

Effects of Terbutaline feeding on some blood parameters and carcass characteristics in broiler chicks

Z. ANSARI-PIRSARAEI¹, A.H. ABOLGHASEMI², A.R. JAFARI-SAYADI², M.A. JALALI-HAJIABADI³

¹Animal Sci. dept., Mazandaran Univ., Sari, Iran (PhD Student of Tehran University); ²Animal Sci. dept., Guilan Univ., Rasht, Iran; ³Animal Sci. dept., Science and Research Campus, Islamic Azad Univ., Tehran, Iran

Corresponding author: zARBakht_ansari@yahoo.com

Today, people are looking for ways to improve overall production efficiency in producing lean chick products. The aim of this experiment was to assess the effects of terbutaline, a beta-adrenergic agonist, feeding on some blood parameters and carcass characteristics. 300 male and female of Cobb broiler chicks (3w-old) were randomly assigned to one of five dietary treatments (terbutaline levels: 0 (control), 5, 10, 15 and 20 mg/kg). Blood samples were collected before the start of terbutaline feeding and before slaughtering. In twelve 6 week old chicks (6 males and 6 females) selected randomly from each treatment and carcass characteristics were measured. Data were analyzed using the SAS and probability level was 5 %.

Levels of creatine phosphokinase (CPK), blood urea nitrogen (BUN), glutamate oxaloacetate transaminase (GOT) were not affected by terbutaline. Cholesterol and triglyceride levels were significantly increased at level of 10 mg/kg. Terbutaline significantly affected glucose levels at 10, 15 and 20 mg/kg treatments. At level of 5 mg/kg, there was a significant increase in live weight, drumstick muscle in male chicks. Feed conversion rate of male chicks was reduced at levels of 5 and 10 mg/kg of body. Terbutaline, a beta-adrenergic agonist, seems therefore capable of improving growth performance in poultry.

Key words: chicken; beta-adrenergic agonist; terbutaline; blood parameters; carcass

Introduction

As human protein needs increase due to larger world population, there may be more and more competition between human and livestock for the cereal grains. We must try to produce more efficient animals in future. Considerable progress has been made recently in understanding the processes regulating the growth and development of muscle and adipose tissue of livestock species. This has been facilitated by the discovery of several compounds that exert dramatic effects on carcass composition. Excessive deposition of fat is a major problem of the livestock industry today. Utilization of nutrients by the animal for accretion of fat, which is of lesser value than lean tissue, represents a loss both to the grower and to the consumer. Along with being unacceptable to consumers, the excess fat represents an inefficient use of feedstuffs. Beta adrenergic agonists are used to increase growth and muscle development. The function of these compounds is similar to adrenalin and noradrenalin (that is called catecholamine) and cause lipolysis and nitrogen retention. In several experiments conducted in United States and in Germany, concerning cimaterol supplementation to broiler chicks summarized by Dalrymple and Ingle and Scholtyssek, a consistent increase in weight gain was observed.

Finally, because the postnatal growth of skeletal muscle is primarily a result of hypertrophy, it is expected that an increase in muscle protein synthesis, a decrease in muscle protein degradation or a combination of both will produce the beta-adrenergic receptor agonist-stimulated increase in muscle

mass. These compounds also stimulate adipocyte triacylglycerol degradation and inhibit fatty acid and triacylglycerol synthesis.

Because the growth-promoting effect of beta-adrenergic agonists is likely to be dependent on type, dosage, and possibly also on strain of broilers, those factors may account for the apparent discrepancies among published studies. The degree of fat reduction by beta-adrenergic agonists in broiler chicks was more evident in subcutaneous and meat fat than abdominal fat (Warriss *et al.*, 1990; Zamiri and Ehsani, 1995). In accordance with the effects of beta-adrenergic agonists on fat deposition in all domestic animal species and in small laboratory animals, fat deposition was pronounced after prolonged supplementation with clenbuterol, indicating that, at least for this parameter, the clenbuterol effect is not transient. According to Merkly and Kartwright (1989), the fat-reducing properties of beta-adrenergic agonists, at least in poultry, are more likely due to the reduction in adipocyte cell size than in adipocyte number.

