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Evaluation of Feeding Different Levels of Red Haricot Bean Screening (*Phaseolus vulgaris.* L) on Fertility, Hatchability and Chicks Quality of White Leghorn Hens

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Abstract

In this paper we investigated the inclusion of different proportions of red haricot bean screening (RHBS) in white leghorn hens' rations for fertility, hatchability, embryonic mortality and one day old chick's quality. A total of 225 (195 hens + 30 cocks) at age of 30 weeks with initial body weight of 1104.7±16.35 gram were randomly distributed in to 15 replications each pens with 13 hens and 2 cocks. The replications were randomly allocated to five treatment diets in completely randomized design. The five treatment rations used in the present study were containing 0%, 20%, 40%, 60% and 80% of RHBS as protein source fo r T1, T2, T3, T4 and T5, respectively. Inclusion of red haricot bean screening has not significant effect (P>0.05) on fertility, hatch ability, embryonic mortality and chick quality parameters among treatments. Therefore, RHBS can be incorporated up to 80% in layers rations as protein source for fertility, hatchability, embryonic mortality and chick quality.

Keywords: Chick Quality, Fertility, Hatchability, Red Haricot Bean Screening

1. Introduction

Ethiopia is believed to have the largest livestock population in Africa. This livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country. Livestock also plays an important role in providing export commodities, such as live animals, hides, and skins to earn foreign exchanges to the country. The total poultry population at country level is estimated to be about 56.53million. In this report, poultry includes cocks, cockerels, pullets, laying hens, non-laying hens and chicks (CSA, 2017).

Poultry production is an area of animal agriculture where food production for human beings is relatively fast, initial investment is low and household labor can be used. Poultry production in Ethiopia is an important economic activity. In addition to its social and cultural benefits, it also plays a significant role in family nutrition (CSA, 2010).

Fertility is partly dependent on genetics and selection of the birds as inherent quality, but also dependent on management, environmental temperature and nutrition. A very important feature is the mating ratio. Hatchability does not depend simply on providing the correct environment in the incubator, but can be influenced by many management and biological factors including the strain and age of the bird, diet, season, bird health, egg handling procedures, egg size and shell quality (Sainsbury, 2000).

In Ethiopia, availability, quality and cost of feeds are the major constraints to commercial poultry production. The country is not self-sufficient in cereal grains which form the bulk of the concentrate feeds for poultry (Solomon, 1996). Under normal conditions, feed costs account for major cost of production and the proportion has been increasing because of the volatility of the feed market and stiff competition for feed resources between human and animal feed industries (Wilson and Beyer, 2000). The major ingredients for preparation of formula feed is still cereal grains, and this will continue in the future since they cannot be fully replaced by cheap feed sources such as agro- industrial byproducts (Shahbaz *et al*., 2005). Therefore, any attempt to improve commercial poultry production and increase its efficiency, needs to focus on efficient utilization of available feed resources and search for non-conventional feed sources (DZARC, 1997).

Haricot bean is one of the many varieties of common beans, non-conventional pulse as poultry feed and has a shape quite similar to that of a human kidney. It is relatively cheaper, locally available and excellent sources of vegetable protein, starch, soluble and insoluble fiber, vitamin (especially B-group), minerals, particularly potassium, iron, zinc, magnesium and manganese (Audu and Aremu, 2011). Erlinda and Ganzon (2014) also noted that kidney beans are rich in vitamins, minerals, folate and amino acids such as tryptophan, threonine, isoleucine, arginine, histidine and glycine. It is known by its high contents of protein, energy and amino acids content except for a lower level of methionine. Using red haricot bean and its screening is economical to fed chickens as protein source since it is relatively cheaper, locally available and good substitute for soybean and other expensive grains. Sisay *et al.* (2015) reported that processed kidney bean can fully substitute soybean meal in layers ration when price of soybean meal is high and it is not available. Hence, this study is intended to investigate feeding value and inclusion levels red haricot bean screening for White Leghorn layers. Therefore, current study aims to evaluate the effects of feeding different proportions of red haricot bean screening on fertility, hatchability, chick quality and embryonic mortality of white leghorn chickens.

