

Effect of constant ME:CP at different levels of CP and ME on growth performance and meat characteristics of broilers from 1-28 days

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SUMMARY

The aim of present study was to investigate the effect of constant ratio between CP and ME at different levels of both nutrients on growth performance and meat characteristics of broilers from 1-28 days of age. One hundred and fifty day-old broiler chicks were divided into five units with 10 chicks in each unit. Each unit was fed on separate experimental diets from 1-28 days of age. Five starter rations were formulated in such a way to differ in CP (19.3%, 20.2%, 21.2%, 22.1% and 23.0%) and ME (2771, 2837, 2963, 3090 and 3216 Kcal/Kg of diet) but all have constant CP: ME (which was 1:140). At the end of trial, growth performance and meat characteristics data were collected. The results of feed consumption and feed conversion ratio showed significant ($P<0.05$) difference in five units fed on five experimental diets separately while weight gain remained unaffected ($P>0.05$). In addition, meat characteristics did not change by changing CP or ME levels ($P>0.05$). The results of present concluded that feed consumption decreased while FCR improve as the diet nutrient density increased. However, it is concluded from present study that in broiler starter period (1-28 days) CP and ME can be lowered up to 19.3% and 2771 Kcal/Kg of diet respectively, without impairing performance of broiler.

Keywords: broilers, digestible amino acids, growth performance, meat characteristics

INTRODUCTION

Feed contributes about 70% of poultry production cost, out of which about 95% cost is used to meet protein and energy requirements. Among macro nutrients, crude protein (CP) and ME is the key element in formulation

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of diet for broilers in terms of cost (Kamran et al., 2004). As broilers are fast growing birds so demand a high CP diet to meet amino acids requirement and consequently increasing the overall cost of finished product (Kamran et al., 2004). However, CP level can be lowered up to certain level if optimum amino acid contents needed for growth and muscle development is provided (Kamran et al., 2004). It has been previously reported that broilers fed on marginal CP but supplemented with methionine and lysine performs well (Jensen and Colnago, 1991). Low CP diet with optimal levels of amino acids is better as birds are unable to utilize excess dietary amino acids efficiently and excessive amino acids are de-aminated and nitrogen is excreted as uric acid (Kamran et al., 2004). In contrary, birds fed on marginal CP level consume more feed in order to acquire the required nutrient level for growth resulting in increased carcass fat and decreased feed efficiency (Thomas et al., 1978) which can be voided if diet contains optimal levels of metabolisable Energy (ME) and amino acids. In addition, increasing environmental concern due to N excretion is also driving the nutritionists to formulate diets with low protein profiles (Moran et al., 1992; Kamran et al., 2004). If the amino acid levels and ME meet the bird's requirements, excessive can be avoided and maximum protein utilization may be achieved with low protein diets (Kamran et al., 2004).

Keeping in view, present study was planned to determine the effect of optimal levels of amino acids and ME, at low Dietary CP with constant ratio between CP and ME (1:140) on growth performance and carcass characteristics of broilers from 1-28 days of age.

MATERIAL AND METHODS

All methods and management procedures employed in this study were according to the guidelines established by Directorate of Research, University of Agriculture, Faisalabad, Pakistan.

Birds and housing

One hundred and fifty day-old Hubbard broiler chicks of mixed sex were purchased from the local market. These chicks were wing banded, marked with different numbers for identification and randomly divided into experimental units of ten chicks each. The house was cleaned and disinfected before fumigation with KMnO_4 . Two inch deep saw dust was used as litter material. Temperature was maintained at 33°C during first week and gradually lowered at the rate of $3^\circ\text{C}/\text{week}$ till it reached at 25°C . Twenty four hour light was provided in the broiler house for first three days, then 23 hours for remaining period (Renden et al., 1992). All chicks were vaccinated against infectious

Bursal and Newcastle disease according to local schedule as described by Poultry Research Institute Rawalpindi.

