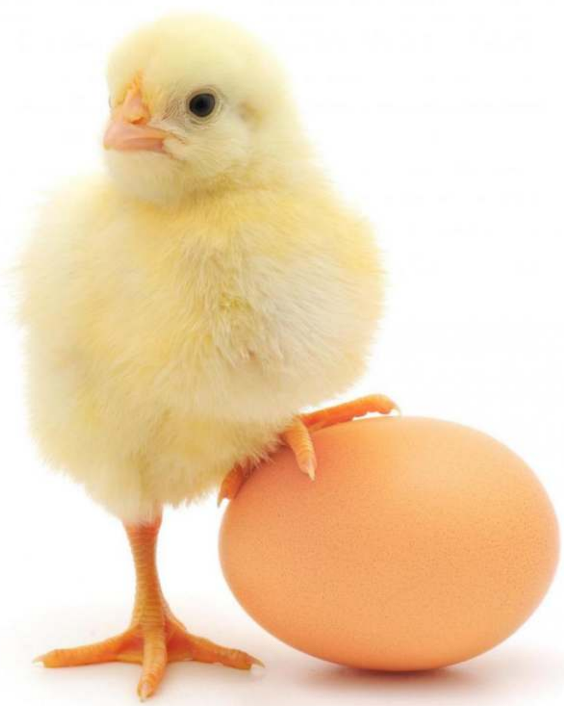
ISSN 1682-8356
ansinet.org/ijps



INTERNATIONAL JOURNAL OF
POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 5 (11): 1082-1086, 2006
ISSN 1682-8356

Influence of β-Adrenergic Agonist (Metaproterenol) and Lysine on Growth, Carcass Quality in Broiler Chickens

A.M. Tahmasbi, E. Kashefi, Gh. Moghadam, A. Taghizadeh and H.A. Ghasemi
Department of Animal Science, College of Agriculture, University of Tabriz, Iran

Abstract: An investigation was made to find out the importance of β - adnergenic and lysine on carcass characteristics and blood metabolite of 648 broiler chickens from 21- 42 days of age. Effect of metaproterenol (a β2- adrenergic agonist) and lysine were assessed by mixing them in feed at 0.0, 0.25, 0.50 and 1.00 ppm metaproterenol sulfate and 100%, 115% and 130% of NRC recommended lysine in a 4×3 factorial arrangement of treatments. Chickens were reared under normal condition to 3 week of ages and then randomly allocated to treatments. Each treatment contained 3 pens with 18 birds/pen. Body weight gains (BWG), feed conversion ratio (FCR) abdominal fat pat (AFP) breast weight (BW) were measured. Result indicate that during 4th and 5th week of study using metaproterenol (0.5 ppm), compare to control group, improved BWG (5.1%), carcass efficiency (3.4%) and breast weight (2.2%), breast and thigh muscle protein and depressed abdominal fat ($P<0.05$). Increasing lysine levels lead to significant increase in body weight gain, carcass weight, carcass efficiency, breast muscle weight ($P<0.5$), but it has no effect on feed intake, feed conversion ratio, blood metabolites. Data from this experiment suggested that both adding 0.5 ppm β-adrenergic agonist metaproterenol sulphate significantly improved birds performance and their carcass quality and the most efficient lysine level for broiler chickens was proved to be 115% NRC recommended.

