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Evaluation of Feeding Different Levels of Red Haricot Bean Screening (Phaseolus Vulgaris.L) on Egg Production and Quality Parameters of White Leghorn Hens

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Abstract
The study was conducted to evaluate effects of feeding different levels of red haricot bean screening (RHBS) on dry matter intake, body weight gain, egg production, egg quality and feed conversion ratio of white leghorn chicken. A total of 225 (195 hens + 30 cocks) at age of 30 weeks with initial body weight of1104.7±16.35 gram were randomly distributed in to 15 pens each with 13 hens and 2 cocks. The pens were randomly allocated to five treatment diets in completely randomized design. The five treatment diets used in the present study were containing 0%, 20%, 40%, 60% and 80% of RHBS for T1, T2, T3, T4 and T5, respectively. Crude protein and metabolizable energy content of RHBS was 29.01% and 3276Kcal/Kg. Dry matter intake (92.5, 95.03, 91.03, 90.09 and 89.7 for T1, T2, T3, T4 and T5, respectively, was significantly ($P<0.05$) different which is high in T2 and low in T5. Hen day egg production (51.82, 54.67, 48.25, 46.7 and 41.45 and hen house egg production (50.45, 54.67, 48.25, 45.49 and 41.45 for T1, T2, T3, T4 and T5, respectively were significantly ($P<0.05$) different which was high T2 and low in T5. feed conversion ratio 3.51, 3.48, 3.71, 3.83 and 4.37 and egg mass 26.35, 27.28, 24.53, 23.47 and 20.49 for T1, T2, T3, T4, and T5, respectively were statistically ($P<0.05$) different among the treatments. There was no significant difference ($P>0.05$) among treatments on average daily body weight gain per bird, egg weight, shell weight, shell thickness, albumen quality, yolk weight, yolk diameter, yolk height. Yolk color and index were significantly ($P<0.05$) different which were high in T5 and low in T1. Therefore, increasing proportions of RHBS above 50% in the layer ration improve yellowness and index of egg yolk, but affect feed conversion ratio, egg mass and egg production negatively.
Keywords; Diet, Egg Production, Haricot Bean Screening

1. Introduction

Poultry includes domestic fowl, Turkey, Duck, Goose, and Ostrich which render economic service to man (Solomon, 2004). Of which chicken are the most important poultry species in most countries. Chickens are kept in many parts of the world irrespective of climate, traditions, life standard, and there is no much religious taboo related to consumption of eggs and their meat like those for pig meat (Daghir, 2001). Poultry production has an important economic, social and cultural benefit and plays a significant role in family nutrition in the developing countries (Delgado *et al.,* 1999).

Poultry has short generation interval, high reproductive rate and higher efficiency of nutrient transformation into high quality animal protein and an interesting tool to respond rapidly to poverty gaps if included in rural development strategies. In addition, poultry meat is the most palatable and easily digestible animal meat and contains essential amino acids required for human beings, and eggs are richly endowed with important nutrients (Lahkotia, 2002).

Chicken rearing system of Ethiopia is characterized by extensive scavenging management, no immunization programs, increased risk of exposure of birds to disease and predators, and reproduction entirely based on uncontrolled natural mating and hatching of eggs using broody hens, where there is no or minimum intervention to maximize their production and reproductive performance (Bushara, 2012). Most of the chicken are owned and managed by smallholder farmers. Due to these factors supply of meat and eggs from the sector is lower than the need of steadily growing urban population and not matched with population of chickens in the country.

