World Applied Sciences Journal 32 (9): 1918-1926, 2014
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2014.32.09.890

Effects of Replacing Soybean Meal with Processed Kidney Bean Meal *(Phaseolus vulgaris)* on Egg Production of White Leghorn Hens

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Abstract: A study was conducted to evaluate the effects of replacing processed kidney bean meal (PKBM) for soybean meal (SBM) on profitability, feed intake, body weight gain and egg production of white leghorn (WL) chicken. A total of 225 (165 layers and 30 cocks) with uniform body weight (BW) and age were randomly distributed in to 15 pens and assigned to five treatments. Treatments were SBM substitution by PKBM at 0, 25, 50, 75 and 100% levels for T1, T2, T3, T4 and T5, respectively. The CP and ME content of treatment rations ranged 16.05 - 17.23% and 2867.49- 2868.53 kcal/ kg DM, respectively. Replacing SBM with PKBM did not affect dry matter intake, average weight gain, egg production and feed conversion efficiency. Feed cost decreased with increasing level of PKBM in the ration because of the lower purchasing price of raw kidney bean. Thus, it can be concluded that 100% (at a rate of 100g/kg concentrate diet) of PKBM as a substitution for SBM in the diet of layers did not affect egg production but egg was produced economically in groups in which PKBM replaced SBM.

Key words: Profitability · Feed intake · Kidney bean · Soybean Meal · Conversion efficiency

INTRODUCTION

The production characteristics of modern laying hens vary according to breed, environmental factors and incidence of disease [1]. Egg production can be affected by such factors as feed consumption (quality and quantity), water intake, intensity and duration of light received parasite infestation, disease, numerous management and environmental factors [2]. When pullets begin laying, there is an increase in protein, vitamin and mineral requirements per day due to deposition in the egg. If dietary protein is too low or the amino acid requirements are not met, poor egg production and hatchability will occur [3].

Stocking rate in terms of birds/m^2 of the shed has been reported to affect the production performance of the chicken. [4] reported that the optimal bird density resulted in higher egg production at lower cost, egg production, livability, egg size and egg quality was deteriorated when the birds were given less than required cage or floor space. Optimal space per birds in multi-deck cage could also result in poor performance when ample ventilation is not there. For this reason, birds per unit area should be well arranged. 8-16 birds/m^2 is recommended by [5]. Heat stress interferes with the birds comfort and suppresses productive efficiency. During period of heat stress, the hens have to make major thermoregulatory adaptation to prevent death from exhaustion and the result is that the full genetic potential of the layer is often not achieved [6].

Ethiopia has the largest livestock population and diversity in Africa [7]. The livestock sector accounts for 19% of national GDP and as much as 40% of agricultural GDP. It supports up to 70% of the livelihoods of Ethiopian people [8]. Though the number of livestock in Ethiopia is high, the productivity and availability of animal products like meat and milk for human consumption is below the standards [9]. One of the constraints for low levels of livestock productivity is nutrition both in terms of quantity and quality [10].

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Poultry production of the country is mainly traditional. Most of the chicken are owned and managed by small holder farmers. The supply of poultry meat and eggs from this sector is lower than the need of the steadily growing urban population [11]. The total national annual poultry meat and eggs production is estimated at 53,493 and 36,624 tons, respectively [12].

One serious problem of poultry production in Ethiopia is availability of feed since cereal grains are often difficult to obtain for poultry feeding, as they form the staple diet of the people. As a result, the country experiences serious shortage of conventional poultry feeds. Thus, production is quite low as the chickens are undernourished for a significant part of the year [13].

Hence, there is a tendency to search for alternative less costly feeds. 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 [14]. Therefore, the search for alternative protein source feeds has become urgent and, in this context, processed kidney bean is worthy of consideration since it is produced locally and relatively low cost ingredient compared to major protein sources. Kidney bean contains high amounts of protein and energy and amino acids content is similar to that of soybean except for a lower level of methionine [15]. It is also a rich source of vitamin, minerals and relatively high in crude fiber [16].

