxalate ( $r = -0.68$ ), phytate ( $r = -0.48$ ); yolk index and haemagglutinin ( $r = -0.54$ ), trypsin inhibitor ( $r = -0.45$ ) and oxalate ( $r = -0.46$ ); haugh unit and tannin ( $r = -0.68$ ), oxalate ( $r = -0.51$ ); yolk protein and haemagglutinin ( $r = -0.51$ ), trypsin inhibitor ( $r = -0.48$ ).

## DISCUSSION

This study investigated the effects of the anti-nutrients in raw jack beans, bambara groundnuts and benne seeds on egg laying performance and egg quality of exotic hens. The crude protein, ash, fiber, fat and carbohydrates contents agree with the findings of Apata [16] on the proximate composition of some tropical grain legumes.

Considerable variations were obtained in the concentrations of anti-nutrients between raw jack bean, bambara groundnuts and benne seeds. These values are however consistent with those reported by Grant *et al.*, [17], Ologhobo [18] and Udedibie and Carlini [19].

Feed intake was more reduced in birds fed with raw jack bean based-diets respectively. The effect of combined actions of canavanine and haemagglutinin in the raw jack beans on feed intake of the birds is suspected this reduction.

According to D'Mello, [20], dietary canavanine inhibits the synthesis of nitric oxide in non-ruminants which regulates feed intake. Pusztai *et al.*, [21] also reported that inclusion of pure lectin in a diet containing 5% casein depressed the feed intake of birds.

Reduction in egg weight was more pronounced in eggs of birds fed with raw benne seed-based diets respectively. This observation supports the earlier work of Mamputu and Buhr [22]. The high oxalate and phytate contents in the raw benne seed-based diets are suspected here to have contributed to the reduction in egg weight. This is because these two anti-nutrients have the tendency to bind dietary calcium and phosphorus [16], thereby making them unavailable in sufficient quantities for egg formation [17]. It is also much likely for these anti-nutrients in the raw benne seeds to have formed complexes with the dietary protein. This will surely reduce the metabolism of the dietary protein [16] and subsequently have an adverse effect on formation of the eggs [13]. The significant correlations between the egg weight and oxalate and phytate in this study support these observations.

Higher feed conversion ratios were obtained in birds fed raw benne seed-based diets. This is indicative of the poor quality of the feed in view of the higher feed intake and corresponding lower egg weight of the birds.

The high reduction in hen-day production of birds fed 50% raw benne seeds agrees with the findings of Mamputu and Buhr [22]. The authors reported decrease in hen-day production when diets rich in tannin, oxalate and phytate were fed to laying hens. Jacob *et al.*, [24] also reported reduction in hen-day production of laying birds fed with sorghum diet containing 2.2% tannin. In addition the reduced hen-day production in birds fed 50% raw jack beans could be attributed to the effect of canavanine contents at inhibiting the metabolism of the dietary protein needed for normal egg production. Since reduction in metabolized protein of has a great tendency to reduce egg production [25], the effect of canavanine content of raw jack bean at inhibiting transaminase activity in the liver, thereby reducing endogenous synthesis of creatine and providing conditions for canavanine-arginine antagonism and poor nitrogen utilization [26] would probably have negative effect on normal egg production.

The results of egg quality showed reduction in the values of yolk index and yolk weight as percentage of egg weight across the groups. This observation may be attributed to an interference with the normal secretion of hormones (follicle stimulating hormones, progesterone and luteinizing hormone) needed for yolk formation in the anterior pituitary gland [13] by the haemagglutinin contents of the raw legumes. According to Pusztai [21], dietary haemagglutinin inhibits hormonal secretion in the body. This is supported with the significant correlations between the yolk index and the haemagglutinin in this study.

The reductions in haugh units were more pronounced in birds fed 50% jack beans, 50% bambara groundnuts and 50% benne seeds respectively. Haugh unit measures the physical quality of the albumen [13]. A similar effect of the haemagglutinin contents in the diets on the androgen hormone needed for normal formation of albumen is also suspected to have contributed to the reductions obtained in their respective haugh units. Other factors likely to have contributed to the lower haugh units in this study are egg shrinkage and egg gaseous exchange. According to Oluyemi and Roberts [25], egg shrinkage involves evaporation of moisture from the albumen and yolk, while gaseous exchange involves liberation of calcium dioxide from the pores of an infertile egg. According to the authors, the more the pores in the

eggs, the more the shrinkage and gaseous exchange. It is therefore assumed in this study that the oxalate and phytate contents of 50% raw benne seeds might have inhibited the metabolism of calcium and phosphorus needed for formation of eggs with normal pores. This might have made more water to be lost from the albumen thereby reducing the haugh unit. Furthermore, the aemagglutinin content of the 50% raw jack beans and 50% bambara groundnuts might have impeded the formation of protein and mucopolysaccharide constituents of the organic matrix, thereby leading to formation of egg shells with more pores than necessary [13]. This is because haemagglutinin has been reported to cause precipitation of glycogen and starch from solutions and binding of glycoproteins and glycolipids of the digestive tract mucosa [27, 28]. The haemagglutinin contents of the diets might also have impeded the flow of blood carbon dioxide needed for formation of eggs with normal pores. According to Liener [29], haemagglutinin causes agglutination of the red blood cells and inhibition of the enzymes of brush borders of the erythrocytes.

The biochemical compositions of the eggs as revealed by the reductions in the yolk and albumen proteins could also be linked with the adverse effects of trypsin inhibitor, haemagglutinin and tannin contents of the diets on the metabolism of dietary protein. According to Pearson [30], the protein contents of yolk and albumen are synthesized from the metabolized protein. Liener and Kakade [5] reported that intake of trypsin inhibitor leads to endogenous secretion of some essential amino acids. D'Mello *et al.* [31] and Apata [16] also reported that haemagglutinin and tannin inhibit protein metabolism and hormones in rats and chickens. According to Harms *et al.* [32] reductions in yolk and albumen proteins are indicators of deficiencies or imbalances in the essential amino acids.

The reduction in fat contents of yolk and whole egg of birds fed 50% raw jack beans, 50% bambara groundnuts and 50% benne seeds could also be attributed to a likely inhibition of metabolism of dietary lipid needed for the normal formation of fats in eggs. According to Jaffe [27], haemagglutinin binds to glycolipids of the digestive tract mucosa thereby restricting the metabolism of dietary lipids. Tannin has also been reported to reduce digestibility of dietary lipids [33].

### CONCLUSIONS

The reductions obtained in the response indices of laying hens fed with raw jack beans, bambara groundnuts

and benne seeds in this study confirm the nutritional toxicity of the anti-nutrients in them as reported for most raw grain legumes by Ologhobo [34]. The inclusion of 50% raw jack beans, 50% bambara groundnuts and 50% benne seeds in diets of the exotic laying hens appeared to have led to higher reductions in the response indices.

Hence, the need for proper processing to detoxify these raw grain legumes before they can be properly utilized in diets of laying hens cannot be over emphasized. Although, they are potential sources of protein and energy, yet the toxic components in them would reduce their nutritive quality unless they are adequately removed.

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