In Ethiopia feed and nutrition is the most critical constraints to chicken production under both the rural smallholder and large-scale production systems especially in commercial chicken production (Demeke, 2004; Mazengia *et al*., 2012 and Dessie *et al*., 2013). The cost of chicken feed is very high and it accounts about 60-70% of the production cost (Wilson and Beyer, 2000). Lack of feed processing facilities, inconsistent availability, distribution and substandard quality of processed feeds are other problems in the sector. This calls not only for better utilization of already known conventional feed resources but also for the identification and introduction of new and less-costly grains and agro-industrial by products (Bandyopadhyay and Ahuja, 1992). Commercial chicken production is primarily dependent on soybean meal as main protein source for practical diet formulation. However, soybean production in the country is small and the price of soybean grain and meal is extremely high. Thus it demands search for alternative protein sources that locally and cheaply available. Grain legumes could be good substitute for soybean meal, as they are known to have similar amino acid profile (Wiryawan, 1997). Hence, this study intended to investigate feeding value and cost efficiency of feeding red haricot bean screening for white leghorn layers. Therefore, this study is designed with the following objectives:

- To evaluate the effect of different levels of red haricot bean screening inclusion in white leghorn layers ration on egg production and quality
- To assess the effect of different levels of red haricot bean screening inclusion in body weight gain, feed intake and feed conversion efficiency of white leghorn hens

2. Material and Methods

2.1. Description of the study area

The experiment was conducted at Haramaya University poultry farm. The farm is located at 42° 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°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°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 determined by atomic absorption spectrophotometer and colorimetrically, respectively in Haramaya University 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
2.6.1. 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.

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

2.6.2. 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.

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

2.6.3. Egg production

Eggs were collected three times (8.30 am, 2 pm and 4 pm) per day from each pen on to egg tray that can hold 30 eggs. The sum of the three collections was recorded as egg production for that day. Rate of lay for each replicate was expressed as the average percentage hen-day and hen-housed egg production by the method of Hunton (1995)

$$\text{Hen day egg production} = \frac{\text{Number of eggs collected per day}}{\text{No of hens present that day}} \times 100$$

$$\text{Hen housed egg production} = \frac{\text{Sum of daily egg counts}}{\text{No of hens orginally housed} \times \text{No. of days}} \times 100$$

2.6.4. Egg weight and egg mass

Eggs collected daily were weighed immediately for each replication, and the average egg weight was computed by dividing the total egg weight to the total number of eggs. After mean weight determined, egg mass per pen was calculate on daily bases (North, 1984).

$$\text{EM} = \text{P} \times \text{W}.$$

Where; EM = Egg Mass; P =percentage of hen day egg production and W = average egg weight

2.6.5. Feed conversion ratio (FCR)

Feed conversion ratio was determined per replicate as ratio of the weight of daily feed consumed to egg mass

$$\text{FCR} = \frac{\text{Daily feed consumed (g)}}{\text{Egg mass}}$$

2.6.6. Egg quality parameters

The internal egg quality was determined through break out analysis method. Freshly laid 3 eggs per replicate were randomly selected and the quality parameters were measured once in a week for seven consecutive experimental weeks. For internal egg quality measurements, eggs were broken on flat glass. After breaking eggs, data on quality parameters such as egg shell thickness, shell weight, albumen weight, albumen height, Haugh unit, yolk weight, yolk diameter, yolk height, and color was recorded. Yolk index was calculated as ratio of yolk height to yolk diameter. Egg shell weight, albumen weight and yolk weight was weighed by using sensitive balance. Immediately after breaking the eggs albumen and yolk height was measured by a tripod micrometer. Roche color fan measurement strip was used to compare yolk color by taking sample yolk on a piece of white paper and diameter was measured by using ruler. Egg shell thickness was measured using micrometer gauge. The samples were taken from three sites of the egg shell; the top (pointed part), bottom (round part) and the middle part of the egg shell. Finally, the average of the three sites was taken as egg shell thickness.