Table 1: Composition of broiler diets fed from 1-28 days of age

Ingredients (%)	Rations				
	A	B	C	D	E
Corn	53	52	51	50	49
Soybean meal	30	32	34	36	38
Wheat bran	5	3.75	2.5	1.25	0
Corn gluten meal 60%	0	0.75	1.5	2.25	0
Corn gluten meal 30%	2	1.5	1.0	0.5	0
Bone ash	1.73	1.75	1.77	1.80	1.82
Limestone	1.17	1.15	1.13	1.11	1.09
DL. Meth.	0.20	0.20	0.20	0.20	0.20
Soy oil	0.0	1.65	3.3	4.95	6.6
Molasses	6.6	4.95	3.3	1.65	0
Vitamin mineral premix ¹	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100

¹Supplied per kg of diet: Vitamin A (as retinyl acetate), 4360 IU; vitamin D3 (as cholecalciferol), 1000 IU; vitamin K (menadione sodium bisulfite), 2.8 mg; Thiamine, 1.5 mg; Riboflavin, 6 mg; Niacin, 30 mg; Pantothenic acid, 14 mg; Pyridoxine, 1.5 mg; Cyanocobalamin, 0.016 mg; Folic acid, 1 mg; Biotin, 0.1 mg; Manganese, 600 mg; Zinc, 200 mg; Ferrous, 150 mg; Copper, 30 mg; Sodium chloride, 1500 mg

Table 2: Chemical composition of diets fed to broilers form 1-28 days of age

Ingredients (%)	Rations				
	A	B	C	D	E
Crude protein%	19.34	20.25	21.15	22.05	22.96
ME (Kcal/Kg)	2711	2837	2963	3090	3216
P:E ratio	1:140	1:140	1:140	1:140	1:140
Calcium	1.00	1.00	1.00	1.01	1.01
Phosphorus (available)	0.45	0.45	0.45	0.45	0.45
Digestible amino acids ¹ (%)					
Lysine	0.877	0.923	0.968	1.014	1.059
Methionine	0.448	0.463	0.478	0.493	0.508
Histidine	0.471	0.492	0.513	0.534	0.554
Tryptophan	0.195	0.204	0.214	0.223	0.232
Threonine	0.629	0.663	0.697	0.731	0.765
Arginine	1.086	1.138	1.189	1.241	1.292
Isoleucine	0.663	0.702	0.740	0.778	0.817
Leucine	1.540	1.644	1.748	1.852	1.956
Phenylalanine	0.869	0.924	0.980	1.035	1.091
Valine	0.803	0.844	0.886	0.927	0.968

¹Digestible amino acids were calculated

Feeding regimen

Five starter rations were formulated in such a way to differ in CP (19.3%, 20.2%, 21.2%, 22.1% and 23.0%) and ME (2771, 2837, 2963, 3090 and 3216 Kcal/Kg of diet) but all have constant CP: ME (which was 1:140) (Table 2). The computer package used for the formulation of diet was Uses Friendly Feed formulation (UFFF) program (Gene et al., 1986). Digestible amino acids requirements in each treatment were based on research of Baker and Han (1994). Each broiler ration was fed to three experimental units. The allotment of rations was at random. Broiler starter rations were fed to chicks from 1 to 28 days. The chicks were fed at ad-libitum.

Data collection

Records of amount of feed offered and consumed by each experimental unit were maintained on weekly basis. The feed consumption was recorded by subtracting the refused feed weight from the offered weight. Data regarding weekly body weight gain/chick/experimental unit were calculated. Weekly feed conversion ratio (FCR) was determined as the ratio between feed consumed and weight gained of each experimental ration. At the end of experiment on 28th day, two chicks from each experimental unit were selected randomly and slaughtered to obtain data regarding dressing percentage, breast meat weight, abdominal fat weight and meat production. Fat and protein contents of breast meat were determined. The meat samples were prepared following method described by de-Almeida et al (2006) and protein content was calculated as nitrogen amount multiplied by 0.625 per 100 g of meat. The nitrogen content was determined by the Kjeldahl procedure (method 928.08 described in Cuniff, 1997). Similarly, fat content was determined by following method described by (de-Almeida et al., 2006).

Statistical analysis

Data collected for different traits was analysed by Analysis of Variance (ANOVA) technique in a Completely Randomized Design. The means were partitioned by Duncan's New Multiple Range test (Steel et al., 1997).