2. Materials and Methods

2.1. Description of the study area

The experiment was conducted at Haramaya University poultry farm. The farm is located at 42^{o} 3' E longitude, 9° 26' N latitude and elevation of 1980 meter above sea level and 505 km East of Addis Ababa. The annual mean rainfall of the area amounts to 790 mm and the average minimum and maximum temperature are 8 and 24^{o}C, respectively.

2.2. Feed ingredients and experimental diets

Chemical composition of the feeds was predetermined for preparation of sound ration to meet nutritional requirement of the layers. The feed ingredients; red haricot bean screening (RHBS), soybean meal (SBM), maize grain, wheat short, noug seedcake, vitamin premix, salt and limestone were used for the experiment. Before formulation of rations RHBS seed was cleaned from dust and dirt materials and soaked in water at proportion of 5 litter water to 1kg RHBS for five hours then rinsed and poured in to boiled water (120^{o}C) at the same proportion then cooked for an hour. The cooked RHBS was rinsed and sun dried by spreading the grain on plastic for five consecutive days until it sufficiently dried (Emiola, 2007). RHBS, maize, and noug seedcake were hammer milled at feed mill of Haramaya University to pass through 5 mm sieve size and stored at feed mill house of the university until the rations were formulated.

The five layers rations were formulated on an iso-caloric and iso-nitrogenous basis in such a way to consist 2800 – 2900 kcal metabolizable energy (ME) per kg dry matter (DM) and 16 – 18% crude protein (NRC, 1994). The five rations represent the experimental treatments. The treatments contain different levels of RHBS at the rate of 0% (control), 20%, 40%, 60% and 80% as T_1, T_2, T_3, T_4 and T_5, respectively. Proportions of the ingredients used for formulation of the layer rations are presented in Table 1.

Table1.Proportion of ingredients (%) used in formulating the experimental rations

	Treatment				
Ingredients	T_1	T_2	T_3	T_4	T_5
SBM	9.6	9.6	8.2	8.4	8.4
RHBS	0	2.4	4.8	7.2	9.6
Wheat short	18.4	18.4	18	16	16
Maize	34	33	35	34	34
NSC	29	29	29.4	29	29
Limestone	7.7	7.7	7.7	7.7	7.7
Salt	0.5	0.5	0.5	0.5	0.5
VP	0.8	0.8	0.8	0.8	0.8
Total	100	100	100	100	100

SBM- Soybean meal, RHBS -Red Haricot Bean Screening, NSC- Noug seedcake, VP- Vitamin pre-mix

2.3. Experimental design and treatments

Completely randomized design (CRD) was employed with 5 treatments each having 3 replications. A total of 195 White leghorn hens and 30 cocks at age of 30 weeks were obtained from Haramaya University poultry farm. The birds were randomly distributed to each replicate making up 13 pullets and 2 cocks per replicate and a total of 45 birds per treatment (Table 2).

Table 2. Layout of the experiment

	Treatments	Replications	No of hens	No of cocks
T1:	0% RHBS	3	13	2
T2:	20% RHBS	3	13	2
T3:	40% RHBS	3	13	2
T4:	60% RHBS	3	13	2
T5:	80% RHBS	3	13	2

RHBS- Red Haricot Bean Screening, No- number

2.4. Management of experimental chickens

The experimental pens, feeding and watering troughs and laying nests were thoroughly cleaned, disinfected and sprayed against external parasites two days before introduction of experimental chickens. The birds allowed to adapt the experimental diets for 7 days before actual data collection and fed *adlibitum* in group. The birds were kept on deep litter housing system covered with dried grass straw of about 10 cm depth. All health precautions and disease control measures were carefully followed throughout the study period. Vitamins (Aminovit, 1g per 5 litters) were given with drinking water according to the manufacturer's recommendation. Oxytetracycline powder 20% was also given with drinking water (0.5 g per 1 Litter) for 5-7 days to increase resistance of birds to disease and to recover the animals from stress of moving at time importation to the experimental house. Footbath was thoroughly cleaned and a new disinfectant added daily.

