*J. Agric. Sci. Technol. (2001) Vol. 3: 273-279*

# Betaine Replacement for DL-Methionine in the Performance and Carcass Characteristics of Broiler Chicks

H. Kermanshahi[1]

## ABSTRACT

**An *in vivo* experiment was conducted to determine the effect of dietary betaine supplementation (Betafin®) as a replacement for methionine on broiler performance and carcass characteristics. In a completely randomized design (CRD) with five treatments of betaine levels (at 0, 25, 50, 75, and 100% in replacement for methionine) and five replicates of 10 birds/replicate, two hundred fifty-day-old Ross broiler chicks were randomly distributed in cages and fed the experimental diets from 0 to 49 days of age. Feed and water were provided *ad libitum*. Feed intake and body weight were recorded weekly. At 49 days of age, one bird from each replicate was killed for comparison of carcass characteristics. Betaine replacement for methionine had no effect on feed intake and feed to gain ratio but decreased body weight gain at 0 to 3 (P<0.0465) and 0 to 7 weeks of age (P<0.01). Betaine as a replacement for methionine decreased the breast weight (P<0.025) and tended to reduce the abdominal fat pad (48.9 *vs* 40.4 grams , 100% methionine *vs* 100% betaine replacement for methionine). The present findings do not support the hypothesis that betaine can effectively replace methionine.**

**Keywords**: Betaine, Broilers, Methionine, Replacement value**.**

## INTRODUCTION

Methionine is an essential amino acid for poultry and is crucial to several metabolic reactions, such as the synthesis of carnitine and creatine. It is well understood that choline may act as a methyl group donor but, in order to function as a methyl group donor, it needs to be converted to betaine in the mitochondria [2]. Some researchers noted a methionine sparing effect in choline [9,10]. The efficacy of increasing the conversion of homocysteine to methionine by betaine is shown by Baker and Czarnecki [1]. Literature regarding the methionine sparing effect of betaine is scarce. In addition to a possible sparing effect of methionine by betaine, it may also interfere with lipid metabolism [17]. Betaine is indirectly involved in the synthesis of carnitine, which is required for transporting long chain fatty acids across the inner mitochondrial membrane for oxidation [3], and therefore may result in a leaner carcass. Many consumers place a high value on lean products. The abdominal fat pad of broilers usually represents a waste product and betaine may decrease the carcass fat of broilers [12]. Although betaine is involved in lipid metabolism, a reduction in carcass fat in poultry as the result of betaine supplementation is not clearly documented and more research is needed to help clarify this issue. Recently, the sensitivity of breast meat yield in broilers to dietary methionine was shown [13]. It is not clear whether betaine might also be capable of sparing methionine in this respect. Therefore, the objective of this study was to examine the methionine sparing effect of betaine, by conducting a growth study with broiler chickens.

[1] Department of Animal Science, College of Agriculture, Ferdowsi University of Mashhad, P.O. Box: 91775-1163, Mashhad, Islamic Republic of Iran, E-mail: kermansh@agric.um.ac.ir

## MATERIALS AND METHODS

A commercial basal diet was formulated to meet the nutritional requirements of the birds [7]. 250-day-old Ross broiler chickens were randomly assigned to cages in a completely randomized design (CRD) experiment with five replicates per treatment and ten birds per cage (replicate). Levels of betaine (Betafin, 0%, 25%, 50%, 75% and 100% in replacement for supplemental methionine, g/g) was added at the expense of methionine. The control diet (treatment 1) had no betaine supplementation while treatment 5 had 100% betaine and no methionine supplementation. Feed and water were provided *ad libitum* and chicks had access to 24 hour light during the experiment. The experimental diets are shown in Table 1. From 1 to 49 days of age, feed consumption, body weight gain, and the feed conversion ratio were recorded weekly. On day 49, one bird from each replicate of treatments (close to mean body weight for each replicate) was killed and dressed and then the carcass weight (body weight minus blood and feathers with skin, head, feet and offal), and the thigh, breast, and abdominal fat pads were recorded.