RESULTS

In present study by lowering CP level in diet but maintaining optimal levels of essential amino acids and CP:ME ratio (1:140) feed intake decreased linearly as CP and ME level increased which eventually improve FCR while there was no effect on body weight gain. Statistical analysis showed significant linear ($P < 0.05$) effects on feed intake and FCR. Highest feed intake was observed in birds fed on ration A and lowest in birds fed on ration E similarly, poor FCR was

observed in broilers fed on ration A and the best FCR was recorded in broilers fed on ration D. However, non-significant impact on weight gain was observed (Table 3).

Table 3: Performance of broilers fed on different diets varying in CP and ME from 1-28 days of age

Parameters	Experimental diets					SEM	Probabilities		
	A	B	C	D	E		L	Q	C
Feed consumption (g)	2040.90 ^a	1919.53 ^{ab}	1952.43 ^{ab}	1856.57 ^b	1634.17 ^c	33	*	NS	*
Weight gain (g)	955.73	1036.47	1002.23	1014.8	892.13	33	NS	NS	*
Feed conversion ratio	2.14 ^a	1.85 ^b	1.95 ^b	1.83 ^b	1.84 ^b	.008	*	NS	*

NS; Non significant, *; significant results, SEM; Standard error of mean, L; Linear response of the treatments, Q quadratic response of the treatments, C; Cubical response of the treatments.

Similarly, by lowering CP level in diet but maintaining optimal levels amino acids and CP:ME ratio (1:140) did not change dressing percentage across all the dietary treatments. It also did not effect abdominal fat weight and gizzard weight but heart and liver showed significant ($P < 0.05$) linear trend. However, carcass CP and fat content) showed same results in all treatments but DM contents were different ($P < 0.05$) for across all dietary treatments (Table 4).

Table 4: Carcass characteristics of broilers fed on different experimental diets varying in CP and ME from 1-28 days of age.

Parameters	Experimental diets					SEM	Probabilities		
	A	B	C	D	E		L	Q	C
Dressing percentage	53.35	54.35	53.50	52.73	53.87	0.096	NS	NS	NS
Breast weight (g)	197	176.60	178.6	199	189.30	0.951	NS	*	*
Abdominal fat (g)	2.09	2.98	2.24	1.7	2.32	0.078	NS	NS	*
Meat Analysis (%)									
Dry matter	25.71	26.20	25.6	25.2	26.6	0.061	NS	*	*
Crude protein	24.06	24.06	24.06	24.06	24.06	0.007	NS	NS	NS
Ether extract	0.5	0.5	0.5	0.5	0.5	0.009	NS	NS	NS

NS; Non significant, *; significant results, SEM; Standard error of mean, L; Linear response of the treatments, Q quadratic response of the treatments, C; Cubical response of the treatments.

DISCUSSION

Experiment 1

In current study, varying levels of CP and ME affected the feed intake. A significant depression in feed intake had been observed with increasing level of CP and ME, although ratio was fixed among CP and ME, CP and AA and also among individual AAs. These results indicate that birds have the ability to

adjust the feed intake with changing energy level. It becomes more complex when we monitor the nutrient requirements of the birds. As dietary energy level increases other nutrients requirements also increase and with decreasing energy concentration nutrient requirements decrease because, as energy increases feed intake decreases (Leeson and Summer 2001). Similar, results have been reported in previous studies of Kidd et al. (2001) and Bregendahi et al. (2002) they observed increased feed intake in broilers fed on CP 20% and supplemented with amino acids as compared to those fed on 23% CP in diet with un-supplemented synthetic amino acids. Jiang et al. (2005) has reported that as essential amino acids concentration is increased the feed intake decreased because bird's requirements are met much earlier. In more recent study by Hernandez et al. (2012), significant effects on average daily feed intake in broilers fed on low protein as compared to birds fed control from 35 to 42 day of age have been reported.

