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# BETAINE AND BREAST MEAT YIELD IN TURKEYS

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Further processing of turkeys to produce a variety of turkey meat products has placed more emphasis on meat yield especially that of breast meat. Breast meat has had greater value and use than other turkey meat in these products. The amount of breast meat at the time of slaughter is a function of age and weight as influenced by nutritional and environmental conditions. As turkeys can be exposed to a number of stresses during rearing, it has been suggested that betaine could improve turkey performance.

Betaine has been indicated to have a number of metabolic and physiological roles in poultry nutrition (Kidd et al., 1997; Remus, 1998). In its function as a methyl group donor it could spare either choline or methionine. Simon (1999) has indicated that betaine may have the greatest effect as an osmolyte especially under coccidial challenge. Enhancing lean meat deposition by decreasing carcass fatness through its effects on lipid metabolism is another proposed role for betaine (Saunderson and MacKinlay, 1990). Relative to increasing carcass and or meat yield, most research has been conducted in broilers. Rostagno and Pack (1996) noted no response to betaine in a broiler study. Male broilers were fed a corn, SBM, sorghum based diet which contained about 70% of the NRC requirement for TSAA. Betaine (.1%) alone had no effect while betaine plus .06% methionine increased breast meat yield slightly. Schutte et al. (1997) supplemented methionine deficient diets with DL-methionine (.05, .1%) and betaine (.04%). Betaine alone increased breast meat yield but not to the same extent as .05% methionine. An improvement in carcass yield was obtained by Esteve-Garcia and Mack (2000) with broiler chicks fed a methionine deficient diet supplemented with betaine. No interaction was noted among methionine and betaine. An interaction of methionine and betaine for breast meat mass was noted by McDevitt et al. (2000) in broilers where betaine did not improve breast meat mass in the basal diet but did enhance breast meat mass when the diet was supplemented with DL-methionine.

Research at the University of Minnesota was initiated to determine the response of turkey toms to dietary supplements of methionine and betaine in practical commercial type diets. Two experiments were conducted. In the first study (Exp. 1), it was proposed to examine the response to supplemental methionine and betaine in an optimal and sub-optimal rearing environment (Kalbfleisch et. al., 2000).

The specific objectives were: 1) to determine the supplemental methionine requirement for gain, feed conversion and breast meat yield of heavy toms; 2) to determine if adding betaine has an additive effect or interacts with TSAA level on turkey performance; and, 3) to determine the effect of dirty barn environment on performance of male turkeys and their response to supplemental methionine and betaine.

Male Nicholas poults were randomly distributed in two rooms, each containing 49 pens at 5 weeks of age. In the “clean’ environment poults were placed into the room which had been previously cleaned and disinfected with new bedding present. In the clean environment, litter, ventilation, water were managed for optimal bird comfort. Caked bedding was removed frequently and replaced with new wood shavings. Waterers were washed daily. Ventilation was maximized to remove ammonia and bird heat to the extent that similar temperatures could be maintained in both rooms. In the "dirty" environment, the room had been left uncleaned from a previous experiment. In the dirty environment, litter conditions were allowed to deteriorate. However, at 11 wks of age the concern was expressed that the birds appeared to be developing leg problems so the cake was removed and the litter base stirred in the pens. Waterers were washed weekly after 11 wks of age.

Dietary treatments (7) were randomly assigned within each of 7 blocks of replicate pens within each environment. Diets were formulated for 3-week feeding periods of 5 to 8 wks, 8 to 11 wks, 11 to 14 wks, 14 to 17 wks, and 17 to 20 wks of age. Diets contained corn, dehulled soybean meal, canola meal and meat and bone meal (poultry blend). Batches of each ingredient were set aside for use throughout the entire experiment and analyzed for proximates, minerals, betaine, and amino acids. Minimum amino acid requirements as specified by the NRC (1994) were adjusted in a linear manner for 3-week feeding periods. Diets were fed in mash form. Canola meal was not used in the last feeding period (17-20 wks). Diets were formulated to reach 96% NRC thr/protein. The desired thr level set the diet protein level. Methionine plus cystine (total sulfur amino acids, TSAA) was set at 90% NRC in the base diet. Lysine was set at 110% NRC. The levels of lysine and methionine were achieved using supplemental amino acids (L-lysine HCl and DL-methionine). All diets were supplemented with BMD and Coban (60g/ton Coban during 5-8 wks and 60 g/ton BMD during 5-20 wks of age) and with choline chloride. When used, betaine (Betafin S96) was supplemented at 2 lbs/ton. The trial was conducted primarily during the winter season months (November through February).