Key words: Broiler, adrenergic agonist, carcass composition, Metaproterenol

Introduction

Feeding programs have primarily emphasized live performance of meat birds taking into account effect on live weight gain, feed conversation and some time liveability (Noll, 2002). Carcass composition has become increasingly more important in recent times as the consumer demand for leaner meat increased. Excess fat production, however, by modern broiler chickens presents a two-fold problem. The consumer has health concerns about the link between cardiovascular disease and dietary fat (Rosebrugh, 2001) moreover broiler producer would like to produce more lean meat rather than fat due to more energy is required to deposit a kilogram of fat that same weight of lean. These facts have provoked a shift of attention to adrenalin and nonadrenalin- analog compound, which have shown evidences of having an important effect on increasing the production of lean meat and reducing the amount of fat deposition (Cardoso and Stock, 1996). The positive effect of β - adrenergic agonist (β - agonist) on altering carcass composition in the desired direction while at the same time increasing carcass weight without increasing feed intake are well documented in meat producing animals (NRC, 1990; Wellenreter, 1991; Smith, 1998) while the exact mechanism of action of these compound remained unclear. It is believed that these compounds interact with β- adrenergic receptors in some organs and initiate a cascade of events that cuminates in tissue responses and partitioning of energy away from fat synthesis and into protein accretion and so improve carcass quality. Waldroup *et al.* (1997) founded that Large white toms increased percentage breast meat yield (BMY) as diets formulated to provide 85 to 120% of NRC (1994) recommendation for amino acids increased in protein content. Lysine is a second limiting amino acid in diets based on corn and soybean meal. Lysine recommended by NRC (1994) for broiler is 11.0, 10.0 and 8.5 g /kg. Lehmann *et al.* (1996) indicated a response to lysine for male turkey during 16-20 wks of age in excess of NRC (1994) (0.8 % vs. 0.96%) for growth and breast yield. Han and Baker (1994) also found a higher lysine requirement for breast meat yield in comparison to that for body weight. However, amino acid balance may compromise breast meat yield (Morris *et al.*, 1999). Therefore it was though of interest to develop a controlled trial to evaluate the effect of β-adrenergic agonist (Metaproterenol) and optimum level of crystalline lysine which can be added to practical broiler rations.

Materials and Methods

Six hundred and eighty two - day old Ross broiler chicks were used from 21- 42 days old to investigate of broiler performance and meat quality as influences by β-adrenergic agonist, lysine and their interactions. Diet were formulated based on corn- wheat- soybean meal and supplemented by crystalline lysine and β-adrenergic agonist. Composition of diets is shown in Table 1. Three replicate pens (eighteen birds per pen) of a completely randomized design were used in a 4×3

Table 1: Composition of the basal diets

Item	Experimental diets (Lysine %) 100% NRC	115% NRC	130% NRC
Corn	53.8	53.8	53.8
Wheat	14.4	14.4	14.4
Soybean meal	23.0	23.0	23.0
Fat meal (8000 Kcal/kg)	2.1	2.1	2.1
Fish meal	3.2	3.2	3.2
Dicalcium phosphate	1	1	1
Oyster shell	1.2	1.2	1.2
Salt	1.0	1.0	1.0
Vitamin premix[1]	0.5	0.5	0.5
Mineral premix[2]	0.5	0.5	0.5
DL- Methionine	0.1	0.1	0.1
Lysine	0.0	0.192	0.384
Metaproterenol sulfate[3]	0	0	0
Calculated composition			
ME, Kcal/kg	3026.2	3026.2	3026.2
CP (%)	19.229	19.229	19.229
Ca (%)	0.9	0.9	0.9
Available phosphorous	0.43	0.43	0.43
Lysine	1.00	1.15	1.300
Methionine	0.47	0.47	0.47

[1] Supplied per kilogram of diet: 600 IU Vit A, 800 IU Vit D_3, 8 mg Vit E, 2 mg Vit B_6, 8 mg Vit B_{12}, 10 mg Nicotine amid, 0.3 mg Folic acid, 20 mg D- Biotin and 160 mg Cholin Chloride. [2]Supplied per kilogram of diet: 32 mg Mn, 16 mg Fe, 24 mg Zn, 2 mg Cu, 800 µg I, 200 µg Co and 60 µg Se. [3]The source of β-adrenergic agonists was metaproterenol sulfate which was added to each diet at levels of, 0.0, 0.25, 0.50 and 1.00 ppm.

factorial arrangement of treatment with 4 levels of β-adrenergic agonist metaproterenol sulfate (0.0, 0.25, 0.50, 1.00 ppm), 9 levels of lysine (100%, 115%, 130% NRC recommended).

At one day of age, chicks were randomly allocated to pens and fed recommended diets (NRC, 1994) without any supplementation. The fortified by β - adrenergic agonist and lysine diets were given from day 21 to 42 days of ages. All diets were provided in mash form. Chickens were weighted weekly. Chicks were exposed to continuous fluorescent light with water and food available *ad libitum*. Subsequent analysis showed that the start weights were not significantly different. Feed consumption was measured daily, the refusal feed were discarded and feed efficiencies were calculated. On day 42, one bird per pen was randomly selected and blood sample was collected from wing vein.

