Alexandria Journal of Veterinary Sciences 2016, Oct. 51 (1): 127-134
ISSN 1110-2047, www.alexjvs.com
DOI: 10.5455/ajvs.241707

Response of Cobb and Sasso Broilers to Feeding Restriction and Tryptophan Supplementation

Mona E. Younis, Mohamed A. El-Edel,* Sherif M. Nasr, Usama E. Mahrous and Mahmoud M. Aboghanima

Animal Husbandry and Wealth Development, Faculty of Veterinary Medicine, Damanhour University, Egypt.

Abstract

An experiment was conducted to investigate the influence of early feed restriction and feeding Tryptophan on growth performance, kidney and liver functions of two broiler breeds. 180 Cobb 500 and 180 Sasso T44 chicks were divided randomly at 14 days of age according to feeding regime into three main groups, 1. Third week feed restricted group, 2. Fourth week feed restricted group and 3. Control group (*ad libitum* feeding). Each group was subdivided into 1. Tryptophan supplemented group (0.02%) and 2. Tryptophan free group, birds in each final group subdivided into 3 replicates (10 birds / replicate). Cobb 500 broilers recorded significantly higher body weight and weight gain throughout the experiment than that of Sasso T44 ($P<0.05$), however, feed restriction of Cobb 500 during 3rd and 4th week of age was significantly lower than Sasso T44 (1.62 and 1.47 vs. 1.78 and 1.73). Early feed restriction and Tryptophan supplementation improved significantly final body weight, weight gain and feed conversion compared to *ad libitum* feeding and Tryptophan free groups. Dressing % and carcass characteristics were significantly better in Cobb 500 than Sasso T44, in 3rd week feed restriction than 4th week feed restriction and *ad libitum* feeding and in Tryptophan supplemented than Tryptophan free groups. Although there were some differences in measured blood parameters, kidney and liver enzymes between the two broiler breeds, the different feeding regimes and two Tryptophan managements all measured values were within the normal reference range. In conclusion Cobb 500 broilers were recommended for meat production, early feeding restriction for a week and Tryptophan supplementation for better growth performance and carcass traits without affecting kidney and liver function.

Key words: Feeding Restriction, Tryptophan, Performance and Carcass traits.

Corresponding Author: Mohamed A. El-Edel: Eledel_m@yahoo.com

1. INTRODUCTION

Feed represents the major cost of poultry production, constituting up to 70 percent of the total cost (Ensminger et al., 1990). The challenge is to optimize animal performance while reducing dietary cost, as a result various strategies were developed, and such include use of alternative feed ingredients, exogenous enzymes, growth promoters, genetic selection, feeding programs/formulations and phase feeding (Makinde, 2012). Compensatory or catch up growth occurs when growth has been retarded by nutritional deprivation and followed by *ad libitum* feeding (Mahmood, 2012). Jahanpour et al., (2015) reported a neutral or slightly beneficial effect of feeding restrictions on 42 days body weight of Ross broilers. Similarly Camacho et al., (2004) and Boostani et al., (2010) stated that, similar production characters and lower breast weight and abdominal fat weight in feed restricted group compared to control one. Mahmood et al., (2007) concluded that restricted birds utilized their feed more efficiently than controls and the dressing percentage and relative weight of heart, liver, spleen, gizzard, pancreas and intestine remained unaffected due to the treatments. Navarro et al., (2006); Siwendu et al., (2013) and Olawumi and Fagbuaro (2015) reported that there was significant variation of growth and carcass characters between different meat type breeds with higher efficiency of commercial white broiler breeds than that of other meat types breeds. Wang et al., (2014) reported that increased dietary Tryptophan significantly reduced the activities of lactic dehydrogenase and GPT while increasing total cholesterol in the plasma, reducing drip loss of breast muscle and improving feed efficiency. However, Gogary and Azzam (2014) reported that increasing L-Trp level in the diet did not affect BW, BWG and FCR (p>0.05). However, feed intake decreased significantly with L-Trp supplementation.

This study was conducted to investigate the impact of early feed restriction and feeding Tryptophan as a growth promoter on growth performance, carcass characteristics, blood parameters, liver and kidney functions in two breeds of broilers.