The 7 dietary treatments fed in each environment (clean and dirty) were:

1. 96% NRC thr/protein, TSAA at 90% NRC
2. As 1 plus supplemental met at 10% NRC TSAA
3. As 1 plus supplemental met at 20% NRC TSAA
4. As 1 plus supplemental met at 30% NRC TSAA
5. As Trt 1 plus 2 lb/ton betaine
6. As Trt 2 plus 2 lb/ton betaine
7. As Trt 3 plus 2 lb/ton betaine

Turkeys were weighed individually at the end of each 3-wk feeding period. Turkeys were processed at a commercial processing plant and carcass cut-up conducted by plant personnel. Breast meat weights were taken without skin and keel bone.

Responses to diet were similar in each environment so the results are presented as main effects (Table 1). Body weight at 8, 11, 14, and 17 weeks was improved with the addition of methionine in comparison to base control diet (Trt 1 vs Trt's 2,3, and 4; and Trt 5 vs Trts 6 and 7). No additional weight benefit was obtained by increasing methionine past that of 10% NRC TSAA (Trt 2 vs Trt's 3 and 4; Trt 5 vs Trt's 6 and 7). Betaine supplementation improved the body weight response in the basal diet (Trt 5 vs Trt 1) at 8 and 11 wks of age. At 20 wks, body weight differences among diets were no longer significant although the trend existed for the birds fed Trt's 1 or 5 to be lower in comparison to the other remaining treatments. Percentage breast meat yield and amount of breast meat was affected by diet. While methionine additions tended to improve percentage breast meat yield, betaine had the greatest affect, significantly improving yield at each methionine addition. The dirty environment depressed body weights at 8 and 11 wks amounting to a depression of 1.7 and 2.7%, respectively. After litter conditions were improved during the 11-14 wks period, body weight differences disappeared until 20 wks.

In Experiment 2 (Exp. 2), similar procedures were used. However, the study was conducted during the summer months (June through September). The design was factorial with study factors of diet protein regime (96 and 104% NRC thr), TSAA level (3 levels), and betaine supplementation as Betafin S96 (none or at 2lbs/ton).

The TSAA treatments were:

1. 96% NRC thr/protein, TSAA at 90% NRC
2. As 1 plus supplemental met at 10% NRC TSAA
3. As 1 plus supplemental met at 20% NRC TSAA

Diet formulations and ingredients were similar to those used in Experiment 1. Measurements and carcass yield were obtained as described for Experiment 1.

The results are summarized by primarily by main effect in Table 2. In comparison to Exp. 1, body weights after 11 wks of age and breast meat yield were reduced by summer time rearing conditions. Average barn temperatures for Exp.2 was 77 F with an average daily maximum temperature of 93 F. Growing performance (body weight and feed/gain) was affected by diet protein regime and TSAA level. Body weights were improved with the higher protein regime and additions of methionine to the basal diet. Body weights responded to the incremental additions of methionine. Betaine addition did not affect live performance of the turkey tom. Breast meat yield as % of carcass weight was affected by dietary protein regime, TSAA level and betaine. No statistical interactions were found among the main effects. Betaine had the greatest effect on yield followed by TSAA level and a weaker effect by protein regimen. An examination of the two-way means by TSAA level and betaine also show the additive effect by betaine. Similar trends were also observed in the amount of breast meat per turkey although only statistically significant for betaine. An interaction was observed here for protein regimen and TSAA level. Additions of methionine produced significant increases in breast meat yield at 96%NRC thr but not at 104% NRC thr (data not shown). Betaine increased yield by 4% over non-supplemented diets. An examination of the two-way means by TSAA level and betaine also show again the additive effect by betaine regardless of TSAA level.

In conclusion, for winter-reared market turkey toms, diets supplemented with methionine to meet 100% NRC requirement for methionine plus cystine (TSAA) was adequate in diets formulated to 96% thr/protein. Similar trends were observed for Exp. 2 in summer conditions although addition of methionine in excess of 100% NRC TSAA tended to improve body weights and lbs of breast meat. Betaine supplementation improved breast meat yield at all levels of methionine supplementation in both studies. No statistically significant interactions were detected for betaine and methionine, indicating the additive response of both factors.