**Table 1**. Composition of the experimental diets

| Ingredients (%) | 0-21 day | 21-42 day | 42-49 day |
|---|---|---|---|
| Corn | 29.89 | 52.40 | 21.97 |
| Wheat | 40.85 | 17.80 | 55.45 |
| Soybean meal 44% | 18.73 | 26.42 | 19.0 |
| Fish meal | 8.0 | - | - |
| Wheat bran | - | - | 0.8 |
| Dicalcium phosphate | 0.48 | 1.01 | 0.71 |
| Oyster shell | 1.11 | 1.32 | 1.27 |
| Vit and Min. premix[a] | 0.25+0.25 | 0.25+0.25 | 0.25+0.25 |
| **DL-Methionine[b]** | **0.2** | **0.16** | **0.1** |
| Lysine | - | 0.1 | 0.03 |
| Common salt | 0.24 | 0.29 | 0.17 |
| Total | 100 | 100 | 100 |
| Calculated analysis | | | |
| ME (kcal/kg) | 2900 | 2900 | 2900 |
| Crude Protein (%) | 20.53 | 18.23 | 16.53 |
| Ca (%) | 0.91 | 0.82 | 0.73 |
| Avail. P (%) | 0.41 | 0.32 | 0.27 |
| Na (%) | 0.18 | 0.14 | 0.11 |
| Linoleic acid (%) | 0.99 | 1.36 | 0.99 |
| Lysine (%) | 1.11 | 1.0 | 0.77 |
| Arginine (%) | 1.17 | 1.1 | 0.91 |
| Met + Cys (%) | 0.9 | 0.75 | 0.63 |

[a] Supplied per kg of diet: vit A. 11000IU; vit D3, 1800IU; vit E, 36mg; vit k3, 5mg; vit B1, 1.53mg; folic acid, 1.26mg; riboflavin, 7.5mg; pantotenic acid, 12.24mg; vit B6, 1.53mg; nicotinic acid, 30.4mg; vit B12, 1.6mg; biotin, 5mg; choline chloride, 1.1g; antioxidant, 100mg; Mn, 161.3mg; Zn, 84.5mg; Fe, 250mg; I, 1.6mg; Cu, 20mg; Co, 0.47mg; se, 0.02mg.
[b] From treatments 2 to 5, in a 25% incremental manner, betaine was replaced for methionine respectively. Treatment one had no betaine and treatment 5 had no methionine supplementation.

## Statistical Analysis

Data were analyzed according to the General Linear Model (GLM) procedure of SAS® [11] as a CRD experiment. The data in percentage were first transformed to its Arc sin% and then analyzed. Duncan's multiple range test [15] was also used to compare means.