2. MATERIALS AND METHODS

2.1. Experimental colony:

Three hundred and sixty of one day old chicks from two different meat breeds; Cobb 500 and Sasso T44 (180 bird from each breed) were obtained from a local commercial hatchery. All birds were wing banded at day old (Metal wing bands from Fath Allah Group Company©, Alexandria, Egypt). The experimental design and procedures were approved by the Committee for Animal Care and Faculty of Veterinary Medicine, Damanhur University, Egypt. Birds of each breed were divided randomly at 14 days of age according to feeding regime into three main groups, 1. Third week feed restricted group as; fed only 8hrs/day during the third week of age, 2. Fourth week feed restricted group as; fed only 8hrs/day during the fourth week of age 3. Control group received *ad libitum* feeding. Each group was subdivided into two groups according to tryptophan supplementation as; 1. Tryptophan supplemented group (0.02% or 2 kg powder of Tryptophan (98.9%) per ton of ration) (Emadi et al., 2011), and 2. Tryptophan free group (received only basal diet), birds in each final group subdivided into 3 replicates (10 birds / replicate).

2.2. Flock management:

Chicks were housed in an open sided house, brooded at 33°C at the birds' level during first three days of age, and then temperature was reduced gradually till room (21°C) temperature at 21st day of age. Chicks were fed on a starter ration (23% protein and 2900 kcal/kg) for the first two weeks and then transformed to grower ration (21% protein and 3000 kcal/kg) till the end of the experiment.

2.3. Traits of concern:

2.3.1. Estimation of Growth and Carcass traits:

Body weights (BW) of chicks were weekly weighed from the second week until 6th weeks of age. The gain in body weight (BWG) was calculated by finding the difference in weight between two successive weights. While, Feed conversion ratio (FCR) was estimated by dividing weekly feed intake (g) per bird on its corresponding weekly body weight gain (Lambert et al., 1936). Birds were deprived of feed prior to slaughtering by 12 hours and weighed for measuring of carcass traits (5 birds / group). After slaughtering, birds were scalded, wet-plucked and eviscerated then carcass weighed to calculate dressing percentage according to (Price, 1967). Carcass divided into breast, left filet (the de-skinned left breast muscle on the left side of sternum), thigh and shoulder (Wang, 2000). Also internal organs including liver, heart, gizzard and abdominal fats in pelvic and abdominal cavity were separated and weighted and expressed as a percent from carcass weight.

2.3.2. Estimation of blood biochemical parameters:

Blood samples were collected from wing vein at the end of the experiment (42 days). Serum was separated through centrifugation at 3000 rpm for 15 minutes and preserved in a deep freezer (at -20°C) until their analysis. Triacylglycerol was measured according to Fossati and Principe (1982), cholesterol according to Allain et al., (1974), total protein according to Gornall et al., (1949), Albumin according to Dumas (1971) and Globulin according to Coles (1974).

2.3.3. Estimation of kidney and liver functions:

To determine the kidney and liver functions following enzymes were estimated: Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST) according to Reitman and Frankel (1957), Creatinine according to Bartels et al., (1972) and Urea according to Fawcett and Scott (1960).

2.4. Statistical analysis

Data were analyzed by statistical analysis system (SAS, 2002). Three way analysis of variance, Proc GLM with the following model: $\mathbf{X_{ijkl} = \mu + A_i + B_j + C_k + e_{ijk}}$

Where:

X_{ijk}	= An observational data,
μ	= Overall mean,
A_i	= Effect of jthbreed of broilers j=1 and 2 (1= Cobb 500 and 2=Sasoo T44),
B_j	= Effect of kth feeding regimen k=1, 2 and 3 (1= feed restricted at 3rd week, 2= feed restricted at 4th week and 3= ad-libitum).

C_k = Effect of l^{th} feeding tryptophan l= 1 and 2 (1= Fed basal diet and 2= treated as fed basal diet supplied with 0.02 % tryptophan 98.9%).

e_{ijk} = Random error.