2.5. Laboratory analysis

Representative samples were taken from each of the feed ingredients used in the experiment and analysed before formulating the actual treatment rations. Samples of treatment rations were taken to determine chemical composition. According to Weender or proximate analysis method (AOAC, 1990) chemical analysis of experimental feeds were carried out for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash in animal nutrition laboratory of Haramaya University.

Nitrogen (N) content was determined by Kjeldahl procedure and crude protein was calculated as Nx6.25. The calcium and phosphorus content was d etermined by atomic absorption spectrophotometer an d colorimetrically, respectively in Haramaya Universit y centeral laboratory. Metabolizable energy (ME) of the experimental diets was determined by indirect method according to the formula given by Wiseman (1987) as follow.

$$\text{ME (Kcal/kg DM)} = 3951 + 54.4\,\text{EE} - 88.7\,\text{CF} - 40.8\,\text{Ash}$$

2.6. Data collection and evaluation parameters

Dry matter intake

A weighed amount of feed was offered twice daily at 8:30 am in the morning and 4:00 pm in afternoon. Orts were collected the next morning and weighed after removing external contaminants by visual inspection. For each replicate, the feed offered and refusal were recorded. Feed intake was determined as a difference between the quantity of feed offered and refused. Mean daily dry matter intake of individual pen was calculated by the following formula.

$$\text{Mean daily dry matter intake} = \frac{\text{total feed offered} - \text{total leftover}}{\text{Duration of experment} \times \text{No. of birds}}$$

Body weight change

The birds were weighed individually per replicate on the first day after being randomly assigned to individual pens to record the initial body weight. Final body weight was also taken in a similar way at the end of the experiment. Body weight change per birds was computed by calculating difference between the final and initial body weight. Data of weight of each replicates was used for analyses.

$$\text{Body weight gain/day/bird} = \frac{\text{Final body weight} - \text{Initial body weight}}{\text{Duration of the experment}}$$

Fertility and hatchability

A total of 300 eggs (60 eggs from each treatment and 20 from each replicates) were used for fertility and hatchability test after half way in the experiment period. Medium sized eggs were selected by visual inspection and incubated. The temperature of the setter and hatchery unit was set at 37.7^{o}C and 36.9^{o}C, respectively. The relative humidity was set at 60% for the first 18 days and 75% in the hatchery unit. In the setter, eggs were kept in a tray with small end down and were turns tilting the trays at 45^{o} by automatically operating turner of the incubator at two hours interval. Spot candling system was used to determine the fertile and infertile eggs at the 7th day of incubation. Eggs that appeared relatively unclear were considered fertile, while those that appeared clear were considered non-fertile. Eggs with living embryo were transferred to the hatching section of the incubator at the end of the 18th day. Hatched chicks counted and chick quality was determined. Finally fertility and hatchability calculated by using the following formulae.

$$\text{Fertility(\%)} = \frac{\text{Total fertile eggs}}{\text{Total eggs set}} \times 100$$

$$\text{Hatchability(\%) (on fertile egg basis)} = \frac{\text{Number of chicks hatched}}{\text{Number of fertile eggs}} \times 100$$

$$\text{Hatchability(\%) (on total egg basis} = \frac{\text{Number of chicks hatched}}{\text{Total eggs set}} \times 100$$

Embryonic mortality

Embryonic mortality was determined by spot candling eggs at 7th, 14th and 18th days of incubation and at hatching to record early, mid, late and piped mortality. According to Butcher (2009), the stages of development of embryos' were classified as early, mid, late and piped and these morphological development stages were used to determine the time of embryonic mortality. Embryonic mortality was computed according to the formulae given by Rashed (2004).

$$\text{Percentage of Early Mortality} = \frac{\text{Total number of early dead embryo}}{\text{Total number of fertile eggs}} \times 100$$

$$\text{Percentage of Mid Mortality} = \frac{\text{Total number of mid dead embryo}}{\text{Total number of fertile eggs}} \times 100$$

$$\text{Percentage of Late Mortality} = \frac{\text{Total number of late dead embryo}}{\text{Total number of fertile eggs}} \times 100$$

$$\text{Percentage of Pip Mortality} = \frac{\text{Total number of pip dead embryo}}{\text{Total number of fertile eggs}} \times 100$$

Chick quality

Five one day old chicks were randomly selected from each replicate for the chick quality assessment. The assessment was done using three different methods, visual scoring, measuring day old chicks' and by measuring weight and length of the sample chicks. Visual scoring of chicks was made by classifying chicks in to good and poor quality by visual examination. According to North (1984), those chicks that are not malformed, not dehydrated, physically active, stand up well and look lively was classified under good quality and those chicks that not fit the criteria's were categorized as poor quality.