As [17] and [18] stated, raw kidney bean (*Phaseolus vulgaris*) inclusion in the diets has a detrimental effect on the performance of chickens. This is attributed to the presence of various biologically active compounds. According to [18], kidney beans contain trypsin inhibitors, amylase inhibitors, haemagglutinins, tannin, phytic acid and oxalates. These anti-nutritional factors negatively affect the nutritive value of the bean through direct and indirect reactions. Thus, processing is a must to minimize these factors.

The processed kidney bean (PKB) is valuable source of crude protein. As [19] reported, PKB was evaluated for use in the compounding of poultry rations and the result showed that PKB improved weight gain, feed consumption, feed efficiency, digestive organs size and digestibility of nutrients (protein and amino acids).

In Ethiopia where soybean and its meal are in short supply and very expensive, the use of soybean meal as protein source of poultry ration is limited. Thus, an alternative protein source should be assessed and used. Therefore, the present research was initiated with the objective of evaluating the profitability of substituting soybean meal with different levels of processed kidney bean meal and its effect on production.

MATERIALS AND METHODS

Management of Experimental Chicken: The experimental house has 15 experimental pens partitioned with a wire mesh, each having a 2.5*2 m dimension. It was cleaned and disinfected (with a cavlon i.e., 10 ml in 1 litter H_2O) very well before the commencement of the experiment. Similarly watering and feeding troughs and laying nests were thoroughly cleaned, disinfected and sprayed against external parasites and the floor of each pen was covered with teff straw of 10 cm depth.

The birds were vaccinated against Newcastle disease, salmonelosis and coccidiosis at the farm. The birds were adapted to the experimental diets and experimental procedures for 7 days before the actual data collection was started. Feed was measured and provided to the birds in group twice a day at 0800 and 1700 hours *ad libitum*. The birds were weighed individually at the beginning and at the end of the experiment using sensitive balance. The feeding and watering troughs were cleaned every morning before feeding. Feed refusals were collected, weighed and recorded every morning. Feed was offered in hanging tubular feeders, which was suspended approximately at a height that birds can reach. Water was available all the time and the experiment lasted for 90 days.

Ingredients and Experimental Rations: The feed ingredients used in formulation of the different experimental rations of the study were processed kidney been, maize grain, wheat short, soybean meal, noug seed cake, vitamin premix, limestone and salt. The kidney bean, maize grain and noug seed cake were coarsely ground before formulating the treatment rations. The five layer rations were formulated on an iso-caloric and iso-nitrogenous basis in such a way to consist about 2800-2900 KCal/ME per kg DM and 16-17% CP to meet the requirements of layers. The treatments consisted of 0% (T_1), 25% (T_2), 50% (T_3), 75% (T_4) and 100% (T_5) processed kidney bean as a substitute for soybean meal as protein source.

The kidney bean seed was cleaned from dust and dirt materials soaked in water at a proportion of 5 liter H_2O to 1 kg bean for five hours, rinsed and poured into boiled

Table 1: Proportion of ingredients (percentage of total ration) used in formulating the experimental rations

	Treatment diets				
Ingredients (%)	T_1	T_2	T_3	T_4	T_5
Maize grain	38	38	38	38	38
Wheat short	18	18	18	18	18
Soybean meal	10	7.5	5	2.5	0
Kidney bean	0	2.5	5	7.5	10
Noug seed cake	25	25	25	25	25
Limestone	7.8	7.8	7.8	7.8	7.8
Vitamin premix	0.7	0.7	0.7	0.7	0.7
Salt	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100

PKBM = processed kidney bean meal; T1= ration containing 0% PKBM; 100% SBM (control); T2= ration containing 25% of SBM substituted by PKBM; T3= ration containing 50% of SBM substituted by PKBM; T4= ration containing 75% of SBM substituted by PKBM; T5= ration containing 100% SBM substituted by PKBM.

Table 2: Layout of the experiment

Treatments*	Replication	No.of layers/replication	No.of cockerels/replication
T_1 100% SBM + 0% PKB	3	13	2
T_2 75% SBM + 25% PKB	3	13	2
$T_3$50%SBM + 50% PKM	3	13	2
T_4 25%SBM + 75% PKB	3	13	2
T_5 0% SBM + 100% PKB	3	13	2

*SBM=soybean meal; PKB=processed kidney bean; 100% SBM represent the amount of SBM in 1 Kg and layers ration

water (100°C) at the same proportion and heated for 1 hour. The cooked kidney bean was rinsed and sun dried by spreading the grain on a canvas until it was sufficiently dry to ground [20].