3. RESULTS AND DISCUSSION

3.1. Growth performance traits:

Cobb 500 broilers had significantly higher body weight and weight gain throughout the experiment than that of Sasso T44 (Table 1). This significant difference could be attributed to the high genetic potential of Cobb 500 as a commercial broilers strain for meat production, while Sasso T44 are less efficient broilers require longer time to retain weight, similarly Sheng et al., (2013), Siwendu et al., (2013), Hristakieva et al., (2014) and Olawumi and Fagbuaro (2015) reported higher efficiency of commercial white broiler strains specially Cobb 500 than that of other broilers. At third week of age body weight and weight gain were significantly lower for 3rd week feed restriction group than *ad libitum* and 4th week feed restriction groups, moreover the 4th week feed restriction regime recorded significantly lower body weight and weight gain than the two other groups during the fourth week of age (Table 1). These reduction of growth performance during feed restriction time followed by improved growth confirming the phenomenon of compensatory growth (Mahmood, 2012). These results revealed that early feed restriction was associated with higher body weight at slaughter age, similar findings were reported by Tumova et al., (2002), Mahmood et al., (2007) and Boostani et al., (2010), while Camacho et al., (2004) and Saleh et al., (2004) were not in agreement with the obtained results in this experiment. Data presented in Table (1) showed that broilers received ration supplemented with Tryptophan recorded significantly higher body weight and weight gain compared to control groups (541.32 vs. 514.42; 1295.40 vs. 1244.06; 1708.49 vs. 1644.15 g at 3rd, 5th and 6th week of age respectively). These results may be illustrated the effect of Tryptophan as an essential amino acid acts as a precursor for neurotransmitters and hormones especially some growth related hormones (Guzik et al., 2002). Similar findings were reported by Moneva et al., (2008) as they concluded that using Tryptophan as a feed additive during stress as feed deprivation had improved productive performance and also a similar study performed by Wei et al., (2011) reported that weight gain was attained by addition of tryptophan to level up to 0.23% in diet during feed restriction. While Rathgeber et al., (2007) findings were not in agreement with the results obtained in our experiment.

Feed conversion of Cobb broilers was significantly lower than those of Sasso T44 during the 3rd (1.62 vs. 1.78) and 4th week of the experimental period (1.47 vs. 1.73), however, during the next two weeks of the experiment Cobb 500 showed better feed conversion ratio than Sasso T44 broilers, at 5th week (1.87 vs. 1.83) and 6th week (2.05 vs. 1.91), with significant difference ($P<0.05$). This pattern of difference in FCR may be attributed to the difference in the period required for a broiler cycle for the two breeds as the genetic potential of commercial strains as Cobb 500 broilers chicks is mainly for 42 days and approaching that age FCR increases, while for Sasso T44 the cycle to attain desirable weight is usually about 60 days. These results are in close agreement with Hanning et al., (2012) who concluded that commercial broiler breeds as White Cornish (Male parent line of Cobb broilers) had a better FCR than improved broiler breed as Naked Neck (one of Sasso strains). The 3rd week feed restricted broilers and 4th week feed restricted broilers showed more efficient FCR than that of *Ad libitum* fed broilers during all of the experiment and this difference was highly significant ($P<0.01$) at the end of 4th week (1.58 and 1.53 vs. 1.68, respectively) and the 6th week (1.95 and 1.96 vs. 2.03). These results are in agreement with Saleh et al., (2004) as they concluded that feed conversion was significantly improved at all ages after the restriction period for the restricted group compared with the control group. Data illustrated in Table (1) showed that feeding broilers ration containing extra Tryptophan (+ 2kg/ton) significantly improved feed conversion ratio all over the experimental periods. However, EL Gogary and Azzam (2014) reported that increasing L-Trp level in the diet did not affect LBW, BWG and FCR this disagreement may be related to the lower level of tryptophan used in this experiment 1% compared to 2% used in our experiment.

3.2. Carcass traits:

As presented in Table (2), Cobb 500 had better dressing percentage, liver %, breast %, shoulder % and left fillet %, while Sasso T44 broilers had higher thigh %. The obtained results are in agreement with Hristakieva et al., (2014) as they reported that Cobb 500 showed better carcass traits than other broilers strains. Early feeding restriction during 3rd week of age produced significantly higher ($P<0.01$) dressing percentage than *Ad libitum* fed and 4th week feed restricted broilers (73.06 vs. 71.84 and 71.79 %, respectively), also the same effect in breast % (28.09 vs. 26.97 and 27.67 %, respectively), and similarly abdominal fat had decreased under the effect of feed restriction but with no significant difference. Similar results were obtained by David and Subalini (2015) whose found that feeding Tryptophan at the level of extra dietary 0.2% significantly increased dressing %, liver %, spleen %, breast %, thigh %, shoulder % and left filet %, while abdominal fat was significantly ($P< 0.001$) reduced with feeding Tryptophan.