Visual observation was made by the researcher and two technicians, and quality was decided with common decision of the three observers based on quality standards of North (1984). The body weight of the chicks was measured in grams (g) immediately after hatching using a sensitive balance. Chick length was taken by measuring the length of stretched chick from the tip of the beak to the middle toe using a cm ruler and recorded in centimeters (cm). Percentage of quality chicks of visual score was calculated by using the following formula.

$$\%\text{ quality chicks of visual score} = \frac{\text{Total number of quality chicks}}{\text{Total number of hatched chicks}} \times 100$$

2.7. Statistical Analysis and Models

The data collected during the study period was subjected to statistical analysis using SAS computer software SAS (2008) version 9.2. During data analysis, namely dry matter intake, body weight changes, chicks weight and chicks length were analyzed following one way analysis of variance procedure (ANOVA). Least significance differences method was used to locate the treatment means that are significantly different Gomez (1984).

The model used for statistical analysis;

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where; Yij =the j observation taken under i treatment

μ =over all mean

Ti =i treatment effect

eij =error term

General logistic regression analysis was employed for analysis of data recorded on fertility (fertile/infertile), hatchability (hatched/un-hatched), embryonic mortality (alive/dead), and visual scoring (good/poor). The general logistic regression model used is given below:

$$Model: \ln\frac{\pi}{1-\pi} = \beta 0 + \beta 1 * (x)$$

Where, π=probability,

β=slope,

x=treatment

Test H0: No treatment effect (*i.e.*, β1=0) vs. HA: Significant treatment effect (β1≠ 0).

Results and Discussion

3.1. Chemical composition of feeds

Chemical composition of feed ingredients used in the current study and five formulated experimental rations are shown in Table 3 and 4.From the analysis result, it was seen that RHBS is good in protein content that could make the bean to be protein source and good potential in the layers ration. The crude protein content of cooked RHBS obtained from the present study is higher than that reported by Qayyum *et al*. (2012), Audu and Aremu (2011), and Emola *et al.* (2007) which were 20.09%, 23.6% and 26.8%, respectively but close to the result of Taju *et al*. (2015), 28%.

Table 3. Chemical composition of feed ingredients used in the experimental rations

Feed ingredients	DM	CP	CF	EE	Ash	ME Kcal/kg
SBM	93.68	40	5.52	10.67	6.00	3797
RHBS	90.42	29.01	5.7	0.83	5.23	3276
Maize	89.07	8.58	2.85	5.22	4.8	3786
NSC	90.93	29.6	14.73	8.20	8.90	2727
WS	88.87	14.4	7.18	3.97	4.42	3350

DM = dry matter; CP = crude protein; EE = ether extract; CF = crude fiber; ME = metabolizable energy; SBM = soybean meal; RHBS = Red Haricot Bean screening; NSC = noug seedcake; WS = wheat short

The CP content of the five treatment rations varied between 17.56% to 18.30% (Table 4), which was within the range of CP requirement (14-19%) and (16-18%) suggested by Leeson and Summer (2001) and Tadelle (1997) for layers, respectively.

