Understanding the efficacy of guanidino-acetic acid (GAA)

What do we know about guanidinoacetic acid (GAA) and its arginine sparing effect? GAA is synthesised in the kidney using L-arginine-glycine amidinotransferase (AGAT) and glycine and arginine (Arg) as substrate. Then, GAA is methylated to creatine in liver using GAA N-methyltransferase (GAMT). Feeding GAA to human and animals increases creatine in blood and muscle tissues.

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High creatine in blood has an inhibitory feedback on AGAT, thus AGAT is known as a rate limiting enzyme in creatine synthesis. Thus, GAA is speculated to have Arg sparing effects.

In broilers, GAA is suggested to have either 77% or 149% Arg sparing effect. Herein, the Arg sparing effect of GAA is tested by means of using a comparative response test of Arg and GAA, simultaneously.

A total of 1,800 male Ross 308 broilers were placed in 120 pens. Thirteen treatment groups (0, 0.06, 0.12, 0.18, 0.30, 0.45 and 0.61% of either Arg or GAA) were randomly allocated to pens (12 pens in basal diet group; 9 pens per treatment for the other treatments; 15 birds per pen).

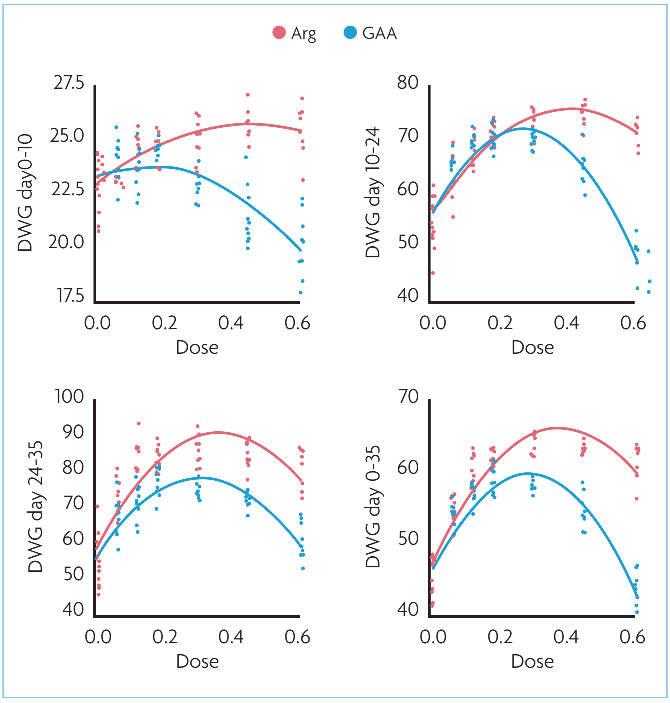


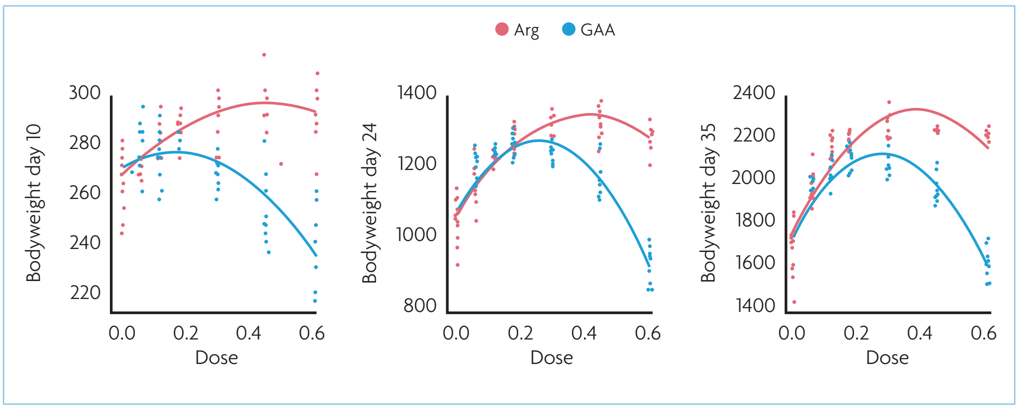
Fig. 2. Efficacy of GAA compared with Arg for daily weight gain (DWG) estimated using a quadratic polynomial model.

The body weight (BW), daily weight gain (DWG), daily feed intake (DFI) and feed conversion ratio (FCR) were measured at the end of each growth phase (day 0, 10, 24, and 35). Four birds per pen were slaughtered at day 35. Carcase, breast and leg yield were measured.

A quadratic polynomial model was used to compare the birds response to different doses of Arg and GAA below and above the known Arg requirements (Aviagen).

The dosage of each additive for the maximum performance was estimated and a ratio of the Arg to GAA dose was defined as bio-efficacy in percentage. Mortality was analysed using cox proportional hazard models.

Fig. 1. Efficacy of GAA compared with Arg for BW estimated using a quadratic polynomial model.



GAA bio-efficacy for BW and DWG defined not more than 59.43%

Approximately 46, 77, and 55% of the GAA dose was needed to achieve the maximum BW when using Arg at the end of the starter, grower, and finisher phases, respectively. Similarly, Arg to GAA ratio for DWG was 46, 84, 44 and 57% during the starter, grower, finisher or during the whole growth period, respectively.

GAA had a negative impact on BW and DWG at higher doses when adding more than 0.18% GAA to an Arg deficient feed (Fig. 1 and 2). Young broilers during the starter phase had a bigger issue with GAA utilisation as an Arg source.