3.3. Blood protein and lipid profiles:

Cobb 500 broilers had significantly higher serum total protein content, serum albumin, A/G ratio, total lipid, triacylglycerol and cholesterol than Sasso T44 (Table 3). These results could be attributed to higher metabolic rate of Cobb 500 as a potential commercial broiler strain and as a result they are in demand for higher protein and fat especially constructional protein to provide the maximum rate of growth than other broilers (Dutta et al., 2013). Feed restriction played a role in increasing total protein specially in 3rd week feed restricted groups against *Ad libitum* fed and 4th week feed restricted groups (4.01 vs. 3.99 and 3.83, respectively) and similarly increased serum albumin (2.13 vs. 2.11 vs. 2.01 mg/dl, respectively), while serum total lipids had significantly decreased in 4th week feed restricted groups than 3rd week and *Ad libitum* fed groups (474.18 vs. 507.37 and 504.97 mg/dl, respectively), while serum globulin, A/G ratio, triacylglycerol and cholesterol showed no significant difference in response to feeding restriction. These findings were in agreement with Boostani et al., (2010) as they concluded that feeding restriction alters the serum biochemical parameters. As Tryptophan is an essential amino acid and play a role in protein synthesis, the data presented in Table (3) showed that feeding of Tryptophan to broilers resulted in significant ($P<0.001$) increase in serum contents of total protein, albumin and globulin (4.44, 2.36 and 2.08 vs. 3.45, 1.81 and 1.64 mg/dl, respectively) and significant ($P<0.001$) decrease in total lipid, triacylglycerol and cholesterol (455.85, 121.17 and 128.35 vs. 535.17, 137.68 and 151.16 mg/dl, respectively) than those fed basal diet.

3.3. Kidney and Liver functions:

Cobb 500 broilers had significantly higher serum urea and AST (Table 3) over Sasso T44 broilers ($P<0.05$) and also Cobb 500 showed higher creatinine and ALT but this difference was not significant, however all that increased levels were within the normal reference range for chicken species and these findings may be attributed to the higher metabolic rate of Cobb 500 broilers as a result of its massive growth rate. These findings were in agreement with Dutta et al., (2013) as they concluded that there were significant difference between different chicken breeds in blood biochemical parameters indicating kidney and liver functions. Feeding restriction had significantly reduced urea and ALT level in serum in both 3rd week and 4th week feed restricted groups, while feed restricted groups showed higher AST level in both 3rd and 4th week feed restricted groups but this difference was only significant with 3rd week feed restricted group than *Ad libitum* fed groups (72.80 vs. 66.85 mg/dl). These findings may be attributed to the positive effect of early feeding restriction on reducing the metabolic rate and improving the health status of the broilers as a result of reliving the stress of the high growth rate. Similar findings were obtained by Rajman et al., (2006) as they concluded that activities of creatine kinase, aspartate aminotransferase, and alanine aminotransferase were significantly higher in *ad libitum* fed chickens during this period. Also, Jahanpour et al., (2013) concluded that feeding restriction reduced the level of serum uric acid. Tryptophan significantly ($P<0.001$) increased urea, ALT and AST levels over control groups (28.28, 30.03 and 62.63 vs. 31.89, 37.30 and 76.83 mg/dl, respectively). These significant increases in blood biochemical parameters indicting kidney and liver functions were all within the normal reference range for chicken species and these differences may be attributed to the role of Tryptophan as an essential amino acid which elevate serum protein level and result in higher growth rate and higher metabolic rate. Similar findings were obtained by El-Neney et al., (2013) as they concluded that AST and ALT had increased in response to Tryptophan supplementation but that increase was not significant, also Moneva et al., (2008) reported that Tryptophan supplementation resulted in increase in serum urea levels. However Emadi et al., (2011) stated that Tryptophan decreased ($P<0.05$) aspartate amino transferase and alkaline phosphatase.

Table (1): Means and standard errors of effect of breed, feeding regimen and feeding Tryptophan on body weight, weight gain and feed conversion ratio of broilers.