Table 4. Chemical composition of treatment diets

Chemical compositions	Treatments				
	T_1	T_2	T_3	T_4	T_5
DM%	91.27	91.1	91.37	92.3	92.4
EE%	5.97	5.73	5.59	5.36	5.75
CF%	7.52	6.95	7.06	7.17	9.2
Ash%	9.88	8.70	9.10	9.6	9.6
Ca%	3.12	3.2	3.05	3.0	2.96
P%	0.69	0.65	0.57	0.55	0.50
CP%	18.3	18.1	18.08	17.78	17.56
ME(Kcal/kg)	3205.64	3291.3	3257.6	3214.9	3056.08

DM = dry matter; CP = crude protein; EE = ether extract; CF = crude fiber; P = phosphorous; Ca = calcium; ME = metabolizable energy

3.2. Dry matter intake and body weight change

Dry matter intake (DMI) and performance of layers are shown in Table 5. There was significant difference (P<0.05) in average daily dry matter intake between the treatments. Relatively the least DMI intake was recorded in T5 (89.71%) but not significantly different to T1, T3 and T4; this may be due to comparatively higher crude fiber content of the diet (9.2%), which is almost closed to the maximum limit (10% crude fiber) for chicken. Xiohe (2010) noted that white leghorn chickens fed on ration consisting above 10% CF in the diet cannot maintain the required metabolic energy, intake and consequently growth of the chickens is reduced.

The overall mean DMI in the current study was 91.67 ± 0.75, which is in agreement with the value (90.6± 1.72) reported by Sisay *et al.*, (2014) for the same breed of birds. The result is contradict to the finding of Ofongo and Ologhobo (2007) who noted that inclusion of cooked kidney beans in the diets of broiler chicks caused a significant (P<0.01) increase in feed intake.

There was no significant difference in initial body wei ght (1104.7± 16.35), final body weight (1212.95 ±19.67) and body weight gain per birds in the present experiment (Table 5). The present study is agreed with result of Sisay *et al*. (2014) who reported as there is no significant difference in daily body weight gain among treatment diets containing different level of processed kidney bean for replacement of soybean meal.

Table 5. Dry matter intake, body weight gain and egg laying performance of white leghorn hens fed ration consisting different levels RHBS

	Treatment						
Parameters	T1	T2	T3	T4	T5	SEM	SL
DMI/bird/day	92.5^{ab}	95.03^{a}	91.03^{b}	90.09^{b}	89.71^{b}	0.75	*
IBW(g/bird)	1110.26	1082.05	1104.61	1113.72	1112.8	16.35	NS
FBW(g/bird	1240.78	1203.71	1219.74	1209.3	1191.22	19.67	NS
BWC(g/bird)	130.52	121.66	115.13	95.58	78.42	15.42	NS
BWG(g/bird/day)	1.45	1.35	1.28	1.06	0.87	0.17	NS

[ab] Means within a row with different superscripts differ (P < 0.05); DMI = dry matter intake; IBW =initial body weight; FBW = final body weight; BWC = body weight change; BWG = body weight gain; SEM = standard error of mean; SL= significant level, NS= not significant, * = significant different.

3.3. Fertility and Hatchability

Mean values for fertility and hatchability of the treatments are presented in Table 6. The logistic regression results for fertility and hatchability of eggs showed no significant difference (*Pr>chi-Sq* 0.5903 and 0.4058 at α = 0.05) with *Wald chi-Square* values of 2.809 and 4.001, respectively. Fertility and hatchability slightly decreased with increasing level of RHBS in the diets, but difference between treatments were not significant. The numerical decrease in fertility and hatchability from T1 to T5 could be the result of increased in level of RHBS in the rations that caused reduction of amino acids content specially methionine in the diets.

Hatchability on total eggs and fertile eggs base in the current study (84.19% and 85.89%, respectively)is less than percentage reported by Getnet (2003);93.3% and 97.1% for total egg set and fertile egg basis, respectively for the same breed of the layers under intensive management.

Table 6. Fertility and hatchabilityobtained from birds fed on rations containing different levels of RHBS

	Treatments						
Parameters	T1	T2	T3	T4	T5	SEM	SL
Fertility (%)	90. 61	92.88	87.44	86.88	84.22	1.13	NS
HTEB (%)	86.57	88.99	84.04	83.33	78.02	2.86	NS
HFEB (%)	89.78	9o.08	85.31	83.77	80.54	2.78	NS
EM (%)	3.62	3.73	6.71	8.64	9.38	1.78	NS
MM (%)	1.54	1.52	2.29	2.37	4.11	0.88	NS
LM (%)	3.6	2.72	3.93	3.97	6.16	0.99	NS
PM (%)	2.65	2.44	2.72	3	3.33	0.64	NS

