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# THE EFFECT OF FULL SUBSTITUTION OF SUPPLEMENTAL METHIONINE WITH BETAINE IN BROILER NUTRITION ON PRODUCTION AND SLAUGHTER RESULTS

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**Abstract:** The use of betaine can influence the resistance, production performance and quality of broiler carcass, and potentially it can reduce the need for choline and methionine in food due to the mutual correlation of these three substances in the organism. Objective of the paper was to investigate the effect of full substitution of added DL-methionine with betaine in diets for broilers on production and slaughter parameters in conditions of optimal amount of choline in the feed. Study was carried out on 1725 one day old broiler chickens of Cobb 500 hybrid divided into 3 groups: Control group (C) fed complete forage mixtures with usual addition of DL methionine and two trial groups where methionine was substituted by 1g (B1group), and by 2g of betaine per kilogram of mixture (B2 group). Research results indicate that the full substitution of supplemented methionine with betaine in feed can have positive and negative impact in broiler fattening. Negative effects on final body mass, gain and feed conversion were determined in broilers fed mixtures where 1g of synthetic methionine was replaced with 1g of betaine preparation, and at the same time positive influence on mortality was observed, especially in broilers fed diets containing 2g of betaine. Production index showed no significant differences between trial groups, as well as studied broiler carcass quality parameters.

**Key words:** betaine, methionine, broiler nutrition, productivity, carcass quality

## Introduction

Betaine (trimethylglycine), derivative of glycine amino acid with three reactive methyl groups, is natural product which can be synthesized in large quantities by certain plants and micro organisms. Especially rich in betaine is sugar

beet and sugar beet molasses from which it is mainly extracted and used in production of commercially high concentrated formulations intended for use as supplement in animal feed (*Eklund et al., 2005; Attia et al., 2005*).

Betaine can be used in broiler nutrition because of its main constituent elements, primarily as donor of methyl group, and also its strong osmotic activity is very important.

Role of betaine as osmotic-regulator in the organism occurs at the cellular level where betaine acts as osmolyte and minimizes the loss of water from the cell, which can be of special importance in conditions of stress and dehydration of the organism caused by disease or high temperature (*Matthews and Southern, 2000; Zulkifli et al.,2004; Gudev et al., 2011*).

As methyl group donor, betaine in the organism is included in the synthesis of series of substances, as well as in the energy and protein metabolism (*Eklund et al., 2005*). Adding of betaine to broiler diets can actually reduce the need for choline and methionine in the feed because of the mutual correlation between these three substances in the organism during so called methyl group ($CH_3$) metabolism. Therefore, the possibility of substitution of the synthetic methionine and choline in broiler diets with naturally obtained betaine is often studied. Previous researches indicate that supplemental choline can be successfully substituted with betaine in broiler diets (*Hassan et al., 2005, Waldroup et al., 2006*). Possibility of substitution of supplemental methionine with betaine still is subject of research and controversy, especially the efficiency of betaine addition for the purpose of full substitution of synthetic methionine in broiler diets (*Rostagno and Pack, 1996; Attia et al., 2005*). On the other hand, such intervention in broiler nutrition can be of interest to producers of organic products, where the use of synthetic nutrients is not allowed, but also in conventional broiler production because of potential decrease of feed costs.

Use of betaine in livestock nutrition can influence the resistance, productivity and carcass quality. However, addition of betaine in the feed resulted in some studies in improvement of daily gain, feed conversion, resistance to stress or carcass quality (*Matthews and Southern, 2000; Hassan et al., 2005; Živković et al., 2007; Gudev et al., 2011*), but in other studies it showed minimum or no effect on animal performance during fattening (*Rostagno and Pack, 1996; Zulkifli et al., 2004; Eklund et al., 2005*).

Objective of this paper was to investigate the effect of full substitution of added DL methionine with betaine in broiler diets on production and slaughter parameters in conditions of optimum choline amount in the feed.

## Materials and Methods

Study was carried out on Experimental broiler farm of the Institute for Animal Husbandry, Belgrade-Zemun. Total of 1725 one day old broiler chickens of hybrid Cobb 500 were divided into 3 groups: Control (C) fed complete forage

mixtures with usual supplement of DL-methionine and two trial groups where methionine was replaced by 1 g (B1group), and 2g betaine per kilogram of mixture (B2 group). Chickens were placed in 15 boxes (5 boxes/replicate in each group - 115 chickens in each box) in floor system of housing and controlled environmental conditions.