	Body weight (g)				Body weight gain (g)				Feed conversion			
Items	**3 Weeks**	**4 Weeks**	**5 Weeks**	**6 Weeks**	**2-3 Weeks**	**3-4 Weeks**	**4-5 Weeks**	**5-6 Weeks**	**2-3 Weeks**	**3-4 Weeks**	**4-5 Weeks**	**5-6 Weeks**
Breed:												
Cobb 500	656.28±7.69^{a}	1179.77±9.94^{a}	1659.70±10.65^{a}	2140.60±11.85^{a}	356.59±5.78^{a}	523.49±5.70^{a}	479.93±3.46^{a}	480.90±4.62^{a}	1.62±0.05^{b}	1.47±0.02^{b}	1.87±0.01^{a}	2.05±0.02^{a}
Sasso T44	398.18±4.04^{b}	621.82±6.01^{b}	875.69±6.65^{b}	1207.21±6.48^{b}	198.19±2.50^{b}	223.64±3.48^{b}	253.87±2.01^{b}	331.53±1.77^{b}	1.78±0.02^{a}	1.73±0.02^{a}	1.83±0.01^{b}	1.91±0.01^{b}
Feeding regimen:												
Ad libitum	532.85±13.71^{ab}	916.18±25.78^{a}	1275.67±34.91^{b}	1669.10±41.39^{b}	282.95±8.97^{a}	383.33±13.43^{b}	359.49±9.87^{b}	393.43±7.92^{c}	1.74±0.07	1.68±0.02^{a}	1.88±0.02	2.03±0.02^{a}
Feed restriction in 3rd week	512.49±13.64^{b}	929.53±29.06^{a}	1301.16±39.27^{a}	1707.43±46.14^{a}	255.62±8.35^{b}	417.04±16.27^{a}	371.63±11.05^{a}	406.27±7.98^{b}	1.66±0.04	1.58±0.03^{b}	1.84±0.02	1.95±0.02^{b}
Feed restriction in 4th week	538.71±14.64^{a}	860.76±27.10^{b}	1232.22±38.05^{c}	1652.51±45.26^{b}	295.24±9.57^{a}	322.04±13.51^{c}	371.46±11.77^{a}	420.29±8.18^{a}	1.70±0.04	1.53±0.03^{b}	1.84±0.01	1.96±0.02^{b}
Feeding Tryptophan:												
Control	514.42±11.04^{b}	881.77±22.09	1244.06±29.96^{b}	1644.15±35.42^{b}	266.56±6.95^{b}	367.35±12.39^{b}	362.29±8.56^{b}	400.09±6.59^{b}	1.87±0.05^{a}	1.66±0.02^{a}	1.91±0.01^{a}	2.04±0.02^{a}
Treated	541.32±11.75^{a}	922.70±22.63	1295.40±31.14^{a}	1708.49±36.74^{a}	288.97±7.76^{a}	381.38±11.92^{a}	372.71±9.23^{a}	413.09±6.56^{a}	1.53±0.02^{b}	1.53±0.02^{b}	1.80±0.01^{b}	1.92±0.01^{b}

Table (2) Means and their standard errors of the effect of breed, feeding regimen and feeding Tryptophan on carcass dressing percentage and carcass traits of broilers.

Items	Dressing %	Liver%	Gizzard%	Heart%	Spleen%	Abdominal Fat%	Breast%	Thigh%	Shoulder%	Left Filet%
Breed:										
Cobb 500	73.26±0.54^{a}	4.25±0.07^{a}	2.98±0.05	0.84±0.01	0.22±0.01	1.58±0.10	28.86±0.42^{a}	15.43±0.23^{b}	5.02±0.13^{a}	12.38±0.25^{a}
Sasso T44	71.20±0.45^{b}	4.06±0.06^{b}	2.87±0.05	0.87±0.01	0.21±0.00	1.63±0.07	26.30±0.44^{b}	16.94±0.23^{a}	4.10±0.13^{b}	10.87±0.23^{b}
Feeding regimen:										
Ad libitum	71.84±0.65^{b}	4.15±0.09	3.03±0.09	0.88±0.02^{a}	0.21±0.01	1.64±0.12	26.97±0.72^{b}	15.87±0.40	4.53±0.21^{b}	11.62±0.40
3rd week feed restriction	73.06±0.73^{a}	4.23±0.06	2.87±0.05	0.83±0.01^{b}	0.20±0.01	1.55±0.07	28.09±0.47^{a}	16.27±0.26	4.31±0.15^{b}	11.45±0.33
4th week feed restriction	71.79±0.55^{b}	4.09±0.08	2.86±0.04	0.86±0.01^{b}	0.22±0.01	1.62±0.12	27.67±0.57^{ab}	16.42±0.31	4.83±0.18^{a}	11.79±0.29
Feeding Tryptophan:										
Control	70.00±0.33^{b}	3.96±0.06^{b}	2.92±0.04	0.86±0.01	0.20±0.01^{b}	2.01±0.04^{a}	25.60±0.38^{b}	15.36±0.23^{b}	4.07±0.11^{b}	10.50±0.19^{b}
Treated	74.46±0.34^{a}	4.36±0.05^{a}	2.92±0.06	0.86±0.01	0.22±0.01^{a}	1.20±0.04^{b}	29.55±0.26^{a}	17.02±0.21^{a}	5.05±0.13^{a}	12.75±0.17^{a}