Experimental Design and Treatments: The experiment was conducted in a completely randomized design with 5 dietary treatments each with three replications. A total of 195 white leghorn pullets and 30 cockerels both were 7 months of old were obtained from Haramaya University poultry farm.

Measurements and Observation

Dry Mater Intake: A weighed amount of feed was offered twice a day (0800 and 1700 hours) at the same time to the layers in each pen on *ad libitum* basis and orts were collected before offering the next morning meal and weighed after removing external contaminants by visual inspection. For each replicate, the feed offered and refused were recorded and multiplied by respective dry mater (DM) content. The amount of DM consumed was determined as the difference between the feed offered and refused on DM basis. The difference between feed offered and refused was divided by the number of birds to calculate the mean daily DM intake of each bird.

Body Weight Measurement: The experimental birds were weighed individually at the beginning of the experiment by using sensitive balance and then randomly assigned to individual pen/replicate. The final body weight was also taken in a similar manner at the end of the experiment and recorded. Body weight change per pen per bird was determined as the difference between the final and initial body weight. Average daily body weight gain or loss per bird for each pen was computed by dividing the body weight change to the number of experimental days. Average body weights of each replicate were used for data analysis.

Feed Conversion Efficiency: Feed conversion efficiency was determined per replicate by calculating the unit of egg weight collected daily per weight of feed DM consumed according to the following formula.

$$FCE = \frac{Daily\,collected\,egg\,weight\,(g)}{Daily\,DM\ \,feed\,consumed\,(g)}$$

Egg Production: Eggs were collected three times at 0800, 1300 and 1700 hours from each pen and the sum of the three collections along with the number of birds alive and dead on each day were recorded and summarized at the end of the experimental period. Rate of lay for each treatment expressed as the average percentage hen-day and hen-housed egg production was computed by taking the average values from each replicate following the method of [21].

$$\%\text{Hen-day egg production} = \frac{\textit{Number of eggs collected per day}}{\textit{Number of hens present that day}} \times 100$$

$$\%\text{Hen-housed egg production} = \frac{\textit{Number of eggs collected per day}}{\textit{Number of hens housed at the start of the experiment}} \times 100$$

Partial Budget Analysis: To estimate the economic benefits of the replacement of processed kidney bean for soybean meal in white leghorn layer ration, the partial budget procedure developed by [22] was employed. To calculate feed cost (the ration) for each treatment, the cost of the feed ingredients used was registered at purchase and feed consumed by birds was multiplied by the cost of the ingredients. The price of the eggs on market (around the study area) at the period of the experiment was used and calculation was done according to [22]. Gross income (total return (TR)) was calculated as a total egg produced multiplied by price of egg during the experimental period. Net return (NR) or net income (NI) was calculated as TR-TVC, (total variable cost). The feed cost is considered as the only variable cost. Change in total variable cost (ÄTVC) was calculated as total feed cost of treatments containing kidney bean (the experimental ration) minus total feed cost of treatments without kidney bean (control). The change in total return (ÄTR) was calculated as the difference between total incomes from the respective experimental treatments minus total income of the control. Change in net return (ÄNR) was calculated as net return of the respective experimental treatments minus net return of the control experiment. The marginal rate of return (MRR) measures increases in net return (ÄNR) associated with each additional units of expenditure (ÄTVC).

$$MRR = \frac{\Delta NI}{\Delta TVC} \times 100$$

Feed cost per dozen of eggs, egg sale to feed cost ratio and feed cost per egg mass were also calculated as an additional method of judging cost benefit of feeding kidney bean.

Statistical Analysis and Models: The data collected during the study period were subjected to statistical analysis using SAS computer software version 9.1.3. [23]. During data analysis, namely dry matter intake, body weight change, egg production and feed conversion ratio were analyzed following one way analysis of variance procedure. When the analysis of variance indicated the existence of significant difference between treatment means, list significant difference (LSD) method was used to locate the treatment means that were significantly different from the other [24].