The Haugh unit was calculated using the following formula (Haugh, 1937).

$$\text{Haugh unit (HU)} = 100\log\left[H - \sqrt{G}\left(\frac{30W^{0.37}-100}{100}\right) + 1.9\right]$$

Where, HU = Haugh unit, G = Gravitational Constant, H = Average albumin Height (mm),
W = Average weight of Egg (g)

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, egg production, egg mass, feed conversion ratio, egg weight, shell weight, albumen weight, yolk weight, yolk height, albumen height, yolk diameter, yolk index, Haugh unit, shell thickness, chick weight and 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;

$$Yij = \mu + Ti + eij$$

Where; Yij =the j observation taken under i treatment, μ =over all mean, Ti =treatment effect eij =error term

General logistic regression analysis was employed for analysis of data recorded on yolk color (1/2/3/4/5/6/7/8/9/10). The general logistic regression model used is given below:

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

Where, π=probability, β=slope, x=treatment

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

3. Result 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 weight (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

Parameters	Treatment						
	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
HDEP (%)	51.82^{ab}	54.67^{a}	48.25^{b}	46.7^{c}	41.46^{d}	0.87	*
HHEP (%)	50.45^{ab}	54.67^{a}	48.25^{b}	45.89^{c}	41.46^{d}	0.91	*
Egg weight(g)	50.853	50.81	50.85	50.26	49.45	0.89	NS
EM(g/hen/day)	26.35^{a}	27.28^{a}	24.53^{ab}	23.47^{b}	20.49^{c}	0.60	*
FCR(feed/egg)g	3.51^{bc}	3.48^{c}	3.71^{bc}	3.83^{b}	4.37^{a}	0.13	*

$^{a\text{-}d}$ 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; FCR=feed conversion ratio; HDEP = hen–day egg production; HHEP = hen-housed egg production; EM = egg mass; SEM = standard error of mean; SL= significant level, NS= not significant, * = significant different.

3.3. Egg Production

Hen-day egg production (HDEP) and hen-housed egg production (HHEP) of White leghorn hens consumed rations containing different levels of RHBS is presented in Table 5 and Figure 1 and 2. Total number of eggs produced, HDEP, HHEP and EM were significantly higher (P < 0.05) for T1 and T2 than T3, T4 and T5 (Table 5). The overall mean HDEP (48.58 ± 0.87) and HHEP (48.14±0.91) in the present experiment is extremely lower than the mean 92.4% and 73% HDEP and HHEP, respectively reported for the same breed of birds by Moorthy *et al*. (2009). These differences might be due to system of management at early growth stage, quality of feeds offered, breed purity level, strain differences of birds and climatic condition differences.