Table (3): Means and their standard errors of the effect of breed, feeding regimen and feeding Tryptophan on blood biochemical (mg /dl) parameters in addition to Kidney and liver functions of broilers.

Items	Blood biochemical (mg /dl) parameters							Kidney and liver functions			
	Total protein (mg/dl)	**Albumin** (mg/dl)	**Globulin** (mg/dl)	**A/G Ratio**	**Total lipid** (mg/dl)	**Triacy-Lglycerol** (mg/dl)	**Cholesterol** (mg/dl)	**Urea** (mg/dl)	**Creat-Inine** (mg/dl)	**ALT**(mg/dl)	**AST** (mg/dl)
Breed:											
Cobb 500	4.07±0.10[a]	2.21±0.07[a]	1.86±0.03	1.19±0.03[a]	555.45±14.67[a]	135.04±3.71[a]	150.17±3.97[a]	30.88±0.40[a]	0.45±0.01	34.03±0.75	71.70±1.82[a]
Sasso T44	3.82±0.10[b]	1.96±0.04[b]	1.87±0.07	1.07±0.03[b]	435.56±10.34[b]	123.81±3.58[b]	129.34±2.56[b]	29.28±0.40[b]	0.43±0.01	33.30±0.84	67.77±1.81[b]
Feeding regimen:											
Ad libitum	3.83±0.13[b]	2.01±0.08[b]	1.82±0.05	1.11±0.03	504.97±25.30[a]	129.45±6.04	143.44±5.68	30.82±0.51[a]	0.44±0.01	35.75±0.89[a]	66.85±2.29[b]
Feed restriction in 3rd week	4.01±0.13[a]	2.13±0.07[a]	1.88±0.07	1.14±0.03	507.37±18.07[a]	133.55±3.83	138.57±4.08	29.90±0.52[ab]	0.46±0.01	32.55±0.84[b]	72.80±2.47[a]
Feed restriction in 4th week	3.99±0.12[ab]	2.11±0.07[a]	1.88±0.07	1.13±0.04	474.18±17.39[b]	125.27±3.58	137.26±4.27	29.52±0.52[b]	0.43±0.01	32.70±1.05[b]	69.55±1.83[ab]
Feeding Tryptophan:											
Control	3.45±0.04[b]	1.81±0.03[b]	1.64±0.03[b]	1.11±0.03	535.17±19.76[a]	137.68±4.42[a]	151.16±4.34[a]	28.28±0.23[b]	0.45±0.01	30.03±0.45[b]	62.63±1.51[b]
Treated	4.44±0.05[a]	2.36±0.04[a]	2.08±0.03[a]	1.14±0.03	455.85±8.42[b]	121.17±2.13[b]	128.35±1.40[b]	31.89±0.30[a]	0.43±0.01	37.30±0.42[a]	76.83±1.03[a]

4. REFERENCES

Allain, c. C., Poon, l. S., Chan, C. S. G. 1974. Enzymatic determination of total cholesterol in serum. Clin. Chem. 20**:** 470.

Bartels, H., Bohmer, M., Heierli, C. 1972. Serum creatinine determination without protein precipitation. Clinica. Chemica. Acta. 37**:** 193-197.