Samples were immediately centrifuged (3000×g, 10 min) and plasma portion were collected into tubes and stored at -20°C until further analysis. Also one bird per pen was killed and after careful dissection, the weights of the following tissue were measured: breast, muscle (*pectoralis major*), leg muscle (*gastrocnemius and peroneous longus*), abdominal fat, liver, and heart. Samples of these tissues were taken and stored at – 20 °C until require for analysis.

Data for all responses variable were analysed as a completely randomized design based on 4 ×3 factorial arrangement using the general linear models procedure (Statistical Analysis Systems Institute, 1999). Food intake and food conversion ratio (FCR) were analysed using a pen as the experimental unit. Differences between treatments were compared by the Duncan's multiple range test following ANOVA, and values were considered statistically differences at p<0.05. Results are reported as least square means with standard error.

Results

Comparison of body weight gain (BWG) and feed conversion ratio (FCR) from feeding of metaproterenol sulfate at levels of 0.0, 0.25, 0.50 and 1.00 ppm and lysine at levels of 100%, 115% and 130% recommended by NRC to broiler chickens during the final 3 weeks of study (21-42 days of ages) are presented in Table 2. The results show that addition of 0.50 ppm metaproterenol sulfate to diets had significantly (P<0.05) effects on the weight gain during 21-35 days of ages, although the difference between 0.25 and 0.5 ppm statistical was not significant. At the final week of experiment the results show no obvious advantage of supplement β-adrenergic agonists. Main effect of lysine on BWG was significant (P<0.05) during 21-35 days of ages, but at the end week of study the BWG was affected by lysine supplementation. The best result was obtained by addition of 15% more lysine than recommended by NRC (1994). The interaction between metaproterenol sulfate and lysine on BWG was not significant during the study. The influence of diets containing metaproterenol sulfate and lysine on FCR were not statistically significant (P>0.05) during the study. However, diets containing metaproterenol sulfate suggested (0.25 ppm) improvement of the FCR of broiler compare to control diets with 0.08 proportional improvements. For all performance parameter, there was no dose-dependent response effect and diets containing more than 0.50 ppm metaproterenol sulfate and 115% lysine had no additional benefit.

The influence of dietary treatments on weight of carcass muscle and organs are summarized in Table 3. β-adrenergic agonist, significantly (p<0.01) influenced the carcass weight, carcass efficiency (p<0.05), muscle breast (p<0.01), and abdominal fat pad (p<0.05). There was no effect of metaproterenol sulfate on the leg muscle, liver and heart weight. Lysine supplementation improved carcass weight (p<0.05), carcass efficiency (p<0.01), muscle breast (p<0.01).

The results of the influence of metaproterenol sulfate and lysine on composition of breast and leg muscle are presented in Table 4. Diets containing metaproterenol sulfate had a significantly effect on breast and leg muscle composition. There was no effect of lysine on the breast and leg muscles composition. The metaproterenol sulfate × lysine interaction was not statistically significant (p>0.05) for any measured

Table 2: Effect of diets containing metaproterenol sulfate and lysine on body weight gain and feed conversion ration of broiler (21- 42 days of ages)[1, 2].

	Body weight gain (g)				Feed Conversion ratio (g:g)			
	21-28 days	28-35 days	35-42 days	21-42 days	21-28 days	28-35 days	35-42 days	21-42 days
Metaproterenol sulfate								
0.0 ppm	1089.4[b]	1584.6[b]	2149.6[a]	1476.2[a]	1.27[a]	1.70[a]	2.19[a]	1.77[a]
0.25 ppm	1107.3[ab]	1623.1[ab]	2173.8[a]	1506.3[a]	1.29[a]	1.58[a]	2.11[a]	1.69[a]
0.50 ppm	1125.2[a]	1656.2[a]	2223.7[a]	1556.3[a]	1.27[a]	1.72[a]	2.15[a]	1.75[a]
1.00 ppm	1094.1[b]	1591.2[b]	2166.6[a]	1496.3[a]	1.32[a]	1.75[a]	2.19[a]	1.79[a]
SEM	8.44	11.45	21.81	21.28	0.03	0.046	0.11	0.043
Lysine								
100%	1082.2[b]	1576.1[b]	2141.1[a]	1472.6[b]	1.30[a]	1.73[a]	2.05[a]	1.73[a]
115%	1120.9[a]	1650.4[a]	2230.2[a]	1559.3[a]	1.28[a]	1.70	2.22[a]	1.81[a]
130%	1108.9[ab]	1614.8[ab]	2163.9[a]	1494.0[ab]	1.29[a]	1.63	2.11[a]	1.71[a]
SEM	7.31	9.92	18.89	18.43	0.26	0.039	0.095	0.037
Significant[3]								
Metaproterenol sulfate	**	**	ns	ns	ns	ns	ns	ns
Lysine	**	**	ns	**	ns	ns	ns	ns
M ×L	ns	ns	ns	ns	ns	ns	ns	ns