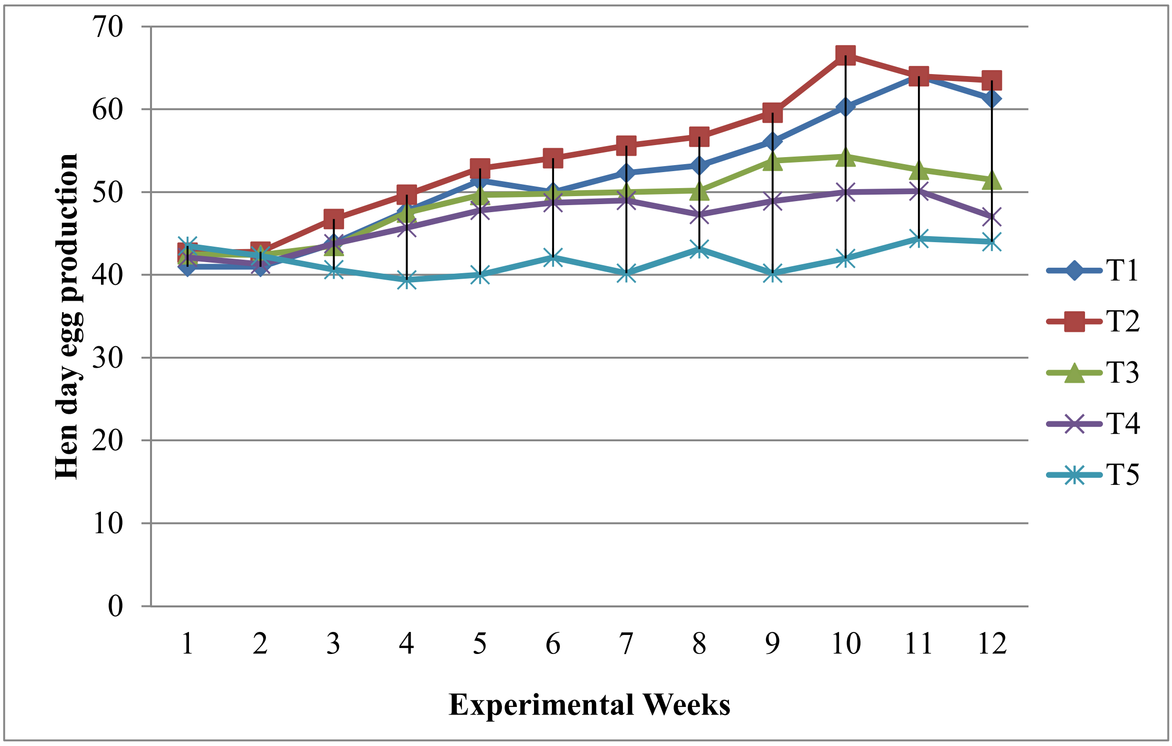

Figure 1. Weekly average hen-day egg production of white leghorn layers fed on diets consisting different levels of RHBS

The total eggs produced by the hens fed on diet which contain 80% RHBS was significantly (P<0.05) lower as compared to the layers fed T1 (0%), T2 (20%), T3 (40%) and T4 (60%) of RHBS in the diets. Hen-day and hen-housed egg production were fluctuated over the experimental weeks, particularly in T5, but better result was recorded in advanced experimental weeks especially after week 4 in all treatments other than T5 (figure 1 and 2).

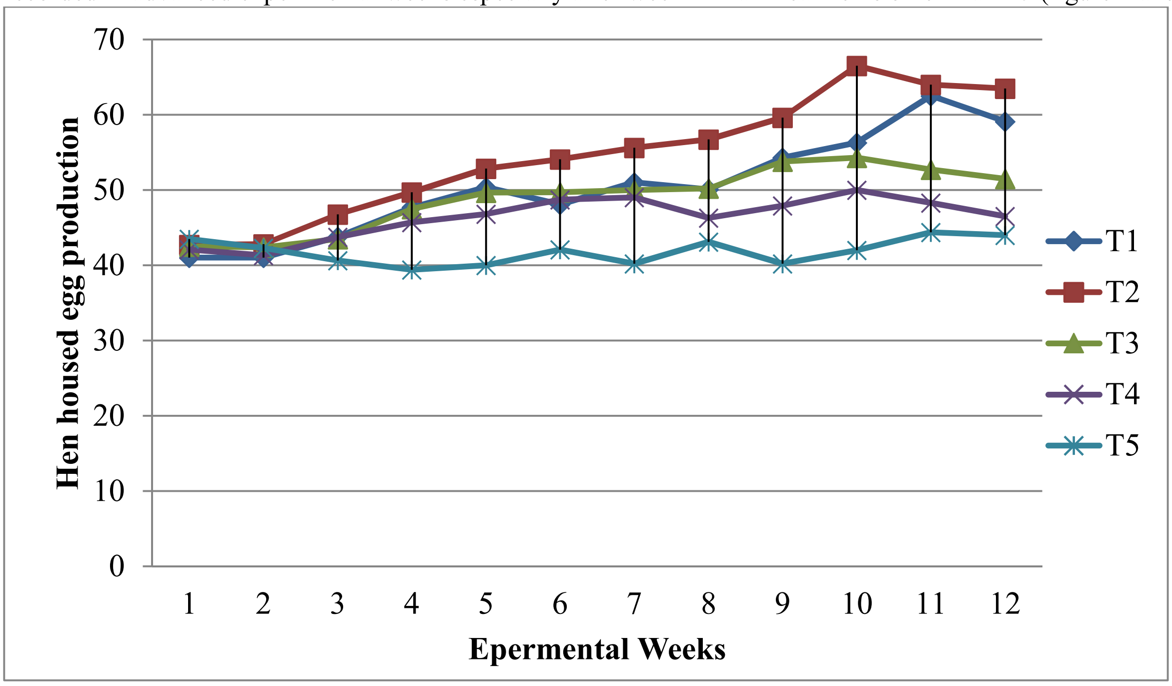

Figure 2. Weekly average hen-housed egg production of white leghorn layers fed on diets consisting different levels of RHBS