This study further strengthens our hypothesis that amino acids have the importance to meet protein requirements rather than CP. However, results of present study are not in line with the study of Corzo et al. (2002) who reported that increasing lysine concentration with fix ratio to other amino acids have no impact on feed intake in male broilers between 42-56 days of age. Similar results have been reported by Kamran et al. (2004) who reported no differences in feed intake in all diets with low protein having optimal levels of essential amino acids as compared to high protein diet without amino acids supplementation with fixed caloric value. The contrasting results of these both studies are natural as birds feed intake depends upon the caloric value of feed so fixed ME in both studies resulted in unaltered output. However, in current study the energy concentration varies among all diets to keep a fixed protein: energy ratio, so birds adjusted feed intake accordingly. These non-significant impacts on feed intake are also reported in previous studies carried on lowering protein from 23% to 20% in poultry diets (Han et al., 1992; Bartov and Plavnik, 1998). These non-significant differences of feed intake might be the results of closely similar energy concentration of diets (Melesse, 2007) or possibly because of the level of protein did not alter palatability of the diets (Pond et al, 2005).

A protein diet if deficient by one or more limiting AAs results in lowered growth rate (Church, 1991), and if supplemented with AAs in excess (Sklan and Plavnik, 2002) is both energetically and economically inefficient or even may result in ammonia toxicity (Perry et al., 2004). In continuation of above statement, current study results indicated that, as NRC 1994 recommended that by keeping the ratio between CP and energy narrow, CP and energy levels can be lowered down up to a certain extent provided that the balance among AAs is maintained.

The results of present study are in line with the study of Corzo et al., (2002) who reported that increasing lysine concentration and keeping its ratio with other amino acids same have no impact on body weight of male broilers. The results of present trial however, were in contradiction to the study of Kamran et al. (2004) who reported an increase in body weight gain in response to lower protein diets when optimal essential AAs level was maintained in hot climate as compared to high protein diets without considering the level of essential AAs. Similar, contrary results have been reported by Thim et al. (1997) when protein in diet was lowered up to 20%. In more recent study by Hernandez et al. (2012) significant depression in body weight had been observed in birds fed on low protein diets as compared to the control. Hussein et al. (2001) reported partial body weight depression due to lowered protein diets fortified with AAs and extra energy. Current study was carried out with optimal levels of AAs and CP: ME was same among all dietary treatments thus no growth depression was observed which is confirmed by previous studies (Kerr and Kidd, 1999; Moran 1994).

As expected, improved FCR results were obtained by increasing CP levels with. But main effect was of feed intake which was reduced with increasing nutrient density in diet. These results were further supported by the study of Corzo et al. (2002) who reported that there was no effect of increasing lysine concentration and by keeping its ratio fixed with other AAs on FCR of male broilers aged between 42 to 56 days. Kamran et al. (2004) reported that broilers fed on lowered CP with supplemented AAs by keeping ratio constant among AAs as compared with high CP without considering essential AAs levels have no impact on FCR. Similarly, Bartov and Plavnik (1998) reported non-significant effect on FCR by decreased level of protein from 23% to 20%. Similarly, Araujo et al. (2004) observed better FCR with iso-proteinous and iso-caloric diets with constant lysine but different ratio of methionine, Meth+cystiene and threonine in broilers.

The divergences in reports of different authors could be due to many dynamics including the relationship between dietary CP levels and energy and AA fortification or other factors impacting bird's requirements, such as age, sex, genotype and managerial strategies.

As expected the optimal levels of protein, ME and AAs resulted in non-significant results of dressing percentage and breast and abdominal fat weight. Kamran et al. (2004) also reported unaltered results of carcass yield, breast meat yield and abdominal fat percentage in broilers fed on low protein diets supplemented with optimal levels of AAs. Previous studies (Holsheimer and Ruesink, 1993; Griffiths et al., 1977; Waldroup et al., 1991; Si et al., 2001) also showed similar findings of fat percentage in breast and leg muscles of broilers. The findings of Bartov and Plavnik (1998) were in contrast with present study

because they compared different protein:energy ratios. They observed increased breast meat yield but decreased fat percentage at low protein:energy ratio by increasing CP content in iso-caloric diet or by decreasing ME content at a constant CP level. In their research, they changed the protein:energy ratio but we kept them same so our results were non-significant and remained unaffected in case of both breast meat yield and abdominal fat percentage.