[1]Mean value of three pens (eighteen birds per pen) per treatment group. [2]Mean on the same column with different superscript are significantly ($p<0.05$) different. [3]**$p<0.01$, ns: non significant.

parameters. Moisture content of breast muscle were not affected by metaproterenol sulfate ($p>0.05$).

Discussion

The ascertain that specific β-agonists would act in animal to stimulate the production of lean tissue while at the same time limiting the deposition of internal and subcutaneous fat has led to the development of a potential new class of feed additive (Dalrymple and Ingle, 1987). In other hand, there are some evidences that demand for some essential amino acid in broiler diets is higher than levels recommended by NRC (Noll, 2002; Rezaei *et al.*, 2004).

The present study demonstrate that inclusion of β-adrenergic agonist (metaproterenol) and lysine, higher than the recommended level, in the diets of broiler has considerably increased body weight gain and improved FCR. Feed conversion ratio was favorably affected by metaproterenol due to the higher growth rate. The finding that β-adrenergic agonist induces a changing the metabolic pathway by inactivation of protein acceleration (Leeson, 2000; Hamano *et al.*, 2002) Decreased weight gain and a lesser numerical response in feed conversion ration at 10 ppm metaproterenol sulfate, suggests that this level is excessive for optimal performance. In other hand, feed conversion ratio is economically is the most important measure for productivity, result presented here evident that feed supplement with metaproterenol sulfate resulted to large growth response and moderate improvement in feed conversion ratio in broiler chickens in agreement with results obtain by Moody *et al.* (2000). The results are not indicative of any improvement of feed conversion ratio within the range of lysine tested consent with results obtained by Kerr *et al.* (1999) and Rezaei *et al.* (2004). Birds given diets containing metaproterenol sulfate, had trend to lower liver, heart weight and abdominal fat pad ($p<0.05$) which are in agreement with Jones *et al.* (1985) and Takahashi *et al.* (1998). The reduction of carcass fat may be inactivate of inhibition of lipid synthesis (Duquett and Muir, 1982). Improvement in body weight gain and subsequently breast weight indicated that probably these compound promotes muscle hypertrophy as reported by Hanrahan *et al.* (1987). In fact the effects of metaproterenol on carcass composition are substantial with the abdominal fat (Table 3), however the same results was not observed by inclusion different levels of lysine in diets.

With regard breast and leg muscle composition effects, there was a consistent reduction in fat content both muscles, with corresponding increases in breast and leg protein (Table 4). Metaproterenol administration promotes muscle hypertrophy and breast muscle being increased. These results were consistence with responses to other β-adrenergic agonist in broiler reported by Hamano *et al.* (1998), but there is some *in vitro* evidence that adipose tissue from poultry is less sensitive to β-agonists than ruminants (Muir *et al.*, 1985; Thornton *et al.*, 1987). This could be a consequence of differences in control of fat metabolism between mammals and birds. Muir *et al.* (1985) in *in vitro* study show lipolysis in adiposcytes originatating from poultry is hardly stimulated by β-agonists treatment.

In summary, the result of the present study indicated that large effect of metaproterenol sulfate on BWG and carcass composition and significantly improvement in breast muscle weight make the use of β-agonists an exciting prospect in modifying the composition of broiler meat toward a lower fat product. On the basis of results of body weight gain breast w eight obtained from this

Table 3: Effect of diets containing metaproterenol sulfate and lysine on carcass muscle and organs[1,2].