Miller *et al.*, (1988) demonstrated that lipogenic enzyme activities (fatty acid synthetase, NADP-malic dehydrogenase, 6-phosphogluconate dehydrogenase and glucose-6-phosphate dehydrogenase) were depressed ($P < 0.05$) in subcutaneous adipose tissue samples from clenbuterol-treated animals (heifers). Rates of basal lipolysis were greater in subcutaneous adipose tissue from control heifers than from the heifers, treated with clenbuterol. Basal lipolysis in intramuscular adipose tissue was approximately 55% of the rate observed in subcutaneous adipose tissue (Miller *et al.*, 1988). Reduced carcass adipose tissue content could be the result of increased rates of lipolysis, decreased fatty acid and triglyceride biosynthesis, reduced adipocyte proliferation, or some combination of these events (Smith and Schiavetta, 1991). Insulin promotes fatty acid and glycerophosphate synthesis and inhibits hormone-sensitive lipase. It also activates lipoprotein lipase in liver and adipose tissue.

Goal of this investigation was to study daily feeding effects of terbutaline on some blood parameters and carcass characteristics in broiler chicks.

Materials and methods

For this experiment, 600 broiler chickens (1-d-old) of the Cobb strain chicks were obtained from a local hatchery and all birds had free access to tap water and were given ad libitum access to a starter diet. At 21 d of age, 150 male and 150 female Cobb broiler chicks ($n=300$) were randomly assigned to one of five dietary treatments (CRD; 5 treatments and 2 sexes). From days 21 to 42 of the rearing period, terbutaline was fed (mixed in grower diet) daily at the rate of 0, 5, 10, 15 and 20 mg per kg of the predicted dietary intake. The amount of daily terbutaline was calculated on weekly basis according to the predicted feed intake for each week (NRC, 1994), to match 5, 10, 15 and 20 mg terbutaline per kg diet. Grower diet had 3.1 ME/kg and 22.3 % CP.

Blood samples were collected from the wing vein before the start of terbutaline feeding and before slaughtering. At 6w-old, 12 chicks (6 males and 6 females) were selected randomly from each treatment and carcass characteristics were measured.

Serum samples were stored at -20°C until assayed for triglycerides (TG), cholesterol, blood urea nitrogen (BUN), glucose, creatine phosphokinase (CPK) and aspartate aminotransferase or glutamic oxaloacetic transferase (GOT). Broilers were slaughtered on day 42. Serum glucose, cholesterol, triglycerides, BUN, CPK, and GOT were determined using commercial kits. Concentrations of triglycerides, glucose, cholesterol and BUN are reported in mg dL^{-1} , and those for GOT and CPK are enzyme activity units per liter (U L^{-1}).

Data were analyzed by using the GLM procedure of SAS. The level of significance was set at $P < 0.05$. If any significant effect of terbutaline treatment was noticed, means were compared by the Duncan's multiple range test.

Results and discussion

At the present study, terbutaline didn't affect daily weight gain, but FCR of male chicks was reduced by 5 and 10 mg/kg terbutaline compared with the control group ($p < 0.05$). Carcass weight

and weight of drumsticks, drumstick muscle, breast, breast muscle and ratio of breast to live weight of female chicks receiving 5 mg/kg terbutaline were higher than for other treatments ($p < 0.05$). In male chicks, the live weight and weight of carcass, ratio of carcass to live weight, drumsticks and drumstick muscle at 5 mg/kg terbutaline treatment were higher than for other treatments ($p < 0.05$). The ability of terbutaline (5 mg/kg) to enhance some carcass components weight in the present study is consistent with the action of beta-agonists on mammalian skeletal muscle (Buttery and Dawson, 1987). Effects of terbutaline on several blood serum chemical constituents are shown in Table 1.

Table 1 Effect of terbutaline on several blood serum chemical constituents of broiler chicks (Mean \pm SD).

