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The Effect of Lentil-By Product on Growth Performance and Carcass Traits of Heavy White Turkeys

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ABSTRACT

The subject of this study was to figure out the effects of lentil by product (LP) on growth performance and carcass traits of the white heavy turkeys. To accomplish this goal, a total of 210 day old big-6 turkey chicks were used. The birds were divided into 7 seven groups with 3 replicates. The 1st, 2nd, 3rd, 4th, 5th, 6th and 7th groups received 0, 5, 10, 15, 20, 25 and 30 % lentil by product, respectively. All the diets were made as izonitrojenic and izocaloric. The highest live body weights of males and females were observed in the control group at the end of the 15th week, which was the time of slaughtering of females, however the differences between the control and the 2nd, 3rd and 4th groups were not significant ($p>0.05$). The same differences continued for males at the end of the 17th wk of age, which was the time of slaughtering of males. Similar results were observed in carcass traits, as well. The best FCR was noted in the control group and it was significantly ($p<0.05$) different than in the treatment groups. The lowest and highest feed intake was observed in the 7th and 3rd groups. No significant differences were observed between control and all treatment groups.

As a result, it could be said that lentil by product could be added into turkey diets up to 15% with no negative effect on live body weight and carcass traits because there was no significant differences between control and treatment groups (5, 10,15 % LP).

INTRODUCTION

Feed is the single greatest cost of poultry production. In poultry diet, corn and soybean meal are most widely fed energy and protein sources, respectively, in North America, Europe and Australia and soybean meal drastic increases in feed cost over the last decade have reduced profit margin of poultry production. Prices of corn and soybean meal more than doubled over the last 7 years (Woyengo *et al*. 2014). Soybean meal, which is traditionally the stable vegetable protein source for poultry feed in Turkey and other countries, is mainly imported and it is predicted that soybean will be scarce and expensive (Leeson & Summer, 1997). Therefore a need exists of alternative feedstuffs to reduce the cost of diet and to replace animal meal concentrate during the period of soybean shortage (Leeson & Summer, 1997; Robinson & Singh, 2001; Defang *et al*. 2008). One of the leguminous, lentils could be used in poultry diet. Lentils (*Lens culinaaris L*.) are relatively tolerant to drought and grow all over the world. Lentil seeds vary in color depending on the cultivar type. Red lentils are typically grown in Turkey. About 60 % of lentil production in the world is in Canada, India and Turkey (Wang & Daun, 2005; Bathy, 1995). It is well known that leguminous seeds are processed before it is used as human nutrition. During this processing, various byproducts are produced such as pea byproduct, lentil byproduct and sunflower meal.

Recently lentils are separated according to color by a special machine. After this processing, if lentils suffered from quality problems such as discoloration, frost damage, or seed damage (Çabuk *et al*. 2014), these by products become occasionally available to the animal feed industry. Nevertheless, these issues do not pose any problems when such lentils are fed to nonruminant animals like poultry and pigs of all ages (Mavromichalis, 2013). The nutritive value of lentil depends on the processing methods, presence or absence of antinutritional factors (Xu B & Chang SKC, 2010). Lentil seeds have relatively high protein energy content (27 %, 3570 kcal ME/kg) and low digestive inhibitors (Gorgulu, 2010). However, the major antinutritional factor in lentils is protease inhibitor, excessive content of polyphenols, especially tannins, but this is not present in sufficient quantities to depress animal performance (Mavromichalis, 2013). In a research (Tsopmo & Muir, 2010), high correlation between phenolic composition and antioxidant activities was present.

There is little information and research available on the use of lentil by product in poultry diets. Up to 30 % of row lentils have been used with success in pig diets (Mavromichalis, 2013). Significantly decrease in egg weights were observed in quails with 20 % lentil byproduct in diets (Çabuk *et al*. 2014). Similarly, more than 20 % lentil byproduct in quail diet had negative effect on quail performance (Kanat, 1992; Kanat & Camcı 1993). On the other hand, more than 5 % lentil byproduct had adverse effect on layer's egg production (Kılıçalp & Benli, 1994). Besides this, 15 % lentil byproduct in the diet of layers decreased body weight, egg yield, FCR, but it did not affect egg quality (Kanat, 1995; Yalcın *et al*. 1991).

As far as now we couldn't find any research about the effect of lentil byproduct on turkey growing performance. To figure out the effects of different levels of lentil byproduct on growth performance and carcass traits of Big-6 white heavy turkeys was the aim of this study.