The model used for statistical analysis was:

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

Where: Y_{ij}= Individual observation T_i = Treatment effect

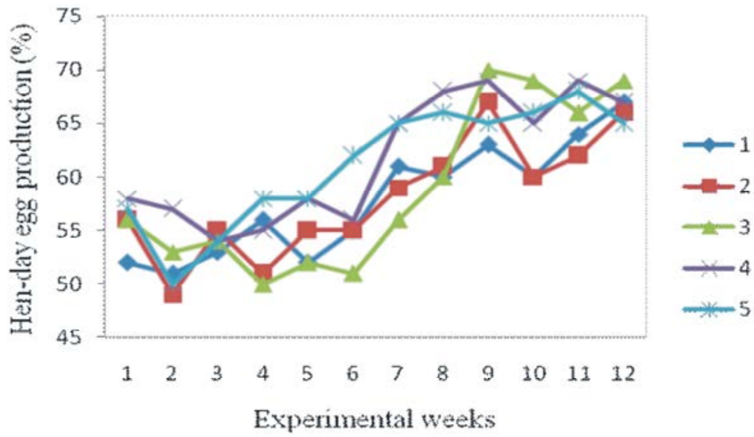
μ = Overall mean e_{ij}= Error term

RESULTS AND DISCUSSION

Dry Matter Intake: Dry matter (DM) intake and performance of layers is shown in Table 3. There was no significant difference (p>0.05) in average daily DM intake of birds among the different treatments, which appears to be consistent with the similar amount of ME, CP and CF in the treatment rations. Feed intake and M.E of diet are inversely related and laying hens had the ability to regulate feed intake according to dietary ME value [25], [26] and [27]. [28] also reported that an increase in CF content in the diet of poultry causes a reduction in digestibility of nutrients and therefore intake.

The finding of this study was in contrast with that of [29] who reported increased feed intake with inclusion of cooked kidney beans in the diets of broiler chicks since cooking tends to increase palatability. In the present study chicks fed diet containing heat-treated kidney bean as a replacement for soybean meal has consumed almost similar amount to that fed with the control diet. This indicates that heat-treated kidney beans can replace 100% of the protein supplied by soybean meal. [20] noted that heat treated kidney bean meal can replace 50% of the protein supplied by soybean meal of the ration. The overall mean DM intake in the current study was 90.39±1.72, which was in agreement with the 94.8 ±0.7 value reported by [30] for the same breed of birds.

Body Weight Change: The body weight parameters are presented in Table 3. There is no significant (p>0.05) differences in initial and final body weight among the treatments (Table 3). There is also no significant difference in daily body weight gain among treatments. This appears to be a consequence of similar intakes of



PKBM = processed kidney bean meal; SBM = soybean meal; T_1= ration containing 0% PKBM; 100% SBM (control); T_2= ration containing 25% of SBM substituted by PKBM; T_3= ration containing 50% of SBM substituted by PKBM; T_4= ration containing 75% of SBM substituted by PKBM; T_5= ration containing 100% SBM substituted by PKBM.

Fig 1: Average weekly hen-day egg production of white leghorn chicken fed different levels of processed kidney bean meal as a replacement for soybean meal

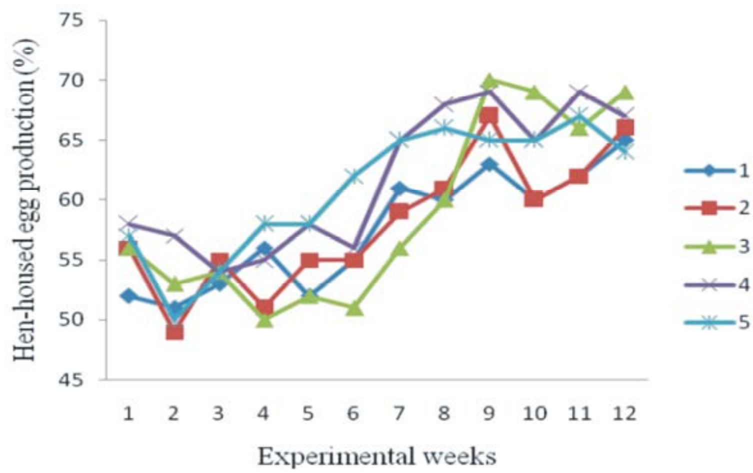


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Fig 2: Average weekly hen-housed egg production of white leghorn chicken fed different levels of processed kidney bean meal as a replacement for soybean meal