Parameters	Treatments					Probability levels		
	Control	5 mg/kg	10 mg/kg	15 mg/kg	20 mg/kg	Sex	Treat.	Sex*Treat.
Glucose ¹	124.6 \pm 14.1 ^b	148.6 \pm 15.7 ^{ab}	168.6 \pm 17.7 ^a	174.7 \pm 48.2 ^a	173.2 \pm 30.5 ^a	0.549	0.028	0.582
Cholesterol ¹	79.2 \pm 9.6 ^b	96.7 \pm 13.8 ^{ab}	111.1 \pm 16.2 ^a	95.2 \pm 34.7 ^{ab}	96.1 \pm 34.1 ^{ab}	0.041	0.043	0.026
Triglyceride ¹	110.8 \pm 6.9 ^c	143.4 \pm 37.1 ^{ab}	168.5 \pm 40.6 ^a	123.5 \pm 10.7 ^{bc}	140.1 \pm 61.4 ^{abc}	0.317	0.022	0.447
BUN ¹	2.83 \pm 1.09	2.82 \pm 1.07	2.87 \pm 0.75	3.03 \pm 0.88	3.04 \pm 0.53	0.062	0.942	0.177
CPK ²	299.7 \pm 5.7	288.6 \pm 25.9	291.4 \pm 17.3	293.7 \pm 12.2	298.1 \pm 14.1	0.503	0.848	0.672
GOT ²	128.7 \pm 16.9	132.8 \pm 18.5	129.7 \pm 22.7	127.8 \pm 21.2	125.8 \pm 11.8	0.601	0.973	0.551

a, b; Within each row, means with a common superscript, do not differ at $P < 0.05$ (DMRT).

GOT: Glutamic Oxaloacetic Transferase; BUN: Blood Urea Nitrogen; CPK: Creatine Phosphokinase

¹ mg dL⁻¹ and ² U per L

It is important to note that terbutaline is capable of altering skeletal muscle gene expression, both quantitatively (i.e. more of each protein) and qualitatively (i.e. different contractile protein isoforms). Terbutaline partially exerts its effects on muscle by inhibition of the degradation processes, but this probably does not occur as a direct inhibition of the activity of the proteases (Buyse *et al.*, 1991).

β -adrenergic agonists by enhancement of satellite cell proliferation; stimulation of myofibrillar protein synthesis, depression of myofibrillar protein degradation and muscle hypertrophy enhance meat protein (Smith and Schiavetta, 1991). Insulin promotes protein formation and also prevents the degradation of protein and it could be a reason for protein accumulation in broiler chicken meat; however, it was not possible to measure insulin levels in this experiment.

Lipids in avian blood are not similar in quantity and quality to those of mammals. Circulating lipids are derived from intestinal absorption of dietary lipids, hepatic synthesis, or mobilization from fat deposits. Plasma triglyceride concentration in broilers are sufficiently well correlated with body fat content and can be used as an indirect means of selecting lean or fat broilers.

In general birds having GOT (AST) values greater than 230 UL⁻¹ are considered abnormal. The most common cause of elevated GOT in birds is liver disease. Published normal values vary according to sex, age, time of year, and breeding activity. A moderate increase in serum GOT activity (two-to fourfold increase) is seen with soft tissue injury, whereas liver necrosis causes a more marked elevation. Moderate increases in serum GOT activity occur following intramuscular injections. Slight elevations in serum GOT may be associated with glucocorticoid excess. Serum GOT levels in this experiment ranged between 125 to 132 U per L and was not affected by the treatment.

Studies of prey birds indicate that the blood urea nitrogen level will become elevated only after major kidney damage. These birds are probably exposed to higher levels of dietary urea than are non-carnivorous birds and excrete absorbed urea through their kidneys. Poultry fed high urea-containing diet will show increased levels of blood urea nitrogen.

Cholesterol levels in avian blood are affected by age, heredity, nutrition, and various diseases. Mean serum cholesterol levels in this experiment ranged between 79 to 111 mgdL⁻¹ for the experimental groups and were significantly increased in birds which received 10 mg/kg terbutaline. Significant increases in serum cholesterol are probably due to releasing of cholesterol from its sources in body. Decrease in LDL receptors also increases serum cholesterol. Increased cholesterol level in serum agrees with the results of Zamiri and Ehsani (1995) in guinea pigs, and Hansen *et al.* in finishing barrows.

Serum CPK activity for most birds is 100-200 UL⁻¹ and elevated CPK activity in avian serum may be seen with physical exercise, neuropathies, lead toxicity, chlamydiosis, and bacterial septicemias. We found mean values of about 1000 UL⁻¹ in the control broiler chicks. Serum CPK level was reduced significantly in chicks which received 5 mg/kg terbutaline as compared with the control group, but the

reason for effect is not known at present. There are no reports of the effect of terbutaline, or other β -agonists on blood CPK as far as we are aware.

The present data indicated that terbutaline affected body composition and metabolism of the broiler chicks, similar to other beta-adrenergic agonists. It is suggested that 5 mg/kg terbutaline is an effective dose for reducing carcass fat and increasing carcass protein content, however, further experiments should be conducted to see if lower doses of terbutaline can be effective in this respect.