MATERIALS AND METHODS

All pullets in this experiment were obtained from a commercial hatchery and vaccinated for Marek's disease, infectious bronchitis and Newcastle disease. A total of 210 big6 white heavy day-old pullets were wing banded and weighed, then divided into 7 groups (1 control and 6 treatments) with three replicates, 10 poults in each pen, randomly. The first group (control) did not have lentil byproduct (LP), the 2nd, 3rd,4th, 5th and 6th groups received 5, 10, 15, 20, 25 and 30 % LP. Pullets were reared in 21 floor pens (1.3x3 m) on wood shaving in an experimental unit with 23D;1L light regiment. The birds were raised in similar environmental conditions. Temperatures of the experimental unit was maintained at 35±1°C during the first week and gradually decreased to 21°C till 3 weeks of age. The birds were fed *ad libitum* and fresh water was provided throughout the experiment.

All diets were balanced with energy and protein and formulated to contain adequate nutrient levels as defined by the National Research Council (1995). The diet was based on corn and soybean meal and calculated based on nutrient level of feed stuffs. All the birds were fed by the feed containing 28 % crude protein and 2800 kcal kg^{-1} ME, 24 % crude protein and 2900 kcal kg^{-1} ME, 22 % crude protein and 3000 kcal kg^{-1} ME, 18 % crude protein and 3200 kcal kg^{-1} ME, for 0-4, 5-8, 9-12, 13-15, 16-17 weeks of age, respectively.

Birds and feed were weighed weekly and individually to determine weight gain, feed intake and feed efficiency. Female and male turkeys were slaughtered at 105 and 120 days of experiment, respectively, and processed at the slaughter-house. Feed was withdrawn for 10 h before slaughtering and the turkeys were weighed individually to get live weight at the plant. After bleeding, the animals were scalded in 50°C for 120 sec, feathers were picked with automated equipment and eviscerated by hand. Carcasses were pre-chilled at 12°C for 17 min and chilled 1°C for 60 min. After the chilling process, the carcasses were aged on ice for 5 h and separated for the parts. Carcass yield, breast, back, wings, legs (thighs and drumsticks) were recorded. Abdominal fat was removed and weighed.

The data were analyzed using the GLM procedure of a statistic packed program. Live weight, feed intake, feed conversion ratio and carcass characteristics were studied by analysis of variance including the effect of rearing conditions. When the F-test was significant, the least mean square was compared by using pdiff of SAS.

Table 1 – Nutrient content of lentil byproduct.

Ca, %	0,05
P , %	0,35
Dry Matter, %	90,1
Crude ash, %	5,8
Ether extract, %	1,4
Crude cellulose, %	8,8
Crude protein, %	18,72
Metabolisable energy, Kcal/kg	2100

RESULTS

The effects that derive from the incorporation of lentil byproduct (LP) in turkey diets on bird performance, carcass traits, feed intake and feed conversion ratio under an intensive production system remain largely unknown. Here an experiment was conducted to evaluate the importance of fattening performance carcass traits, feed intake and FCR of turkeys.

The effect of dietary LP on Body Weight in different age, carcass traits (CT), Feed intake (FI) and Feed conversion ratio (FCR) are given in Table 2, 3, 4 and 5, respectively.

Body weight (BW)

At the beginning of the experiment (day 0), there was no significant effect among the mean of treatments. The differences among the means of treatments were present at wk 1. The highest BW was observed in the 3rd and 4th groups, which received 10 and 15 % LP; the lowest one was in the 6th group, which received 25 % LP among males (M). The differences between the control and the 3rd and 4th groups were significant (p<0.05). However, the highest BW was observed in the 5th group and the lowest one was in the 7th group among the females (F), and the control and the 5th group were not different (p>0.05). In terms of BW, the differences between the control and the 4th group (the highest) were not significant (p>0.05) but it was between the control and the 6th and 7th groups, the lowest BW, among male+female (MF) mixed group. Similar differences were observed at the 5th week of age but it was not significant among M groups. The lowest BW was in the 5th and 6th groups, and differences between control and these groups were significant (p<0.05) among M an F at the 8th wk of age. These gaps were observed at the 12th week of age, as well.

At the end of the 15th week of experiment, the females were slaughtered and the average BW of females' differences between the control and groups 2, 3, 4, 6 were not significant (p>0.05), but it was (p<0.05) with other treatment groups. The lowest BW was observed in group 7, and the mean of BW was significantly different than the control. At this term, males were continued to be fed and bled at the end of the 17th wk of age. The control group had the heaviest BW, however, this differences were not significantly (p>0.05) higher than in groups 2, 3, 4, 6 and 7, except for group 5 (p<0.05). The highest BW was observed in the control group but differences were not significantly higher than in the treatment groups.