3.4. Feed conversion ratio

The effect of inclusion of varying levels of RHBS in the layers ration on feed conversion ratio is expressed in feed consumed per egg mass presented in Table 5. Feed conversion ratio (FCR) of layers in the current experiment was significantly different (P<0.05) with sequence of T2 < T4 < T5. Lower FCR was recorded in T5 than the other treatments; this could be because of low dry matter intake in T5. The result is disagreed with the finding of Emola *et al*. (2007) who noted that feed conversion efficiency was superior in birds fed the control diet compared with those fed diets containing processed kidney bean meal diets. Egg production in T5 is lower than other treatments, this is also in line with finding of Hirnik *et al*. (1977) who reported that variation in feed conversion efficiency is highly dependent on the number of eggs produced (by about 51%) followed by feed consumption (31%) and egg weight (18%). Egg production (HDEP and HHEP) and dry matter intake between treatments was significantly different and variation in feed conversion ratio was expected.

3.5. Egg weight and egg mass
There was no significant (P>0.05) difference in egg weight among the treatments diets. Egg mass was significantly (P< 0.05) different in the present study (Table 5). Birds in T5 had significantly lower egg mass than birds that were receiving 0%, 20%, 40% and 60% of RHBS in the diets. Fakhraei *et al*. (2010) noted that egg mass follow the same trend as egg production. The same trend has been seen in the present study because both egg production and egg mass decreased with increasing percentage of RHBS in the diets. The overall mean egg weight (50.44 ± 0.89) and egg mass (26.7 ± 0.60) in the present experiment is lower than the mean egg weight (54.3 ± 0.1) reported by Solomon (1998) and egg mass (40.5 ± 0.1) reported by Sabri *et al*. (1999) for the same breed of birds at commercial management. But comparable egg weight (50 ± 1.46) and egg mass (28 ± 0.92) was reported by Senayt (2011) for the same strain of birds.

3.6. Egg Quality Parameters
3.6.1. Egg shell weight and thickness

Egg shell weight and thickness was not significantly different (P > 0.05) among treatments (Table 6). Proportional composition of shell weight in current study is 10.94% of egg weight. The result is agreed with finding of Etches (1996) who reported ranges for standard proportional composition of shell weight which is 9-14% of egg weight.

Table 6. Egg quality parameters of white leghorn hens fed ration containing different levels of RHBS

Parameters	Treatments T1	T2	T3	T4	T5	SEM	SL
Egg weight(g)	50.85	50.83	50.78	50.26	49.45	0.89	NS
Shell weight (g)	5.59	5.52	5.67	5.28	5.53	0.06	NS
Shell thickness (µm)	0.31	0.32	0.32	0.29	0.32	0.001	NS
Albumen height (mm)	8.4	8.6	8.8	8.7	8.5	0.09	NS
Albumen weight (g)	28.3	28.2	27.9	27.8	27.0	0.98	NS
Yolk height (mm)	15.03	14.96	14.93	15.50	15.23	0.05	NS
Yolk weight(g)	15.0	14.5	14.8	15.1	14.3	0.34	NS
Yolk index (%)	39.2^{b}	40.1^{ab}	40.5^{ab}	41^{a}	41.3^{a}	0.02	*
Yolk color	3.61^{b}	3.68^{b}	4.15^{ab}	4.28^{ab}	4.71^{a}	0.16	*
Yolk diameter(cm)	3.82	3.8	3.68	3.75	3.49	0.004	NS
Haugh unit (%)	93.39	94.89	95.87	95.52	94.77	0.19	NS