Unaltered results of current study regarding meat analysis are in line with those reported by Kamran et al. (2004) who observed unaffected CP and fat of breast meat with low protein diet in broilers. These results are also in accordance with the findings of Shahid (1997) who reported that formulation on total as compared to digestive AAs has a non-significant effect on the carcass CP values of chicks. Similar results had been reported in previous studies (Robins, 1981; Han et al., 1992; Holseimer and Ruesink 1993).

CONCLUSIONS

The present study result has indicated that CP level of diet could be lowered up to 19.34% and ME 2771 Kcal/Kg without impairing body weight gain of birds or meat characteristics provided that all essential amino acids requirements are met at this CP and ME level. However, for better FCR higher levels of CP and ME are required.

REFERENCES

- Araujo, L.F., Junqueira, O.M., Arahjo, C.S.S., Faria, D.E., Andreotti, M.O. 2004. Different criteria of feed formulation for broilers aged 43 to 49 days. *Braz. J Poult. Sci*, 6, 61-64.
- Baker, D. H., Han, Y. 1994. Ideal amino acids profile for chick during the first three weeks post hatching. *Poult. Sci.* 73, 1441-1447.
- Bartove, I., Plavbnik, I. 1998. Moderate excess of dietary protein increases breast meat yield of broiler chicks. *Poult. Sci.* 77, 680-688.
- Bregendahl, K., Sell, J.L., Zimmerman, D.R. 2002. Effects of low protein on growth performance and body composition of broiler chicken. *Poult. Sci.* 81, 1156-1167.
- Church, D.C., Vareia-Alvarez. 1991. Ration formulation. In: *livestock feed and feeding 3rd Ed.* D.C. Church, Ed. Prentice Hall, Englewood Cliffs, New Jersey USA.
- Corzo, A., Moran, E.T. Jr., Hoohler, D. 2002. Lysine need of heavy broiler males applying the ideal protein concept. *Poult. Sci.* 81, 1863-1868.

- Cuniff, P. In: 1997. AOAC International. Official methods of analysis of AOAC international. 16 ed. Maryland USA: AOAC, Vol. II pp5-6.
- De-Almeida J.C., Neura-Bragagnolo, M.S.P., Gross, J.L., Camargo, J.L. 2006. Fatty acid composition and cholesterol content of beef and chicken meat in southern Brazil. *Braz. J Pharm Sci.* 42, 109-117.
- Gene, MP., Miller, BR., Chamber, R. 1986. User friendly feed formulation program, Univ. Of Georgia, USA
- Griffiths, L., Leeson, S., Summers J.D. 1997. Influence of energy system and level of various fat sources on performance and carcass composition of broilers. *Poult. Sci.* 56, 1018-1026.
- Han, Y., Suzuki, C., Parsons, M., Baker, D.H. 1992. Amino acid fortification of low protein corn and soybean meal diets for chicks. *Poult. Sci.* 71, 1168-1178.
- Hernandez, F., Lopez, M., Martinez, S., Meglas, M.D., Catala, P., Madrid, J., 2012. Effect of low protein diets and single sex on production performance, plasma metabolites, digestibility and nitrogen excretion in 1 to 48 day old broilers. *Poult. Sci.* 91, 683-692.
- Holsheimer, J.P., Ruesink, E.W. 1993. Effect on performance, carcass composition, yield, and financial return of dietary energy and lysine levels in starter and finisher diets fed to broilers. *Poult. Sci.* 72, 806-815.
- Hussein, A.S., Cantor, A.H., Pescatore, A. J. 2001. Effect of low protein diets with amino acid supplementation on broiler growth. *J. Appl. Poult. Res.* 10, 354-362.
- Jensen, L.S., Colnago, L. 1991. Amino acids and proteins for broilers and laying hens. *Proc. Maryland Nutr. Conf. for Feed Manufacturers*, Baltimore, USA, pp 29-36.
- Jiang, Q., Waldroup, P.W., Fritts, C.A. 2005. Improving the utilization of diets low in crude protein for broiler chicken. 1 Evaluation of special amino acids supplementation to diets low in crude protein. *Inter. J. Poult. Sci.* 4, 115-122.
- Kamran, Z., Mirza, M.A., Haq, A.U., Mahmood S. 2004. Effect of decreasing dietary protein levels with optimal amino acids profile on the performance of broilers. *Pak Vet J.* 24, 165-168.
- Kerr, B.J., Kidd, M.T. 1999. Amino acid supplementation of low-protein broiler diets: 2 Formulation on ideal amino acid basis. *J. Appl. Poult. Res.* 8, 310-320.
- Kidd M.T., Peebles, E.D., Whitmarsh, S.D., Yeatman, J.B., Wideman, R.F. Jr. 2001. Growth immunity of broilers chicks as affected by dietary Arginine. *Poult. Sci.* 80, 1535-1542.