DISCUSSION

We want to highlight that this study is most probably the first one about lentil byproduct on turkey production. That's why it couldn't be discussed with turkey studies much. We tried to compare our results to other poultry breeds and leguminous seeds.

Body weight (BW)

The inclusion of LP in excess of 5 and 10 % didn't alter BW much. In the sight of these results, 10 and 15 % of LP could be included in the diet of female and male turkeys with no negative effect. Similar results were reported by Kanat, (1995) and Yalcın *et al*. (1991) for broiler. Besides, using more than 20% of LP in quail diets had negative effect on the birds' egg and BW performance (Kanat, 1992; Kanat & Camcı; 1993; Çabuk *et al*. 2014). Using boiled cowpea (14 %) and black common bean (14 %) to replace fish meal and meat meal, members of leguminous family like lentil, in broiler diet acquired lighter weight gains ((p<0.05) compared to the control group (Defang *et al*. 2008). The lighter BW in the present study agrees with the findings of Defang *et al*. (2008). Similar results were also reported by Amaefule & Osuagwu (2005) that including row Bambara groundnut up to 20 % into chicken starter and finisher diet to replace maize reduced BW gain. In a research in earlier time, Bambara groundnut didn't have positive effect on BW gain but made diet cheaper (Onwuke & Equakun, 1994).

If Table 2 is evaluated overall, it could be seen that inclusion of LP up to 15% into diet didn't alter CT of the M+F turkeys much. Besides, there were no significant differences among the groups in terms of eatable parts (liver, heart, gizzard and abdominal fat) of CT by adding LP up to 15 % into turkey diet. The highest dressing percentage (p>0.05), thigh, breast and wing weights were noted in the control group. No significant differences were observed between control and treatment groups with regard to dressing percentage, thigh, and breast and wing weights.

Carcass traits (CT)

The highest gizzard weight was observed in the control group but differences among the treatments were not significant. However, the weights of heart, liver and abdominal fat in treatment groups, up to 15 % of LP, were higher than in the control group, but not significant. It may be concluded with these results that the inclusion of LP up to 15 % in turkey diets may not have adverse effect on carcass features. In contrast to the results of the present study was noted by Defang

Table 2 – Least square means of body weight (g) and standard error (±) of turkeys at different age (week)

Age (week)		1	2	3	4	5	6	7
1	M	167.90±27.56ac	160.47±10.10ac	199.43±29.04b	201.30±40.35b	185.27±29.23ab	148.54±27.77c	163.62±45.51ac
	F	159.92±8.57ab	164.23±6.72a	138.26±7.00b	154.28±6.72ab	162.58±8.08ac	157.86±7.67ab	144.04±7.31bc
	M+F	163.9±6.34ab	162.35±6.51ab	168.85±6.34ab	177.79±6.15a	173.93±6.24a	153.2±6.21b	153.8±6.24b
	M	1990.91±219.64a	1936.05±167.71a	2176.45±118.5a	2057.34±261.4a	1763.79±265.26b	1702.37±224.03b	1785.44±353.32b
5	F	1857.05±59.67a	1780.30±46.81a	1636.0±48.72b	1513.64±46.81b	1608.33±56.26b	1493.95±53.37b	1568.20±50.89b
	M+F	1923.98±46.92a	1858.18±48.20ac	1906.22±46.92a	1785.49±48.20bc	1686.06±46.21bd	1598.16±45.98d	1676.82±46.21bd
	M	4603.58±465.05a	4216.85±410.27ab	4856.62±244.90a	4594.28±371.38a	3975.72±306.76b	4104.40±504.19b	4341.66±623.18ab
8	F	4163.00±117.82a	3605.30±92.42bc	3715.33±96.20b	3410.07±92.42c	3472.66±111.08bc	3378.30± 105.38c	3655.27±100.48bc
	M+F	4383.29±94.00a	3911.08±96.54bc	4285.97±94.00a	4002.18±96.54b	3724.19±92.56c	3741.35±92.10bc	3998.46±92.56b
	M	9022.33±958.77a	8307.85±870.79a	8859.37±287.95a	8821.42±622.74a	7912.27±923.82b	8116.00±892.38ab	8230.00±1061.7ab
12	F	7378.62±196.78a	7056.15±154.36ab	6858.75±160.67bc	6626.15±154.36bc	6621.11±185.52bc	6437.00±176.00c	6691.36±167.81bc
	M+F	8200.47±162.22a	7682.00±166.62bc	7859.06±162.22ab	7723.79±166.62bd	7266.69±159.74c	7276.50±158.94cd	7460.68±159.74bc
	M	12216.66±1437.13a	11588.5±1122.6a	12071.25±710.5a	12095.71±633.5a	10786.36±1006.02a	11531.00±1232.42a	11322.22±1251.3a
15	F	9043.75±242.63a	8797.69±190.33a	8603.7±198.11ab	8474.61±190.33ab	8177.77±228.75b	8442.00±217.01ab	8085.45±206.92b
	M+F	10630.20±208.36a	10193.13±214.01ab	10337.50±208.36ab	10285.16±214.01ab	9482.07±205.18c	9986.50±204.15bc	9703.83±205.18dc
17	M	13485.83±327.31a	13097.14±428.55a	13680.00±400.87a	13610.00±428.55a	11801.81±341.86bc	12714.00±358.55ab	12903.88±377.95a