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Table 1. Performance and the effect of methionine supplementation as % of NRC TSAA requirement and supplementation with betaine of diets for market tom turkeys grown in two environments (Exp.1)

| Study Factor | Treatment | Weight, 11 wks (lbs) | Weight, 20 wks (lbs) | Feed/ Gain, 5-20 wks | Breast Meat Yield (% of carcass) | Breast Meat Yield (lbs/bird) |
|---|---|---|---|---|---|---|
| Diet | 1. TSAA at 90% NRC | 15.8$^{c}$ | 43.3 | 2.597 | 32.44$^{c}$ | 11.00$^{e}$ |
| | 2. As 1+10% NRC TSAA | 16.9$^{a}$ | 43.8 | 2.568 | 32.94$^{bc}$ | 11.40$^{cd}$ |
| | 3. As 1+20% NRC TSAA | 17.0$^{a}$ | 43.9 | 2.600 | 32.79$^{c}$ | 11.29$^{d}$ |
| | 4. As 1+30% NRC TSAA | 17.1$^{a}$ | 44.0 | 2.590 | 32.65$^{c}$ | 11.33$^{d}$ |
| | 5. As 1 plus betaine | 16.2$^{b}$ | 43.7 | 2.562 | 33.44$^{ab}$ | 11.53$^{bc}$ |
| | 6. As 2 plus betaine | 16.9$^{a}$ | 44.2 | 2.568 | 33.78$^{a}$ | 11.60$^{ab}$ |
| | 7. As 3 plus betaine | 16.9$^{a}$ | 44.0 | 2.599 | 33.58$^{a}$ | 11.73$^{a}$ |
| | | | | | | |
| Env | Clean | 16.9$^{a}$ | 44.0$^{a}$ | 2.573 | 33.11 | 11.40 |
| | Dirty | 16.4$^{b}$ | 43.7$^{b}$ | 2.593 | 33.06 | 11.42 |

$^{abc}$Means with different superscripts within diet or environment are statistically different (P.05)

Table 2. Performance and the effect of methionine supplementation as % of NRC TSAA requirement and supplementation with betaine in two protein dietary regimens for market tom turkeys (Exp.2)

| Study Factor | Treatment | Weight, 11 wks (lbs) | Weight, 20 wks (lbs) | Feed/ Gain, 5-20 wks | Breast Meat Yield (% of carcass) | Breast Meat Yield (lbs/bird) |
|---|---|---|---|---|---|---|
| Main Effect Means | | | | | | |
| | | | | | | |
| Protein | 96% NRC Threonine | 18.1$^{b}$ | 40.1$^{b}$ | 2.50 | 30.28$^{b}$ | 9.61 |
| | 104% NRC Threonine | 18.3$^{a}$ | 40.5$^{a}$ | 2.49 | 30.57$^{a}$ | 9.77 |
| | | ** | * | | * | |
| TSAA | 1. TSAA at 90% NRC | 17.4$^{b}$ | 39.9$^{a}$ | 2.52$^{a}$ | 30.17$^{b}$ | 9.56 |
| | 2. As 1+10% NRC TSAA | 18.5$^{a}$ | 40.3$^{ab}$ | 2.48$^{c}$ | 30.68$^{a}$ | 9.71 |
| | 3. As 1+20% NRC TSAA | 18.7$^{a}$ | 40.7$^{b}$ | 2.50$^{b}$ | 30.42$^{ab}$ | 9.79 |
| | | *** | ** | ** | ** | |
| Betaine | None | 18.1 | 40.2 | 2.50 | 30.01$^{b}$ | 9.50$^{b}$ |
| | + Betaine | 18.2 | 40.4 | 2.49 | 30.83$^{a}$ | 9.88$^{a}$ |
| | | | | | *** | *** |
| Two-way Means | | | | | | |
| | | | | | | |
| TSAA* | 1. TSAA at 90% NRC | 17.4$^{c}$ | 39.9$^{b}$ | 2.53$^{a}$ | 29.87$^{c}$ | 9.42$^{b}$ |
| Betaine | 2. As 1+10% NRC TSAA | 18.4$^{b}$ | 39.9$^{b}$ | 2.49$^{bc}$ | 30.23$^{c}$ | 9.46$^{b}$ |
| | 3. As 1+20% NRC TSAA | 18.6$^{ab}$ | 40.8$^{a}$ | 2.49$^{bc}$ | 29.92$^{c}$ | 9.62$^{ab}$ |
| | 4. As 1 plus betaine | 17.4$^{c}$ | 39.9$^{b}$ | 2.51$^{ab}$ | 30.46$^{bc}$ | 9.71$^{ab}$ |
| | 5. As 2 plus betaine | 18.5$^{ab}$ | 40.6$^{ab}$ | 2.47$^{c}$ | 31.12$^{a}$ | 9.96$^{a}$ |
| | 6. As 3 plus betaine | 18.8$^{a}$ | 40.7$^{ab}$ | 2.50$^{abc}$ | 30.92$^{ab}$ | 9.96$^{a}$ |
| | | | | | | |

$^{abc}$Means with different superscripts within a factor are statistically different (P.05)
*,**,*** Significant main effect or interaction at P<.10, P<.05, and P<.01