References

- ANSARI, Z. and ZAMIRI M.J. (2001). Effects of Salbutamol on carcass characteristics and blood parameters in broiler chickens. 4th *International Conference on Farm Animal Endocrinology*. Salsomaggiore, Italy.
- BUTTERY, P.J. and DAWSON, J.M. (1987). The mode of action of beta-agonists as manipulators of carcass composition. In: *Beta-Agonists and their Effects on Animal Growth and Carcass Quality*. J.P. Hanrahan (ed.), Elsevier Applied Science, New York, pp. 29.
- BUYSE, J., DECUYPERE, E., HUYGHEBAERT, G. and HERREMANS, M. (1991). The effect of clenbuterol supplementation on growth performance and on plasma hormone and metabolite levels of broilers. *Poultry Science*. 70: 993-1002.
- DALRYMPLE, R.H., BAKER, P.K., GINGHER, P.E., INGLE, D.L., PENSACK, J.M., and RICKS, C.A. (1984). A repartitioning agent to improve performance and carcass composition of broilers. *Poultry Science*. 63: 2376 (Abst.).
- HANSEN, J.A., YEN, J.T., KLINDT, J., NELSEN, J.L., and GOODBAND, R.D. 1997. Effects of somatotropin and salbutamol in three genotypes of finishing barrows: Blood hormones and metabolites and muscle characteristics. *J. Anim. Sci.*, 75: 1810-1821.
- MERKLY, J.W., and CARTWRIGHT, A.L. 1989. Adipose tissue deposition and cellularity in cimaterol-treated female broilers. *Poult. Sci.*, 68: 762-770.
- MERSMANN, H.J. (2002). Beta-adrenergic receptor modulation of adipocyte metabolism and growth. *Journal of Animal Science*. 80: 24-29.
- MILLER, M.F., GARCIA, D.K., COLEMAN, M.E., EKEREN, P.A., LUNT, D.K., WAGNER, K.A., PROCKNOR, M., WELSH, T.H. and SMITH, S.B. (1988). Adipose tissue, longissimus muscle and anterior pituitary growth and function in clenbuterol-fed heifers. *J. Anim. Sci.* 66: 12-20.
- NAVEGANTES, L.C.C., RESANO, N.M.Z., MIGLIORINI, R.H. and KETTELHUT, I.C. (2001). Catecholamines inhibit Ca^{2+} -dependent proteolysis in rat skeletal muscle through β_2 -adrenoceptors and cAMP. *American Journal of Physiology, Endocrinology and Metabolism*. 281: 449-454.
- National Research Council. (1994). *Nutrient Requirements of Poultry*. 9th rev. edition, National Academy Press, Washington, DC.
- REEDS, P.J. and MERSMANN, H.J. (1991). Protein and energy requirements of animals treated with β -adrenergic agonists: a discussion. *Journal of Animal Science*. 69: 1532-1550.
- REHFELDT, C., SCHADEREIT, R., WEIKARD, R. and REICHEL, K. (1997). Effect of clenbuterol on growth, carcass and skeletal muscle characteristics in broiler chickens. *British Poultry Science*. 38: 366-373.
- SCHOLTYSSSEK, S. 1987. The effect of cimaterol on the performance of broilers. In: *Beta-Agonists and their Effects on Animal Growth and Carcass Quality*, J.P. Hanrahan (ed.), Elsevier Applied Science, New York, pp. 178.
- SMITH, S.B. and SCHIAVETTA, A.M. (1991). Beta-adrenergic agonist: Mechanism of action. Report to the American Society Ad Hoc Committee on Emerging Technologies to Alter Fat: Lean Ratio of Livestock (Unpublished).
- WARRISS, P.D., KESTIN, S.C., ROLPH, T.P. and BROWN, S.N. (1990). The effects of the beta-adrenergic agonist salbutamol on meat quality in pigs. *J. Anim. Sci.*, 68: 128-136.
- WELLENREITER, R.H. (1991). β -Adrenergic agonists for poultry. *Critical Reviews in Poultry Biology*. 3: 229-237.
- ZAMIRI, M.J. and EHSANI, K. (1995). Salbutamol affects body composition of the guinea pig. *Iran. Agr. Res.* 14: 1-18.