*a, b, c: Differences between means of the same line with different letters are significant. $p<0.05$, M: Male, F: Female.

Table 3 – Least square means of Carcass traits of turkeys and standard error (±) of turkeys at slaughter

Traits	Sex	1	2	3	4	5	6	7
Dressing, %	M+F	0.778±0.004a	0.771±0.004a	0.775±0.004a	0.776±0.004a	0.769±0.004a	0.777±0.004a	0.780±0.004a
Thigh, g	M+F	2804.5±81.69a*	2655.5±81.69ab	2639.0±81.69ab	2599.5±81.69ab	2271.0±81.69c	2340.0±81.69c	2506±81.69bc
Breast, g	M+F	2725.5±51.34a	2641.0±51.34a	2579.0±51.34abc	2594.0±51.34ab	2441.0±51.34bc	2436.5±51.34bc	2423.5±51.34c
Wing, g	M+F	1122.0±27.57a	1058.5±27.57ab	1089.0±27.57a	1072.0±27.57ab	997.0±27.57b	993.0±27.57b	1036.5±27.57ab
Liver, g	M+F	133.89±5.65a	136.89±5.65a	138.57±5.65a	130.84±5.65ab	122.10±5.65ab	114.05±5.65b	136.01±5.65a
Heart, g	M+F	86.40±5.97a	94.03±5.97a	91.67±5.97a	91.06±5.97a	98.15±5.97a	92.67±5.97a	97.13±5.97a
Abdominal fat, g	M+F	61.61±11.67c	71.21±11.67bc	77.51±11.67bc	93.96±11.67abc	86.06±11.67abc	117.97±11.67a	104.98±11.67ab
Gizzard	M+F	93.89±4.89a	86.95±4.89a	90.49±4.89a	83.28±4.89a	78.97±4.89a	83.62±4.89a	89.75±4.89a

Mean±standart deviation * a, b, c: Differences between means of the same line with different letters are significant. $p<0.05$, M: Male, F: Female.

Table 4 – Least square means (g) of cumulative feed intake and standard error (±) of turkeys at different age.

Time (week)	1	2	3	4	5	6	7
0-1	115.0±2.88a*	115.0±2.88a	115.0±2.88a	115.0±2.88a	115.0±2.88a	115.0±2.88a	115.0±2.88a
0-5	4248.1±46.3a	4220.0±46.3a	4220.0±46.3a	4220.0±46.3a	4220.0±46.3a	4220.0±46.3a	4220.0±46.3a
0-10	16160.0±177.49a	16267.7±177.49a	16160.0±177.49a	16160.0±177.49a	16160.0±177.49a	16160.0±177.49a	16160.0±177.49a
0-15	34146.6±373.3a	34278.9±373.3a	34546.4±373.3a	33694.5±373.3a	34190.9±373.3a	33939.6±373.3a	33425.3±373.3a

*$p>0.05$.

Table 5 – The least square means (g) of cumulative feed conversion ratio and standard error (±) of turkeys at different age.