Boostani, A., Ashayerizadeh, A., Mahmoodian, F. H., kamalzadeh, A. 2010. Comparison of the effects of several feed restriction periods to control ascites on performance, carcass characteristics and hematological indices of broiler chickens. Revista Brasileira de Ciência Avícola. 12**:** 170-177.

Camacho, M. A., Suarez, M. E., Herrera, J. G., Cuca, J. M., Garcia-Bojalil, C. M. 2004. Effect of age of feed restriction and microelement supplementation to control ascites on production and carcass characteristics of broilers. Poult. Sci. 83**:** 526-32.

Coles, E. H. P. 1974. Veterinary clinical pathology. 211-213.

David, L. S., Subalini, E. 2015 Effects of feed restriction on growth performance, organ size and carcass characteristics of broiler chcikens. Sch. J. Agric. Vet. Sci. 2**:** 108-111.

Dumas, B. T. 1971. Determination of total protein and albumin in serum. Clin. Chem. Acta. 31**:** 87-96.

Dutta, R. K., Islam, M. S. and Kabir, M. A. 2013. Haematological and biological profiles of Gallus Indogenous, exotic and hybrid chicken breeds from Rajshahi, Bangladesh. Bangladesh J. Zool. 41**:** 135-144.

EL-Neney, A. M. B., EL-Slamoney, A. E., Hassaan, S. F., Raga, E. A. and Abdalla, E. A., . 2013. Effect of photoperiod and Tryptophan amino acid supplementation on Pineal gland hormone and its relation to performance in local strains. Egypt. Poult. Sci. 33: 769-794.

EL Gogary, M. R. and Azzam, M. M. 2014. Effects of dietary tryptophan and stocking density during the growing-finishing phase on broilers growth performance and immunity. Asian J. Anim. Vet. Adv. 1-10.

Emadi, M., Jahanshiri, F., Kaveh, K., Hair-Bejo, M., Ideris, M. and Alimon, A. R. 2011. The effects of the combination of arginine and tryptophan on growth performance, serum parameters and immune response in broiler chickens challenged with infectious bursal disease vaccine. Avian Pathol. 40**:** 63-72.

Ensminger, M. E., Heinemann, W. W. & Olfield, J. E. 1990. Feeds and nutrition, Clois [California], Ensminger.

Fawcett, J. K. and Scott, J. E. 1960. A rapid and precise method for the determination of Urea. J. Clin. Pathol. 13**:** 156-159.

Fossati, P., Principe, I. 1982. Determination of triglycerides on serum. J. Clin. Chem. 28**:** 2077.

Gogary, M. R. E., Azzam, M. M. 2014. Effects of Dietary Tryptophan Levels and Stocking Density During the Growing-Finishing Phase on Broiler Performance and Immunity. Asian J. Anim. Vet. Adv. 9**:** 568-577.

Gornall, A. G., Bardawell, C. J., David, M. M. 1949. Determination of serum proteins by means of the biuret reaction. J. Biol. Chem. 177**:** 751-766.

Guzik, T. J., West, N. E., Pillai, R., Taggart, D. P., Channon, K. M. 2002. Nitric oxide modulates superoxide release and peroxynitrite formation in human blood vessels. Hypertension. 39**:** 1088-1094.

Hanning, I., Clement, A., Owens, C., Park, S. H., Pendleton, S., Scott, E. E., Almeida, E., Gonzalez, G. and Ricke, S. C. 2012. Assessment of production performance in 2 breeds of broilers fed prebiotics as feed additives. Poult. Sci. 91**:** 3295-3299.

Hristakieva, P., Mincheva, N., Oblakova, M., Lalev, M., Ivanova, I. 2014. Effect of genotype on production traits in broiler chickens. Slovak J. Anim. Sci. 47**:** 19-24.

Jahanpour, H., Sedavi, A., ALI, A. Q., Rita, P. C. 2013. Effects of two levels of quantitative feed restriction for a 7- or 14 days period on broilers blood parameters. Acta Scientiae Veterinariae. 41**:** 1144.

Jahanpour, H., Seidavi, A., Qotbi, A. A., Van Den, R. H., Rocha, S. S., Laudadio, V. and Tufarelli, V. 2015 Effects of the level and duration of feeding restriction on carcass components of broilers. Arch. Anim. Breed. 58**:** 99-105.