DM and nutrients among treatments. This also justifies the similar feeding value of PKBM and SBM to layers in terms of growth rate. The present experiment failed to agree with the finding of [19] who reported that feeding extruded kidney bean resulted in reduced body weight gain than the control diet in rat.

Egg Production: The effect of replacing soybean meal with processed kidney bean meal in layer's ration on hen-housed and hen-day egg production is presented in Table 3 and Figure 1 and Figure 2. The hen-day and hen-housed egg production were not affected by substitution of soybean meal with different levels of kidney bean meal ($p>0.05$). Hen-day and hen-housed egg production over the experimental weeks tend to fluctuate but appeared to increase with advance in experimental weeks (figure 1 and figure 2). The present experiment agrees with the result of [31] who noted that up to 50% replacement of soybean meal with field pea (*Pisum sativum L.*) had no significant effect on the hen-day egg production. [32] also reported

Table 3: Dry mater intake, body weight gain and egg laying performance of white leghorn layers fed rations containing different proportion of processed kidney bean as a replacement for soybean meal.

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
DMI (g/hen/day)	90.64	89.63	90.51	91.00	91.15	1.72
Initial BW (g/bird)	1005.73	977.87	959.33	1001.60	961.73	19.21
Final BW (g/bird)	1132.86	1091.13	1069.88	1082.11	1080.68	21.42
BW gain (g/bird)	127.20	113.26	110.55	100.25	118.94	26.26
BW gain (g/head/day)	0.16	0.14	0.14	0.12	0.15	0.034
Total no. of eggs/ hen	42.7	42.43	43.64	45.66	45.37	2.18
HDEP (%)	57.7	57.36	58.97	61.73	61.34	2.94
HHEP (%)	57.7	57.33	58.97	61.73	61.3	2.95
FCE (g egg/g feed)	0.26	0.26	0.27	0.27	0.27	0.013

SEM=standard error of mean; DMI=dry matter intake; g=gram, BW=body weight; HDEP=hen day egg production; HHEP=hen housed egg production; FCE=feed conversion efficiency; PKBM= processed kidney bean meal; SBM= soybean meal; T1= ration containing 0% PKBM; 100% SBM (control); T2= ration containing 25% of SBM substituted by PKBM; T3= ration containing 50% of SBM substituted by PKBM; T4= ration containing 75% of SBM substituted by PKBM; T5= ration containing 100% SBM substituted by PKBM.

Table 4: Economics of replacing soybean meal with processed kidney bean meal in layers ration

	Treatments				
Variable	T1	T2	T3	T4	T5
Total feed consumed (kg)	267.34	271.15	278.32	281.10	281.98
Total feed cost/ treatment (birr)	1730.75	1668.43	1633.3	1565.21	1485.88
Labor cost (for processing) (birr)	0.00	19.95	40.91	62.10	79.25
TVC (birr)	1730.75	1688.38	1674.21	1627.31	1565.13
Total egg produced	1409.00	1400.00	1440.00	1507.00	1497.00
Gross income (TR)(birr)	2818.00	2800.00	2880.00	3014.00	2994.00
Net income (NI) (birr)	1087.25	1111.62	1205.79	1386.69	1428.87
?TR (birr)	-	-18.00	62.00	196.00	176.00
?TVC (birr)	-	-42.37	-56.54	-103.44	-165.62
?NR (birr)	-	24.37	118.54	299.44	314.62
MRR (birr)	-	-57.52	-209.66	-289.48	-189.96
Dozens of egg	117.42	116.67	120.00	125.58	124.75
Feed cost/dozen egg (birr)	14.74	13.68	13.61	12.46	11.38