Age (wk)	Tratment Groups						
	1	2	3	4	5	6	7
0-1	0.96±0.035ab	0.95±0.035ab	0.94±0.035b	0.91±0.035b	0.88±0.035b	1.06±0.035a	1.07±0.035a
0-5	2.18±0.006f	2.31±0.006d	2.28±0.006e	2.48±0.006c	2.49±0.006c	2.64±0.006a	2.53±0.006b
0-10	2.59±0.007f	3.00±0.007a	2.79±0.007e	2.91±0.007c	3.00±0.007a	2.96±0.007b	2.85±0.007d
0-15	3.12±0.008c	3.50±0.008b	3.46±0.008c	3.46±0.008c	3.56±0.008a	3.40±0.008d	3.50±0.008b

*: 1; control, 2; 5%, 3; 10%, 4; 15%, 5; 20%, 6; 25%, 7; 30%. Mean±standart error a, b, c: Differences between means of the same line with different letters are significant $p<0.05$, M: Male, F: Female.

et al. (2008) that Carcass yield was significantly ($p<0.05$) higher for the birds finished with boiled cowpea diet compared to the other treatments. Under uncontrolled temperature and pressure of cowpea and black common bean boiled for 30 min could not be recommended for broiler's diet formulation by the authors. Besides, the proportion of the heart, liver and gizzard were higher for birds fed with the treatment diets (Defang *et al*. 2008). Similar results to Defang *et al*. (2008) were previously reported by Teguia *et al*. (2003) when birds of same strain were fed raw cowpea and Bambara groundnut and the low carcass yield was attributed to the presence of antinutritional factors (ANFs) in the diet.

The researchers (Defang *et al*. 2008) interpreted that the increase in the size of liver and gizzard was related to the increased activity to overcome the effect of toxic antinutritive compounds in the diets not totally destroyed by boiling. The performance of data of broiler chicks fed diets containing different level of plant concentrate which include faba bean, cowpea, pigeon pea and alfalfa meal showed that 5 % plant concentrate had highest dressing carcass percentage (69.76%) than the control (67.63 %), however, 15 % plant concentrate had lowest (63.79 %; $p>0.05$) dressing percentage (Atti *et al*. 2011). Carcass weight and dressing percentage were not affected ($p>0.05$) by up to 15 % cowpea in the diet (Abdelgani *et al*. 2013; Kur *et al*. 2013). This similarity to the present study could be related to similar feed intake and diets of the groups that were all isocaloric and isonitrogenous.

Feed intake (FI) and feed conversion ratio FCR.

Feed intake of the turkeys in all groups was very similar throughout the experiment, and differences were not significant. However, the best FCR was observed in the control group. These results show us that the birds in the treatment groups consumed as much feed as the control group but they couldn't get BW gain as in the control groups. The reason for this is that the birds couldn't get nutrition needs by consuming feed containing LP, which has more fibrous biomass (8.8 %), even though the protein and energy levels were similar. In this study, negative effects on FCR was observed in contrast to the result of Çabuk *et al*. (2014) who demonstrated that there were no differences ($p>0.05$) between the treatments through the 11 week period in quails' diet containing up to 20 % LP. In some researches, the effects of some legume seed on broiler performance; significantly lower FI ($p<0.05$) by inclusion of faba bean, cowpea, pigeon pea and alfalfa meal (Atti *et al*. 2011), lower FI and FCR ($p<0.05$) by adding 5 % Raw bambarra groundnut (Osuagvu & Amaefule, 2005), no significant change ($p>0.05$) on FCR by inclusion of boiled cow pea and black common bean were (Abdelgani *et al*. 2013; Kur *et al*. 2013; Atti *et al*. 2011) noted. The results of the present study show similarity to results of Abdelgani *et al*. (2013) and Kur *et al*. (2013).

CONCLUSION

Lentil byproduct could be easily found in some countries such as Canada, India and Turkey. This by product is mostly used in ruminant diets, not in poultry in such countries mentioned above. Because lentil byproduct in the diet up to 15 % didn't have adverse effect on BW, carcass features and FI, but FCR, it could easily be used in the diet of turkeys to reduce the cost of feed. More research is needed to figure out the effects of different kinds of lentil byproduct on the performance of turkey and other poultry breeds. As in other leguminous, some tannin is present in lentil and it has not been eliminated. These tannins could affect animal physiology, and it may decrease utilization of nutrients by enzyme inhibitor (Arora,1983; South & Miller 1998; Kaya *et al*. 1999). For that reason, the effect of lentil byproduct on poultry has to be investigated after heat process.

REFERENCES

Abdel Atti KA, Dousa BM, Fadel Elseed A.M. Effect of substitution the imported concentrate by plant concentrate on performance and blood chemistry of broiler chicks. Pakistan Journal of Nutrition 2011;10 (11):1000-1003.