^{abc} Means within a row with different superscripts differ (P < 0.05); SEM = standard error mean; SL significant level; NS= not significant; * = significant different; g = gram; µm = micro meter; mm = millimeter; cm = centimeter; % = percentage

3.6.2. Albumen weight, albumen height and Haugh unit

There was no significant (P>0.05) difference in albumen weight, height and Haugh unit (HU) among the treatments (Table 6). As documented by William (1992), albumen quality is not greatly influenced by bird nutrition, and the decline in Haugh units is mostly related to age of the hens and egg storage conditions. Haugh unit (HU) is a measure of albumen quality. Difference in Haugh units was not expected hence eggs broken from all replications were fresh and age of the layers were uniform (7 months). Having no difference in albumen weight was consistent with similarity in egg weight among the treatments since albumen is 60% of egg weight, which is in line with that demonstrated by Suk and Park (2001) who noted that albumen weight is positively associated with egg weight.

3.6.3. Yolk weight, height, diameter and index

Yolk weight, height, diameter and index are presented in Table 6. There was no significant (P>0.05) difference in yolk weight, yolk height, and diameter among treatments. Difference in yolk weight was not expected because no differences in egg weight were observed among treatments because they are positively associated (Suk and Park, 2001). Yolk index was significantly (P<0.05) different among eggs produced from hens consumed diets containing different levels of RHBS. Yolk index is a measure of the standing-up quality of the yolk. In the present experiment better standing up quality of yolk was noted with increasing inclusions level of RHBS. Yolk index value of the present result ranged 0.393 - 0.413, which is within the accepted range of 0.33 – 0.50 for fresh eggs (Ihekoronye and Ngoddy, 1985).

3.6.4. Yolk color
The yolk color is presented in Table 6 and 7. Logistic regression result for yolk color showed remarkable difference (Pr>chisq<0.001 at $\alpha = 0.05$) with Wald chiSq value of 20.64 among the treatments. Yellow color intensity was increased at higher level of RHBS inclusion. Williams *et al*. (2009) noted that yolk color drives from the deposition of xanthophylls (carotenoid pigments). Increasing of yolk coloration with increasing inclusion level of RHBS in the diets showed that RHBS has high carotenoid content. The current result is in line with finding of Sisay *et al*. (2015) who noted that yellow color intensity of yolk is increased with increasing processed kidney bean in the diets. The odd ratio value of T1 versus T5 shows that T1 has 1.625 times the odds of receiving a lower score than T5 and the others follows the same trend.

The Roche color fan reading recorded during the experiment ranges from 1 (pale yellow) to 10, with majority of the eggs having 3 and 4 values on the yolk color point (Table 7). The Roche color fan number of 7 to 8 is appreciated by consumers in most areas (Leeson and Summers, 1997); 7 and 8 is most frequently repeated in T4 and T5 in which proportion of RHBS is 60% and 80%, respectively. The result of the present study showed that higher level of RHBS gave yolk color closer to the accepted range as compared to control group (T1).

4. Conclusion and recommendations
The nutritional composition of RHBS was good compared to previous reports particularly for crude protein. Therefore, RHBS can be good source of protein with relatively least cost as compared to other protein sources in layer ration. This study showed that body weight gain, egg weight and egg quality are not statistically affected. Egg production, egg mass, feed conversion ratio and dry matter intake was negatively affect at higher than 50% inclusion levels, but yolk color and yolk index was improved with increasing inclusion level of the bean screening. According to the present study, it can be concluded that inclusion of RHBS up to 50% found to be economically feasible feeding strategy in layers. Therefore, the following points are recommended

- ✓ Commercial and smallholder chicken farmers should be taught as RHBS is non-conventional, cheap and locally available protein source for chickens than other grains such as soybean.
- ✓ The bean consists anti-nutritional factors that cannot be digested by chicken; to eradicate or to minimize composition of the factors from the bean farmers should be trained for methods soaking and cooking before feeding.
- ✓ Further investigation is required to evaluate the inclusion level of RHBS in layers and broilers ration.

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