MRR: marginal rate of return; ÄTR = change in total return; ÄNR = change in net return; ÄTVC = change in total variable cost; kg = kilogram; PKBM = processed kidney bean meal; SBM = soybean meal; T1= ration containing 0% PKBM; 100% SBM (control); T2= ration containing 25% of SBM substituted by PKBM; T3= ration containing 50% of SBM substituted by PKBM; T4= ration containing 75% of SBM substituted by PKBM; T5= ration containing 100% SBM substituted by PKBM.

that Age at first egg lay, percent hen-day egg production, hen-housed production, average number of cracked eggs produced and mortality did not show significant differences among the layers fed the control or processed Pigeon Pea (*Cajanus cajan*) seed meal diets.

The overall mean HDEP (59.42±2.94%) and HHEP (59.41±2.95%) in the present experiment were similar with the mean for this breed in the same farm reported by [30] and [33], who recorded HDEP of 58.5±1.22% and 59.3±2.5 and HHEP of 58.0±1.21% and 56.6±2.9, respectively. Similarly [34] reported almost similar percent HHEP and HDEP (56±2.25) for White Leghorns obtained from the same flock of the birds used in the present experiment. However, [35] reported 92.4% and 73% HDEP and HHEP, respectively for White Leghorn layers. Such difference could be due to differences in strain and breed purity.

Feed Conversion Efficiency: The outcome of replacement of soybean meal by processed kidney bean meal in layers ration on feed conversion efficiency (FCR) is presented in Table 3. The feed conversion efficiency did not differ (p>0.05) among treatments. As [32] reported there were no differences (P>0. 05) among the layers fed on boiled, soaked Pigeon Pea (*Cajanus cajan*) seed meal and control diets in feed conversion efficiency, egg mass, age at first egg lay, age at 25 and 50% egg production, final live weight and mortality indicating that inclusion of processed food legume crop seed do not have detrimental effect on performance of layers. [36] noted that the variation in feed conversion efficiency is highly dependent on the number of eggs produced (by 51%) followed by feed consumption (31%) and egg weight (18%). Since the variation in egg production and feed consumption among treatments did not exist in this study, a difference in feed conversion efficiency is not expected.

Partial Budget Analysis: Effects of different level of substituting processed kidney bean meal for soybean meal on net return (NR) and marginal rate of return (MRR) is presented in Table 4. The result obtained from partial budget analysis indicated that NR increased with increasing dietary level of processed kidney bean meal in the ration of White Leghorn layers. The change in total variable cost is negative because feed cost in T1 was higher than T2, T3, T4 and T5. T5 has higher total return and superior egg sale to feed cost ratio and it has higher profit margin than all other treatments. Therefore, the replacement of soybean meal with processed kidney bean meal is profitable because of the similar egg production but lower cost of the kidney bean as compared to soybean meal.