Abdelgani AA, Abdelatti KA, Elamin KM, Dafalla KY, Malik HEE, Dousa BM. Effects of Dietary Cowpea (Vignaunguiculata) seeds on the performance of broiler chicks. Wayamba Journal of Animal Science 2013;5:678-684.

Amaefule KU, Osuagwu FM. Performance of Pullet chicks fed graded levels of Raw Bambarra groundnut (Vigna subterranean (L.) Verdc) offal diets as replacement for soybean meal and maize. Livestock Research for Rural Development 2005;17(5).

Arora SK. Chemistry and biochemistry of legumes. London: Edward Arnold, 1983.

Bathy RS. Lentils as victory cereal complement. Cereal food World 1995;40(5):387-392.

Çabuk M, Eratak S, Malayoğlu HB. Effects of dietary inclusion of lentil by product on performance and oxidative stability of eggs in laying quail. Scientific World Journal 2014; 2014:1-5. Available from: http://dx.doi.org/10.1155/2014/742987.

Defang HF, Awah-Ndukum ATJ, Kenfack A, Ngoula F, Metuge F. Performance and carcass characteristics of broilers fed boiled cowpea (Vigna unguiculata L Walp) and or black common bean (Phaseolus vulgaris) meal diets. African Journal of Biotechnology 2008;7(9);1351-1356.

Görgülü M. Ingredient of nutrients. 2010. Available from: http://www.muratgorgulu.com.tr/altekran.asp?id=79.

Kanat R, Camcı Ö. The effects of different level of lentil byproduct in the diet on laying performance and some hatchery features. Proceedings of the Southeastern Anatolia 1st Animal Congress; 1993 May 12-15; Sanliurfa. Turquia.

Kanat R. The effects of different level of lentil byproduct in the diet on live body weight, feed intake, feed conversion ratio and carcass traits of quails. Harran University Agriculture Journal 1992;3(4);35-44.

Kaya S, Yarsan E, Özdemir M. Major items may cause growth retardation, yield decreasing and poisoning in poultry. Proceedings of the International Poultry Fair and Congress; 1999 June 3-6; İstanbul. Turquia.p.366-379.

Kılıçalp N, Benli Y. Possibilities of lentil byproduct using in laying hen diets. Animal Research Journal 1994;(4):47-49.

Kur ATY, AbdelAtti KA, Dousa BM, Elagib HAA, Malik HEE, Elamin KM. Effect of Treated Cowpea Seeds on Broiler Chicken. Global Journal of Animal Scientific Research 2013;1(1):58-65.

Leeson S, Summer J. Commercial poultry nutrition. 2nd ed. Ontário: University Books; 2013.

Mavromichalis L. El papel de los antioxidantes en la nutrición porcina. Suis 2013;(102):6-8.

Onwudike OC, Eguakun A. Nutritional evaluation of raw and heat-treated bambara groundnut meals for starter broilers birds. Journal of Agricultural Technology 1994;2:38-46.

Robinson D, Singh DN. Rural industries research and development corporation [publication NDAQ- 241]. Queensland: Poultry Research and Development Centre; 2001.

SAS Institute. Sas user's guide: statistics. Cary; 1998.

South PK, Miller DD. Iron binding by tannic acid: effects of selected ligands. Food Chemistry 1998;63(2):167–172.

Teguia A, Japou IB, Kamsu EC. Response of broiler chickens to Vigna unguiculata(L) Walp (cowpea), and Phaleolus vulgaris (black bean) and Voandzeia cubterranean (Bambara groundnut) as feed ingredients in replacement of meat meal. Animal Feed Science 2003;11:127-133.

Tsopmo A, Muir AD. Chemical profiling of lentil (Lens culinaris Medik.) Cultivars and isolation of compounds. Journal of Agricultural Food Chemistry 2010;58(15):8715-21.

Wang N, Daun JK. Determination of cooking times of pulses using an automated Mattson cooker apparatus. Journal of the Science of Food and Agriculture 2005;85(10):1631–1635.

Woyengo TA, Beltranena E, Zijlstra RT. Controlling feed cost by including alternative ingredients into pig diets: A review. Journal of Animal Science 2014;92(4):1293-1305.

Xu B, Chang SKC. Phenolic substance characterization and chemical and cell-Based antioxidant activities of 11 lentils grown in the Northern United States, Journal of Agricultural and Food Chemistry 2010;58(3):1509–1517.

Yalçın S, Ergün A, Çolpan I. The possibilities of utilization of some leguminous seeds on poultry diets. Proceedings of the International Poultry Congress; 1991 May 22-25; Istanbul. p.182-194.