## RESULTS AND DISCUSSION

The effect of the treatments on feed consumption and body weight gain is shown in Tables 2 and 3. Feed consumption and body weight gain within the periods given was not affected by treatment. Body weight gain was reduced at 0 to 3, and 0 to 7 weeks of age and by betaine replacement. The effect of treatments on the feed conversion ratio is given in Table 4. There was no significant effect of betaine replacement on feed to gain ratio but there was a trend towards an increase at 0 to 3, 3 to 7, and 0 to 7 weeks of age. The carcass characteristics of the experimental chicks are shown in Table 5. Carcass composition was not affected, except breast weight, by betaine replacement. There was a trend towards a reduction in carcass weight, the percentage of carcass to body weight, the abdominal fat pad, and the percentage of abdominal fat pad to body weight with betaine replacement. Breast weight showed a significant reduction effect ($P<0.025$) with an increase in the amount of betaine (352.6 *vs* 296.0 g). There is a noticeable variation in the published literature regarding the efficacy of betaine, choline and methionine for methylation [5,6]. It is reported that betaine methylates homocysteine to methionine about three times more efficiently than choline [16]. Conversely, other experiments showed that betaine, choline and methionine appear to be equivalent as sources of methyl group [9]. Pesti and his co-workers [10] using a chick growth model concluded that the sparing of methionine by the methylation of homocysteine to methionine is increased by adding choline or betaine. These results are also confirmed by others who evaluated the effect of supplemental betaine and choline in rats [4]. There is no indication that betaine has the potential to spare methionine as betaine appeared to be less efficient than methionine. The results of this experiment are in agreement with those of Saunderson and Mckinlay [12] who also showed dietary replacement of methionine with betaine did not increase chick weight gains. Equal or inferior effects of 0.23% betaine on bird performance in comparison with 0.23% DL-methionine supplementation was also seen in other studies [8,10]. An inconsistent effect of betaine or methionine on carcass fat was observed [14]. However, the results of this study are in contrast to the later study. The numerical reduction effect of betaine on the abdominal fat pad was highest when the level of betaine replacement for methionine was increased. The results are also in agreement with other studies [13,18]. However, with the limited sample size of 50 chickens, it is difficult to detect such a variable parameter and relate it to the treatment effect. DL-methionine, when added to basal diet with no betaine supplementation produced significantly more breast meat (Table 5) and this is in agreement with the result of Shutte *et al*. [14] However, it is in contradiction with those of Virtanen and Rosi [18] who showed betaine to be more efficient than DL-methionine in supporting breast meat yield. The result of this study clearly showed a difference of about 56 grams between treatment 1 and treatment 5 (352.64 *vs* 295.98) or a difference of 2.67% in favor of methionine supplementation alone when calculated for breast meat to carcass weight or 2.24% when calculated for breast to live body weight. Under the conditions of the present study, it would appear that betaine may not be an effective replacer of DL-methionine, which enhanced breast meat yield.

In conclusion, the present study does not support the hypothesis that betaine can be an effective replacer of DL-methionine in broiler diets under the conditions of this experiment. Further research is needed to asses whether or not betaine is able to share its methyl groups with choline and methionine in broilers.

## ACKNOWLEDGMENTS

The author wishes to express his special thanks to Mr. Madaeni for his technical help. The financial support of Ferdowsi University of Mashhad for this experiment is greatly acknowledged.

## REFERENCES

1. Baker, D.H. and Czarnecki, G.L. 1985. Transmethylation of Homocysteine to Methionine: Efficiency in the Rat and Chick. *J. Nutr.*, **115**:1291-1299.
2. Baker, A.J., and Tuma, D.J. 1983. Betaine, Metabolic by-product or Vital Methylating Agent? *Life Sci.*, **32**: 771-774.
3. De Ridder, J.J.M., and Van Dam, K. 1975. Control of Choline Oxidation by Rat Liver Mitochondria. *BBA*., **408**: 112-122.
4. Finlelstein, J.D., Martin, J.J., Harris, B.J., and Kyle, W.E. 1983. Regulation of Hepatic Homocysteine Methyltransferase by Dietary Betaine. *J.Nutr*., **113**: 519-521.
5. Lowery, K.R., Izquierdo, Q.A., and Baker, D.H. 1987. Efficacy of Betaine Relative to Choline as a Methyl Donor. *Poultry Sci*., **55** (Supplement **1**): 135.
6. Molitoris, B.A., and Baker, D.H. 1976. The Choline Requirement of Broiler Chicks During the 7th week of Life. *Poultry Sci*., **55**: 220-224.
7. National Research Council 1994. "*Nutrient Requirement of Poultry*". 9th ed. National Academy Press, Washington, DC.
8. Pesti, G.M., Harper, A.E., and Sunde, M.L. 1979. Sulfur Amino Acid and Methyl Donor Status of Corn-soy Diets Fed to Starting Broiler Chicks and Poults. *Poultry Sci.*, **58**: 1541-1547.
9. Pesti, G.M., Harper, A.E., and Sunde, M.L. 1980. Choline/methionine Nutrition of Starting Broiler Chicks. Three Models for Estimating the Choline Requirement with Economic Considerations. *Poultry Sci*., **59**: 1073-1081.
10. Pesti, G.M., Benevenga, N.J., Harper, A.E., and Sunde, M.L. 1981. Factors Influencing the Assessment of the Availability of Choline in Feedstuffs. *Poultry Sci.*, **60**: 188-196.
11. SAS Institute 1985. "*SAS® User's Guide: Statistics*". SAS Institute Inc., Cary, NC.
12. Saunderson, C.L., and Mckinlay, J. 1990. Changes in Body Weight, Composition and Hepatic Enzyme Activities in Response to Dietary Methionine, Betaine and Choline Levels in Growing Chicks. *Brit. J. Nutr*., **63**: 339-349.
13. Shutte, J.B., and Pack, M. 1995. Sulfur Amino Acid Requirement of Broiler Chicks From 14-38 Days of Age. 1. Performance and Carcass Yield. *Poultry Sci*., **74**: 480-487.
14. Shutte, J.B., De Jong, J., Smink, W., and Pack, M. 1997. Replacement Value of Betaine for DL-methionine in Male Broiler Chicks. *Poultry Sci*., **76**: 321-325.
15. Steel, R.G.d., and Torrie, J.H. 1980. "*Principles and Procedures of Statistics. A Biometrical Approach*". 2nd ed. McGraw-Hill Book Co., Inc. New York.
16. Stekol, J.A., Hsu, P.T., Weiss, S., and Smith, P. 1953. Labile Methyl Group and its Synthesis *de novo* in Relation to Growth in Chicks. *J. Biol. Chem*., **203**: 763-773.
17. Stryer, L. 1988. Biosynthesis of Amino Acids and Heme. In: "*Biochemistry*", 3rd ed, W.H. Freeman and Company, New York, pp. 575-626.
18. Virtanen, E., and Rosi, L. 1995. Effects of Betaine on Methionine Requirement of Broilers Under Various Environmental Conditions. *Proc. Aust. Poult. Sci. Sympo*., pp. 88-92.