Study lasted 42 days. Nutrition of chickens was ad libitum using 4 different complete mixtures in different fattening periods, same mixtures for all three groups except in regard to added methionine in the control, and betaine in mixtures for groups B1 and B2. Mixtures were formulated to contain the optimum amount of nutrients, according to the recommendations of the technology, including choline, and all mixtures, except the final, contained coccidiostatic. Mixtures were produced in the experimental feed mill of the Institute for Animal Husbandry, and chemical and microbiological quality were analyzed using accredited methods in the laboratories of the same institute. In the analysis of the quality it was established that mixtures complied with the technological norms and trial design. Raw material and chemical composition of used mixtures are presented in Table 1.

**Table 1. Composition of mixtures used in the trial**

| Ingredients (%) | Pre-starter (1-10. days) | Starter (11-20.days) | Grower (21-32.days) | Finisher (33-42.days) |
|---|---|---|---|---|
| Yellow corn | 52.0 | 53.5 | 54.0 | 57.6 |
| Soybean meal (44%CP) | 20.0 | 30.0 | 29.0 | 27.0 |
| Full fat soybean extruded | 18.0 | - | - | - |
| Sunflower meal (33% CP) | - | 3.0 | 4.0 | 4.0 |
| Fish meal (60% CP) | 4.0 | 4.0 | 2.0 | - |
| Fat | 2.0 | 5.5 | 7.0 | 7.0 |
| Limestone | 1.2 | 1.2 | 1.4 | 1.6 |
| Mono calcium phosphate | 1.4 | 1.4 | 1.2 | 1.4 |
| Salt | 0.2 | 0.2 | 0.2 | 0.2 |
| Methionine/Betaine * | +/- | +/- | +/- | +/- |
| Vit.Min. mixture (premix) | 1.0 | 1.0 | 1.0 | 1.0 |
| Calculated and analyzed composition | | | | |
| ME (Kcal/kg) | 2990 | 3050 | 3120 | 3150 |
| Crude protein, % | 22.30 | 21.10 | 19.70 | 17.80 |
| Ca, % | 0.95 | 0.92 | 0.90 | 0.90 |
| P, % | 0.76 | 0.74 | 0.70 | 0.70 |
| P available, % | 0.44 | 0.41 | 0.35 | 0.34 |
| Methionine –control diet, % | 0.50 | 0.47 | 0.45 | 0.40 |
| Methionine – B1,B2 diets, % | 0.40 | 0.37 | 0.35 | 0.30 |

* 1g DL methionine per kg was added into control mixture; in B1 mixture - 1g, and in B2 mixture - 2g of preparation „Betafin S1“ (96% betaine, produced by „Danisco“) per kilogram of mixture

During trial, the feed consumption was monitored and mortality recorded daily. Measuring of body mass of all trial chickens was carried out in the middle

and at the end of the trial, i.e. at the age of chickens of 21 and 42 days. Based on obtained data the daily gain, mortality, feed conversion and production index were calculated at the level of a box.

At the end of the trial, by principle of random sample, 12 broilers from each group (6 males and 6 females) were taken for analysis of slaughter carcass parameters. Cutting and determination of the dressing percentage was done according to standard current national regulations on determination of the carcass quality. The amount of abdominal fat was put in the relation to pre-slaughter body mass, in order to obtain the relative share of abdominal fat in carcass. From each carcass breast part, drumstick and thighs were separated and by dissection the percentage of meat was determined in these carcass parts.

Computer program STATISTICA v.6 was used to establish mean values and variability measures, variance analysis was carried out, and in case of expressed statistical significance in variance analysis, Tuckey test was applied at the level of 0.05% probability.

## Results and Discussion

Production results of broilers in the trial are presented in Table 2. It was established that the tested treatment which included full substitution of additional methionine with 1 g of betaine in broiler diets had negative impact on productivity of broilers. Statistically significant ($p<0.05$) decrease of body mass, gain and conversion after three weeks of trial were recorded, as well as decrease in final body mass and gain of trial broilers after six week fattening period, compared to control group fed diets with added methionine. At the same time, all above mentioned productivity parameters were slightly lower in chickens of G2 group compared to control group, however, the applied treatment of substitution of 1 g of DL methionine in mixtures with 2 g of betaine preparation in this group of trial chickens had no statistically significant effect.