- Mellesse, A., 2007. Poultry production and Management in the tropics: Teaching material Hawassa University, college of Agriculture, Hawassa, Ethiopia, pp 195-206.
- Moran, E.T., Bushong, R.D., Bilgili, S. F. 1992. Reducing dietary crude protein for broiler while satisfying amino acids requirement by least cost formulation: live performance, litter composition and yield of fast-food carcass cuts at six weeks. *Poult. Sci.* 71, 1687-1694.
- N. R. C. (1994): Nutrient requirements of poultry. Ninth ed. National Academy press Washington, Dc, USA.
- Perry, T.W., Cullison, A.E., Lowrey, R.S. 2004. Feeds and Feeding 6th Ed. Prentice Hall, USA.
- Pond, W.G., Church, D.C., Pond, K.R., Schoknecht, P.A. 2005: Basic animal Nutrition and feeding. 5th Ed. Wiley. USA.
- Renden, J.A., Bilgili, S.F., Kincoide, S.A. 1992. Live performance and carcass yield of broiler strain crosses provided either sixteen or twenty three hours of light per day. *Poult. Sci.* 71, 1427-1435.
- Robbins, K.R. 1981. Effects of sex, breed, dietary energy level. Energy source and calorie: protein ratio on performance and energy utilization by broiler chicks. *Poult. Sci.* 60, 2306-2315.
- Rostango, H. S., Pupa, J.M.R. 1995. Diet formulation for broilers based on total versus digestible amino acids. *J. Appl. Poul. Res.* 4, 293-299.
- Shahid, F. 1997. Digestible amino acids as a base of ration formulation M.Sc. thesis. University of Agriculture, Faisalabad.
- Si, J., Fritts, C. J., Burnham, D. J., Waldroup, P. W. 2001. Relationship of dietary lysine levels to concentration of all essential amino acids in broiler diets. *Poult. Sci.* 80, 1472-1479.
- Sklan, D., Plavnik, K. 2002. Interactions between dietary protein and essential amino acids intake on performance in broilers. *Br. Poult. Sci.* 43, 442-449.
- Steel R.G.D., Torrie J.H., Dickey, D.A. 1997. Principles and Procedures of Statistics. A Biometrical Approach. 3rd Ed. McGraw Hill Book Co. New York, USA.
- Steel, R.G.D., Torrie, J.H., Dickey, J.D. 1997. Principles and procedures of statistics: A biometrical approach. 3rd ed. McGraw-Hill book Co., New York, NY.
- Thim, K. C., Hamre M.L., Coon, C.N. 1997. Responses of broilers to dietary protein levels and amino acids supplementation to low protein diets at various environmental temperatures. *J. Appl. Poult. Res.* 6, 18-33.
- Thomas, O.P., Twining, P.V. Jr., Bossard, E.H. 1978. The lysine and sulfur amino acids for broilers. *Proc. Georgia Nutr. Conf. Atlanta, GA, USA*, pp 27-35.

- Waldroup P. W., Tidwell N. M., Izat A. L. (1991): The effect of energy and amino acids level on performance and carcass quality of male and female broiler grown separately. *Poult. Sci.* 69, 1513-1521.
- Waldroup, P.W., Jiang, Q., Fritts, C.A. 2005. Effects of glycine and threonine supplementation on performance of broiler chicks fed diets low in crude protein. *Inter. J. Poult. Sci.* 4, 250-257.