Lambert, W. V., Ellis, N. R., Block, W. H. and Titus, H. W. 1936. The role of nutrition in genetic research. The Am. Soc. Anim. Product. 29:236.

Mahmood 2012. Feed restriction in broiler chicken production. .J. Golobal Veterineria. 8**:** 449-458.

Mahmood, S., Mehmood, S., Ahmed, F., Masood, A. and Kausar, R. 2007. Effect of feed restriction during starter phase on subsequent growth performance, dressing percentage, relative organ weights and immune response of broilers. Pakistan Vet. J. 27**:** 137-141.

Makinde, A. A. 2012. Influence of timing and duration of feed restriction on growth and economic performance of finisher broiler chickens African J. of food Agri., Nut. Develop. 12**:** 6976-6986.

Moneva, P., Popova, R. S., Gudev, D., Sredkova, S., Yanchev, I. 2008. Study of the metabolic implication of supplemental Tryptophan in exposed to stress chicken. Bulg. J. Agric.Sci. 14**:** 424-431.

Navarro, P., Visscher, P. M., Chatziplis, D., Koerhuis, A. N., Haley, C. S. 2006. Genetic parameters for blood oxygen saturation, body weight and breast conformation in 4 meat-type chicken lines. Br. Poult. Sci. 47**:** 659-70.

Olawumi, S. O. and Fagbuaro, S. S. 2015. Genotype ×Sex Interaction Effects on Carcass Traits of Three Strains of Commercial Broiler Chickens. J. World's Poult. 2**:** 21-24.

Price, M. A. 1967. Dressing percentages (%): what does it mean? . AgriOttawa Condex publications Canada**.** 420-450.

Rajman, M., Marián, J., Dalma, L., Mariana, M., Monika, S. Ľ., K., Daniela, J. and Pavel, V. 2006. The effects of feed restriction on plasma biochemistry in growing meat type chickens (Gallus gallus). Comparative Biochemistry and Physiology. Part A. 145**:** 363 - 371.

Rathgeber, B., Mackenzie, M., Macisaac, J. L., Anderson, D. 2007. Growth performance and muscle protein turnover of two broiler chicken strains fed supplemental Tryptophan. A.P.R.I. Factsheet. 27. April. 2007. Canada.

Reitman, S. and Frankel, S. 1957. A colorimetric method for the determination of serum glutamic oxalacetic and glutamic pyruvic transaminases. Am. J. Clin. Pathol. 28**:** 56-63.

Saleh, E. A., Watkins, S. E. W., A. L. and Waldroup, P. W. 2004. Effects of dietary nutrient density on performance and carcass quality of male broilers grown for further processing. Intl. J. Poult. Sci. 3**:** 1-10.

SAS 2002. Statistical Analysis System. A.S.A. Users Guide. Statistics (SAS) Institute Inc; Editors Cary, N.C

Sheng, Z., Pettersson, M. E., Hu, X., Luo. C. Qu, H., Shu, D., Shen, X., Carlborg, Ö. and Li, N. 2013. Genetic dissection of growth traits in a Chinese indigenous×commercial broiler chicken cross. BMC. Genom. 14**:** 151-157.

Siwendu, N. A., Norris, D., Ngambi, J. W., Shimelis, H. A., Benyi, K. 2013. Heterosis and combining ability for body weight in a diallel cross of three chicken genotypes. Trop. Anim. Health. Prod. 45**:** 965-70.

Tumova, E., Skrivan, M., Skrivanova, V., Kaceroveska, L. 2002. Effect of early feed restriction on growth performance in broilers, turkeys and rabbits. Czech. J. Anim. Sci. 47**:** 418-428.

Wang 2000. Effect of betaine on growth performance and carcass traits of meat ducks. J. Agri. and life Sci. 26**:** 347-352.

WANG, B., Min, Z., Yuan, J., Zhang, B., Guo, Y. 2014. Effects of dietary tryptophan and stocking density on the performance, meat quality, and metabolic status of broilers. J. Anim. Sci. Biotechnol. 5**.** 44.

Wei, Z. Y., Wang, L., Ji, Y., Hu, L. H., Pan, X. H., Wang, M. Z. and Wang, H. H. 2011. Effects of Dietary Tryptophan Supplementation and Feed Restriction on Growth Performance and Carcass Characteristics of Goslings. J. Anim. Vet. Adv. 10**:**2079-2083.