It is apparent from presented results the positive effect of applied treatment on health condition and resistance of fattening broilers, expressed by mortality of broilers during the trial. Statistically significantly lower mortality in broilers fed diets containing 2 g of betaine in the first and second fattening phase is registered, and it was almost twice lower than value determined in the control group and by over 3% lower than mortality of broilers fed diets with 1 g of betaine. At the same time, group of broilers fed diets with 1 g of betaine had by approx. 20% lower, but not statistically significantly lower mortality, compared to the control.

**Table 2. Production parameters of broiler chickens after three week and six week trial period, Means ± Standard Deviation**

| Treatment | Start BW[1], G | Final BW, g | Daily gain, G | Mortality, % | FCR[2] | EPEF[3] |
|---|---|---|---|---|---|---|
| 0 – 21. day of age | | | | | | |
| C | 43.9±3.1 | 620±22$^{a}$ | 27.4±1$^{a}$ | 5.74±1.1$^{a}$ | 1.66±0.06$^{b}$ | - |
| B1 | 43.8±2.6 | 519±38$^{b}$ | 22.7±1.8$^{b}$ | 4±0.5$^{ab}$ | 1.78±0.09$^{a}$ | - |
| B2 | 44.3±2.4 | 579±22$^{ab}$ | 25.5±1.7$^{ab}$ | 2.96±0.4$^{b}$ | 1.71±0.04$^{ab}$ | - |
| 0 – 42. day of age | | | | | | |
| C | - | 2141±46$^{a}$ | 49.9±1.1$^{a}$ | 9.22±2.6$^{a}$ | 1.96±0.07 | 236 |
| B1 | - | 2014±85$^{b}$ | 46.9±2.1$^{b}$ | 7.65±1.8$^{a}$ | 2.01±0.09 | 231 |
| B2 | - | 2085±58$^{ab}$ | 48.6±1.4$^{ab}$ | 4.52±2.1$^{b}$ | 1.93±0.05 | 246 |

$^{a-b}$ Means within a column with different superscripts differ significantly ($p < 0.05$)
[1]BW – Body weight of chicken
[2]FCR – Feed conversion ratio, kg feed/kg gain
[3]EPEF – Production index

Production index, parameter of productivity which combines all other production parameters, was comparable in all groups of trial chickens, which can be explained as result of determined positive effect of applied treatment on mortality and negative effect on most of other production parameters..

Obtained results of monitored parameters relating to carcass quality expressed through determined mass in grams and percentage in relation to live weight of chickens, are presented in Table 3.

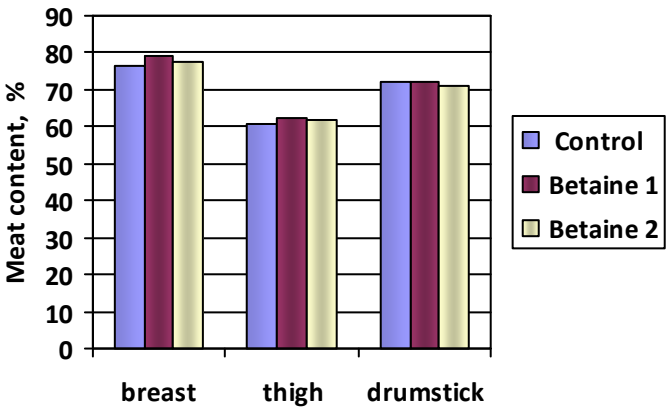
**Table 3. Slaughter parameters according to treatments**

| Treatment | Sex | Body weight, g | Processing percentage | | | | | | Abdominal fat | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | T, g | T, % | RR, g | RR, % | RG, g | RG,% | g | % |
| C | M | 2473 | 2067 | 83.5 | 1920 | 77.5 | 1726 | 69.7 | 27 | 1.09 |
| | F | 2193 | 1791 | 81.7 | 1674 | 76.3 | 1495 | 68.2 | 30 | 1.38 |
| | M+F | 2333 | 1929 | 82.6 | 1797 | 76.9 | 1610 | 68.9 | 29 | 1.23 |
| B1 | M | 2334 | 1922 | 82.2 | 1784 | 76.3 | 1590 | 68.0 | 24 | 1.02 |
| | F | 2336 | 1916 | 82.0 | 1801 | 77.0 | 1611 | 69.0 | 31 | 1.32 |
| | M+F | 2335 | 1919 | 82.1 | 1791 | 76.6 | 1599 | 68.4 | 27 | 1.15 |
| B2 | M | 2295 | 1875 | 81.7 | 1732 | 75.5 | 1540 | 67.1 | 28 | 1.20 |
| | F | 2237 | 1846 | 82.4 | 1728 | 77.1 | 1546 | 69.0 | 32 | 1.43 |
| | M+F | 2266 | 1861 | 82.1 | 1730 | 76.3 | 1543 | 68.1 | 30 | 1.31 |