	Carcass weight (g)	Carcass Efficiency (%)	Breast muscle (g)	Leg muscle (g)	Liver (g)	Heart (g)	Abdominal fat pad (g)
Metaproterenol sulfate							
0.0 ppm	1619[b]	72.00[b]	796[b]	690[a]	46[a]	10[a]	33[a]
0.25 ppm	1674[ab]	74.23[ab]	801[b]	691[a]	41[a]	8[a]	30[ab]
0.50 ppm	1702[a]	74.53[a]	814[a]	707[a]	43[a]	9[a]	28[b]
1.00 ppm	1651[b]	73.88[b]	808[ab]	691[a]	43[a]	9[a]	35[a]
SEM	0.619	0.619	3.59	5.32	2.31	0.58	1.3
100%	1612[b]	72.30[b]	798[b]	691[a]	45[a]	9[a]	32[a]
115%	1719[a]	74.94[a]	813[a]	699[a]	144[a]	9[a]	30[a]
130%	1653[ab]	73.76[ab]	801[ab]	694[a]	41[a]	8[a]	33[a]
SEM	10.19	0.536	3.11	4.61	2	0.5	1.12
Significant[3]							
Metaproterenol sulfate	**	*	ns	ns	ns	ns	*
Lysine	*	**	ns	**	ns	ns	ns
M ×L	ns	ns	ns	ns	ns	ns	ns

[1]Mean value of three birds per treatment group. [2]Mean on the same column with different superscript are significantly (p<0.05) different. [3] *<p<0.5; **p<0.01; ns: non significant.

Table 4: Effect of diets containing metaproterenol sulfate and lysine on breast and leg muscle composition [1,2]

	Muscle protein (%)		Muscle fat (%)		Moisture (%)	
	Breast	Leg	Breast	Leg	Breast	Leg
Metaproterenol sulfate						
0.0 ppm	21.1[b]	21.9[b]	7.4[a]	11.8[a]	66.8[a]	67.5[a]
0.25 ppm	25.7[b]	22.1[b]	6.1[ab]	11.5[a]	64.6[a]	65.7[a]
0.50 ppm	28.8[a]	26.0[a]	5.6[b]	9.6[a]	61.7[a]	60.5[a]
1.00 ppm	26.2[b]	23.4[ab]	6.4[a]	12.0[a]	69.1[a]	64.4[a]
SEM	9.05	0.92	0.31	0.67	2.71	1.33
100%	25.0[a]	22.7[a]	6.4[a]	11.3[a]	64.5[a]	63.5[a]
115%	25.8[a]	24.4[a]	6.3[a]	10.7[a]	70.3[a]	64.0[a]
130%	25.5[a]	22.9[a]	6.5[a]	11.6[a]	61.8[a]	66.0[a]
SEM	0.91	0.80	0.27	0.58	2.35	1.06
Significant[3]						
Metaproterenol sulfate	**	*	ns	ns	ns	ns
Lysine	*	**	ns	**	ns	ns
M ×L	ns	ns	ns	ns	ns	ns

[1]Mean value of three birds per treatment group. [2]Mean on the same column with different superscript are significantly (p<0.05) different. [3] *<p<0.5; **p<0.01; ns: non significant.

study, it may be speculated that the lysine may effect on body weight because of high portion of carcass, made of breast and also due to high level of lysine presented in this organ. Therefore, the present study suggested that maximum BWG was achieved at 115% of lysine recommended by NRC (1994) although the greater requirement over this level was thought to be due to other environmental factors.

References

Cardoso, L.A. and M.J. Stock, 1996. Effect of clenbuterol on growth and body composition during food restriction in rats. J. Anim. Sci., 74: 2245-2252.

Dalrymple, R.H. and D.L. Ingle, 1987. Effects of the beta-agonist CIM on growth, food efficiency and carcass composition in poultry in the USA.

Duquett, P.F. and L. Muir, 1982. Effect of the beta-adrenergic agonists isoproterenol, celnbuterol, L-640, 033 and BRL 35135 on lipolysis and lipogeesis in rat adipose tissue *in vitro*. J. Anim. Sci., 46: 310-3211998.