CONCLUSION

A study was conducted to evaluate the effect of replacing soybean meal (SBM) by processed kidney bean meal (PKBM) on profitability, egg production, body weight gain (BWG), feed intake (FI) and feed conversion efficiency (FCE) of White Leghorn layers at Haramaya University poultry farm. A total of eight months old 195 layers and 30 cocks with uniform body weight (BW) previously fed commercial diets were used for the feeding trial on litter housing system. The experimental hens were randomly distributed into 15 pens which were distributed into five treatments. Treatments were T1 (0% of SBM substituted by PKBM), T2 (25% of SBM substituted by PKBM), T3 (50% of SBM substituted by PKBM + 50% SBM), T4 (75% of SBM substituted by PKBM) and T5 (100% of SBM substituted by PKBM) in a completely randomized design. The five treatment rations were formulated to be isocaloric and closely isonitrogenous to meet the nutrient requirements of layers 2868 kcal ME/kg DM and 16-17% CP). Feed and water was provided *ad libutum* to the experimental hens throughout the experimental periods. The experiment lasted for a period of 90 days including 7 days of adaptation to the diet, the pen and procedures. The data were analyzed using the SAS (2004, version, 9.0) computer software. The differences that existed between treatment means were tested by the use of the least significant difference. A measured amount of feed was offered to the birds and refusals were collected every morning and weighed. Bird's body weights were measured at the beginning and at the end of the experiment. During the experiment, feed intake, body weight gain, percentage of hen-day egg production and feed conversion efficiency were evaluated. Economic analysis was undertaken to evaluate the economic benefits of substituting soybean meal with different levels of PKBM on the parameters measured. The CP and ME content of the treatment rations ranged 16.05- 17.23% and 2867.49- 2868.53 kcal/ kg DM, respectively. The chemical analysis showed that PKBM contained 25.8 crude proteins and 3513.23 kcal ME/kg DM. Results showed that substitution of PKBM for SBM had no significant ($p>0.05$) effect among treatments in daily dry matter intake (90.64, 88.63, 90.51, 91 and 91.15 g/bird/day (SEM =1.72)) and mean body weight change (127.2, 113.26, 110.55, 100 and 118.94 g/bird (SEM = 26.26)) for T1, T2, T3, T4 and T5 respectively. Hen day egg production (57.7, 57.36, 58.97, 61.73 and 61.34 (SEM $=\pm 2.94$)) ($p>0.05$) and feed conversion efficiency (0.26, 0.26, 0.27, 0.27 and 0.27 (SEM =0.013)) ($p>0.05$) for T1, T2, T3, T4 and T5, respectively, were similar among treatments. The economic return in terms of partial budget analysis showed that higher level of substitution of PKBM (T5) returned higher profit. Profit on this study was in the order of T5 > T4 > T3 > T2 > T1, which is attributed to the low purchase cost of raw kidney bean as compared to soybean meal. We concluded that PKBM can fully substitute SBM in layers ration when price of SBM is high and it is not available. Since the highest soybean in the ration was only 100g/kg in the present study, substitution at higher level per kg should be evaluated in ordered to know the maximum level of kidney bean in layers ration.

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Appendix

Appendix table 1. Analysis of variance summary result for body weight, feed intake and egg production of white leghorn chicken fed diet containing different proportions of processed kidney bean as a substitute for soybean meal.

Source	DF	SST	MST	F-cal	Prob.	CV%
DMI(g/hen/day)	4	12.33	3.08	0.26	0.89	3.81
Initial body weight	4	4440.45	1110.11	0.75	0.57	3.92
Final body weight	4	7150.15	1787.53	0.97	0.46	3.92
Body weight change	4	1779.29	444.82	0.16	0.95	46.49
Daily Body weight gain	4	0.00	0.00	0.16	0.95	45.31
Total egg/bird	4	26.76	6.69	0.35	0.83	9.92
Hen-day egg production	4	49.16	12.29	0.35	0.83	9.91
Hen-housed egg production	4	49.23	12.30	0.35	0.83	9.94
Mortality	4	0.40	0.10	0.75	0.58	273.86
Egg weight	4	2.10	0.52	0.89	0.50	1.53
Egg mass	4	35.65	8.91	0.49	0.74	14.67
Feed conversion efficiency	4	0.00	0.00	0.08	0.98	10.37

DF= degree of freedom; SST= sum square of treatments; MST=mean square of treatment; F-cal= F-calculated; CV= coefficient of variance; %=percent; prob. =probability

Appendix table 2. Weekly average of HDEP of white leghorns during the experimental period (data used for figure 1)

	weeks											
Treatments	1	2	3	4	5	6	7	8	9	10	11	12
1	52	51	53	56	52	55	61	60	63	60	64	67
2	56	49	55	51	48	55	59	61	67	60	62	66
3	56	53	54	50	52	51	56	60	70	69	66	69
4	59	61	54	55	58	56	65	71	69	58	69	67
5	65	50	54	58	58	62	65	66	65	66	71	63

Appendix table 3. Weekly average of HHEP of white leghorns during the experimental period (data used for figure 2)

	weeks											
Treatments	1	2	3	4	5	6	7	8	9	10	11	12
1	52	51	53	56	52	55	61	60	63	60	62	65
2	56	49	55	51	48	55	59	61	67	60	62	66
3	56	53	54	50	52	51	56	60	70	69	66	69
4	59	61	54	55	58	56	65	71	69	58	69	67
5	65	50	54	58	58	62	65	66	65	65	68	61