HTEB = hatchability total eggs based; HFEB = hatchability fertile eggs based; SEM = standard error mean, SL= significant level; NS = not significant

3.4. Embryonic Mortality

Early, mid, late and pip embryonic mortality is presented in Table 7 below. In logistic regression, *Wald chi-Square* statistics indicated that early, mid, late and pipembryonic mortality were not significantly different at α= 0.05 level of significance with a *Wald chi-Square* values of 1.3209, 1.1645, 1.136 and 1.120 and *Pr>chi-Sq* value of 0.8578, 0.8839,0.8885l and 0.95l, respectively. Higher embryonic mortality was recorded in early and late stage of incubation. The result is in line with report of Christensen (2001), who found that more embryos die in the first and third trimesters. Higher mortality in early and late embryonic development stages might be due to inability to resume the incubation environment and abnormal positioning of embryo in the stages, respectively.

Table 7. Embryonic mortality of birds fed on rations containing different levels of RHBS

	Treatments						
Parameters	T1	T2	T3	T4	T5	SEM	SL
EM (%)	3.62	3.73	6.71	8.64	9.38	1.78	NS
MM (%)	1.54	1.52	2.29	2.37	4.11	0.88	NS
LM (%)	3.6	2.72	3.93	3.97	6.16	0.99	NS
PM (%)	2.65	2.44	2.72	3	3.33	0.64	NS

EM = early mortality; MM = mid mortality; LM = late mortality; PM = pip mortality; SEM = standard error mean, SL= significant level; NS = not significant

3.5. Chick Quality Measurements

The result of this study revealed that inclusion of RHBS at different levels in the layers ration has no significant impact (P>0.05) on chick quality (Table 8). The logistic regression result for visual score showed no significant difference with *Wald chi-Square* value of 1.06and *Pr>chiSq* value of 0.9006 thus, the difference among the treatments was not significant.

Chick weight and length was not statistically (P>0.05) different among treatment diets. As documented by Wilson (1991) egg weight has a direct impact on the weight of chick and a positive correlation between egg and chick weight exists. Sahin *et al*. (2009) also reported variation in chick weight depending on the weight of eggs incubated. Positive association of egg weight with hatching chick weight was also reported by Farooq *et al*. (2001b).Eggs weight in the current experiment was not significantly different and differences in chicks' weight were not expected. Therefore, the absence of difference in chick weight among the treatments could be due to similar size of the eggs incubated.

Petek *et al*. (2009) classified chicks' length intervals in to short, middle and long for a day old chicks. The authors, category layer chick with a length of < 17.8, 17.8-18.2 and > 18.2cm, are grouped as short, medium and long chicks, respectively. According to this classification, chick lengths in the present experiment for all treatments fall within a short category.

Table 8. Effects of feeding different levels of RHBS on chick quality measurements

	Treatments						
Parameters	T1	T2	T3	T4	T5	SEM	SL
Chick weight	33.2	32.1	30.9	31.9	30.2	0.08	NS
Chick length	16	16.2	15.7	15.8	15.7	0.70	NS
Visual score	87.95	88.95	85.95	87.15	84.26	1.36	NS

SEM = standard error mean SL = significant level; NS = no significant

4. Conclusion and Recommendations

Red haricot bean is good source vegetable protein, energy, vitamin and minerals and it is relatively cheaper, locally available than others protein sources. Fertility, hatchability, embryonic mortality and chick quality among treatments diets that contain different levels of RHBS were not statistically affected. Therefore, according to the present result, it can be decided that addition of RHBS up to 80% as protein source in layers ration found to be economically feasible. Hence, based upon the above facts the following tips of points are recommended:-

- Awareness creation is mandatory for those farmers who are engaged in poultry sector about good nutritive values, local availability and cheaper purchasing cost of RHBS for chickens feeding.
- RHBS contains anti-nutritional factors (ANFs) that are hardly digested by chicken; to eliminate or reduce the composition of ANFs the farmers ought to be taught for methods solving the problems.

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