# اثر جایگزینی متیونین با بتائین بر عملکرد و کیفیت لاشه در جوجه های گوشتی

**ح. کرمانشاهی**

## چکیده

آزمایشی به منظور بررسی تاثیر جایگزینی متیونین با بتائین بر عملکرد جوجه‌های گوشتی انجام شد. در یک طرح کاملا تصادفی شامل ۵ تیمار (۵ سطح بتائین: صفر، ۲۵، ۵۰، ۷۵ و ۱۰۰ درصد جایگزینی با متیونین) و ۵ تکرار ۱۰ قطعه ای در هر تیمار، ۲۵۰ قطعه جوجه یکروزه راس در یک دوره ۴۹ روزه مورد آزمایش قرار گرفتند. جوجه‌ها به طور تصادفی در قفسهای آزمایشی تقسیم شده و آب و غذا به طور آزاد در اختیار آنها قرار گرفت. مصرف غذا و وزن بدن به طور هتفگی رکوردگیری شد. در ۴۹ روزگی، یک جوجه از هر تکرار که به میانگین وزن تکرار نزدیکتر بود انتخاب شده و برای اندازه‌گیری خصوصیات لاشه کشتار شد. نتایج به دست آمده در این آزمایش تاثیر مثبت بتائین را بر مصرف غذا، افزایش وزن و ضریب تبدیل غذا نشان نداد. ولی افزایش وزن بدن در ۰ تا ۳ (P< ۰/۰٤٦٥) و ۰ تا ۷ هفتگی (P<۰/۰۱) کاهش یافت. با افزایش جایگزینی متیونین با بتائین وزن سینه به طورمعنی‌داری کاهش یافت (P < ۰/۰۲۵). با افزایش جایگزینی متیونین با بتائین میزان چربی حفره بطنی از نظر عددی یک روند نزولی را نشان داد (٤٨/۹ در مقابل ٤٠/٤ گرم، ۱۰۰٪ میتونین در مقابل ۱۰۰٪ بتائین جایگزین شده با میتونین). با توجه به نتایج بدست آمده دراین آزمایش چنین به نظر می‌رسد که بتائین نمی‌تواند جایگزین مناسبی برای متیونین باشد.