**T -Processing percentage - traditional**
**RR - Processing percentage - ready to roast**
**RG- Processing percentage - ready to grill**

Obtained results indicate that there were no statistically significant differences in carcass quality between the control and trial groups, in regard to obtained dressing percentages (yields) as well as the amount of abdominal fat in broiler carcass.

Obtained results relating to the percentage, i.e. yield of meat in major carcass parts (breast, thigh and drumstick) determined by dissection of these parts, are presented in Graph 1.




**Graph 1. Meat content in major carcass parts**

Investigated treatment had no statistically significant effect on meat content in breast, thigh and drumstick, which indicates that substitution of supplemental methionine with betaine in feed for broilers had no resulting in decrease of meat yield.

Our results are in concordance with research by *Rostagno and Pack (1996)* who in a similar trial demonstrated that full substitution of additional methionine with betaine in diets for broilers as a consequence had decrease in gain and lower feed conversion ratio, and no consistent effect on carcass quality. On the other hand, *Attia et al (2005),* based on the study of the ratio of added methionine and betaine in nutrition of slow growing chickens, reported that successful substitution of methionine with betaine is possible. Other researchers (*Matthews and Southern, 2000; Hassan et al., 2005; Gudev et al., 2011*) have indicated that in certain conditions, adding of betaine into the feed resulted in improvement of one or several parameters of productivity, primarily daily gain, feed conversion ratio and resistance of broilers. However, other studies report of minimum or no effect at all of betaine supplementation on performance of fattening poultry (*Rostagno and Pack, 1996; Zulkifli et al., 2004*). Controversy of results can be associated with

different trial conditions, primarily presence or absence of stress and concentration of other methyl donors (choline and methionine) in broiler nutrition.

## Conclusion

Full substitution of additional methionine with different quantities of betaine in broiler nutrition had negative effect on final body mass, gain and feed conversion rate in broilers fed diets where 1 g of synthetic methione had been replaced with 1 g of betaine preparation and positive effect on decrease of mortality, especially in broilers fed diets with 2 g of betaine. On the other hand, production index showed no significant difference between trial groups. Also, slaughter results of all broilers in trial were comparable, regardless if methionine or betaine were added to feed.

Results of the research indicate that full substitution of supplemental methionine with betaine can have positive and negative effects in broiler fattening, therefore this approach in formulation of mixtures for broilers should be applied with special attention.

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## Uticaj potpune zamene dodatnog metionina betainom u ishrani brojlera na proizvodne i klanične rezultate

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## Rezime

Upotreba betaina može imati uticaja na otpornost, proizvodne performanse i kvalitet trupa brojlera, a potencijalno može smanjiti i potrebu za holinom i metioninom u hrani usled međusobne povezanosti ove tri supstance u organizmu. Cilj rada je da se ispita uticaj kompletne zamene dodatog DL-metionina betainom u obrocima brojlera na proizvodne i klanične parametre u uslovima optimalne količine holina u hrani. Istraživanje je izvedeno na 1725 jednodnevnih brojlerskih pilića hibrida Cobb 500 podeljenih u 3 grupe: kontrolnu grupu (C) hranjenu potpunim krmnim smešama sa uobičajnim dodatkom DL metiona i dve ogledne grupe kojima je umesto metionina dodavan 1gram (B1grupa), odnosno 2g betaina po kilogramu smeše (B2 grupa). Rezultati istraživanja ukazuju da potpuna zamena dodatnog metionina betainom može imati i pozitivne i negativne efekte u tovu

brojlera. Utvrđen je negativan uticaj na završnu telesnu masu, prirast i konverziju hrane kod brojlera kojima je u smešama 1g sintetičkog metionina zamenjen sa 1g betainskog preparata, ali i pozitivan uticaj na smanjenje mortaliteta, posebno kod brojlera sa 2g betaina u hrani. Proizvodni indeks se nije značajnije razlikovao između oglednih grupa, a takođe i ispitivani parametri kvaliteta trupa brojlera.

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