Hamano, Y., K. Kume, S. Yamazaki, S. Kobayashi and Terashima, 1998. Combined effects of clenbuterol and various concentrations of protein on performance of broiler chickens. Br. Poult. Sci., 39: 117-122.

Hamano, Y., 2002. Influence of lipolic acid on lipid metabolism and β - adrenergic response to intravenous or oral administration of clenbutarol in broiler chickens. Poult. Sci., 42: 307-316.

Han, Y. and D.H. Baker, 1994. Digestible lysine requirement of male and female broiler chicks during the period three to six weeks posthatching. Poult. Sci., 73: 1739-1745.

Hanrahan, J.P., 1987. Beta- Agonists and their effects on animal growth and carcass quality. Elsevier Applied Science. NY.

Jones, R.W., R.A. Easter, F.K. Mckeith and P.J. Becht. 1985. The effect of a β-adrenergic agonist on the growth and carcass characteristics of finishing swine. J. Anim. Sci., 61: 4-9.

Kerr, B.J., M.T. Kidd, K.M. Halpin, G.W. McWard and C.L. Quarles, 1999. Lysine level increases live performance and breast yield in male broiler. J. Appl. Poult. Res., 8: 381.

Leeson, S., 2000. Nutrition and quality of the broiler carcass. J. Agri. Food Sci., 43: 547-553.

Lehmann, D., M. Pack and H. Jeroch, 1996. Responses of growing and finishing turkey toms to dietary lysine. Poult. Sci., 75: 711-718.

Moody, D.E., D.L. Hancock and D.B. Anderson, 2000. Phenethanolamine repartitioning agents in: D, Mello, J.P.F. (Ed). Farm animal metabolism and nutrition. CABI Publishing, New York, pp: 65-69.

Morris, T.R., R.M. Gous and C. Fisher, 1999. An analysis of the hypothesis that amino acid requirement for chicks should be stated as a proportion of dietary protein. World's Poult. Sci. J., 55: 7-22.

Muir, L.A., S. Wein, P.F. Duquette and G. Olsen, 1985. Effect of the β-adrenergic agonists L-640,033 on lipid metabolism, growth and carcass characteristics of female broiler chickens. J. Anim. Sci., 61, Suppl, 1-138.

Noll, S.L., 2002. Feeding for live performance and breast meat yield. Multi- State Poultry Meeting.

NRC, 1990. Metabolic modifiers effects on the nutrient requirement of food-producing animals. National academy of Science. Washington, DC.

NRC, 1994. Nutrient requirements of domestic animals. Nutrient requirements of poultry. National academy of Science. Washington, DC.

Rezaei, M., H. Nassiri Moghaddam, J. Pour Reza and H. Kermanshahi, 2004. The effects of dietary protein and lysine levels on broiler performance carcass characteristics and N excretion. Int. J. Poult. Sci., 3: 148-152.

Rosebrugh, R.B., 2001. Dietary adrenergic active compounds and the response of broiler to isoproterenol and cyclic adenosine monophosphate *in vitro*. Int. J. Vit. Nutr. Res., 71: 352-355.

Smith, D.J., 1998. The pharmacokinetic, metabolism and tissue residues of β - adrenergic agonists in livestock. J. Anim. Sci., 76: 173-194.

Statistical Analysis Systems Institute, 1999.SAS/STAT User's Guide: Statistics. SAS Institute, Inc., Cary. NC.

Thornton, R.K., F.T. Baumann, D.H. Fishell, V.K. and B.A. Crooker, 1987. Effects of cimatrol on growth of hypophysectomized rats. Fed. Proc., 46: 1176.

Takahashi, K., K. Akita and M. Horiguchi. 1993. Effect of beta-adrenergic agoist (clecnbutarol) on performance, carcass composition, hepatic microsomal mixed function oxidase and antibody production in female broiler treated with or without corticosterone. Br. Poult. Sci. 34: 167-175.

Waldroup, P.W., M.H. Adams and A.L. Waldroup, 1997. Evaluation of national research council amino acid recommendations for large white turkeys. Poult. Sci., 76: 711-720.

Wellenreter, R.H., 1991. β - adrenergic agonists for poultry. Cr. Rev. Poult. Biol., 3: 229-237.