GAA bio-efficacy for DFI and FCR defined not more than 55.88%

Feed intake was increased as a response to Arg or GAA addition (Fig. 3). However, GAA had a negative impact on feed intake in an age dependent manner. Bio-efficacy of GAA compared with Arg during the grower, finisher or during the whole growth period was 73, 39, or 44%, respectively.

During the starter phase, GAA created only a negative impact on feed intake, thus Arg bio-efficacy was determined to be infinite. Thus, GAA was considered to have zero bio-efficacy in starter phase.

Feed conversion ratio was improved by both Arg and GAA. However, GAA had a detrimental impact on FCR at doses higher than 0.18% (Fig. 4).

The efficacy of GAA vs. Arg was defined equal to 50, 102, 61, and 78% during the starter, grower, finisher and during the whole growth period, respectively. Thus, young broilers during the starter phase do not benefit from GAA as an Arg source and they drop feed intake.

Continued on page 9

Continued from page 7

GAA bio-efficacy for slaughter parameters defined not more than 54%

At day 35, maximum slaughter performances (live weight, carcase weight, breast weight and leg weight) were also achieved with much less Arg compared with GAA (56, 53, 51, and 56%, respectively) (Fig. 5).

New data confirming EFSA opinion on GAA

GAA is a pro-oxidant, a methyl group scavenger, and a precursor of creatine which its application as a feed additive needs to be carefully monitored because its efficacy is highly depending on availability of methyl donors. There is also a minimum inclusion rate needed for its efficacy (600g per ton of feed) and a maximum inclusion rate is recommended for safety reasons (1,200g per ton of feed). Herein, we observed a clear negative impact of GAA on performance parameters with a dose higher than 0.18% when GAA is added to an Arg deficient diet.

What would be the consequences of adding GAA to an Arg adequate diet remains to be elucidated.

What did we learn in addition to the currently available data on GAA?

Using a semi-purified broiler feed, Dilger et al. (2013) attempted to define the efficiency of GAA. Adding 0.06, 0.12, 0.39, 0.78% GAA to an Arg deficient diet (0.88% Arg) could not match the performance results (212 vs. 145g weight gain; 8-17 days post hatch) with the deficient diet supplemented with 1% Arg (source of L-Arg was not mentioned: unknown purity).

Dilger et al. (2013) in an additional experiment using a semi-purified diet, compared the efficacy of GAA with Arg using an exponential response model.

However, in this model in both groups the response was created with graded levels of Arg in two different basal diets: with or without GAA inclusion (0.12% vs 0%).

Dilger concluded that GAA is an efficacious Arg source under Arg deficient conditions because there was a difference between the two groups when less than 0.4% L-Arg was supplemented to the deficient diet (0.88% Arg) and no response was found when more than 0.4% L-Arg was supplemented to the basal diet.

According to the current broiler Arg requirements (1.37% SID basis; Aviagen), 0.88% Arg is considered a severely deficient diet. Nevertheless, a quantitative efficacy number was not provided. Herein, we defined the bio-efficacy of GAA and compared it with Arg. On average, GAA could be replaced with 56.44% Arg to achieve a similar maximum performance.

During the starter phase, one needs to be more careful with GAA because of a linear negative impact of GAA on feed intake and a less bio-efficiency of GAA (47.33%) in young birds.

Conclusion

Herein, complications attached with the use of GAA is clearly demonstrated. It is not clear how much Arg sparing effect one can expect depending on animal age and physiological condition. Currently, it is two sized solutions (77% and 149% Arg sparing) for all animal species at different ages. According to our findings, GAA can be easily replaced with 56.44% L-Arg in broiler chickens.

GAA is not recommended to be used in young chickens because GAA linearly caused a reduction in their feed intake. The current recommended 77% or 149% Arg efficacy for GAA is rejected. ■

References are available from the author on request

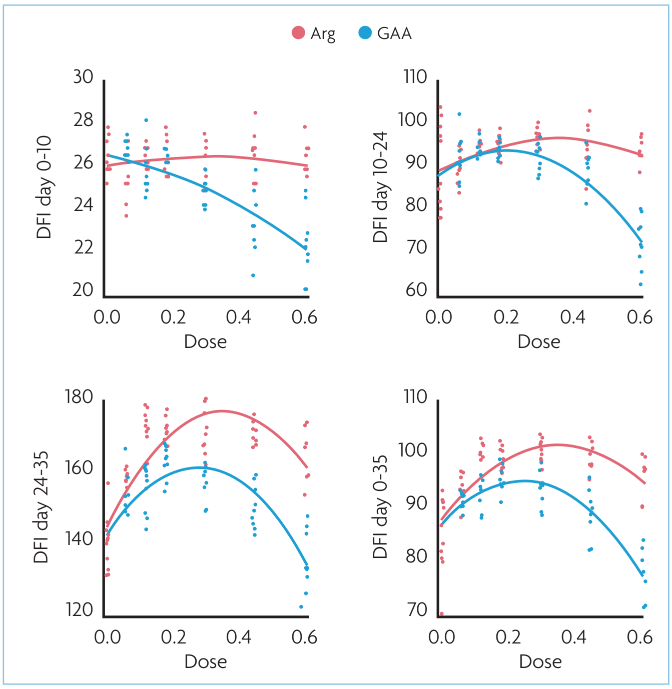


Fig. 3. Efficacy of GAA compared with Arg for daily feed intake (DFI) estimated using a quadratic polynomial model.

Fig. 4. Efficacy of GAA compared with Arg for feed conversion ratio (FCR) estimated using a quadratic polynomial model.

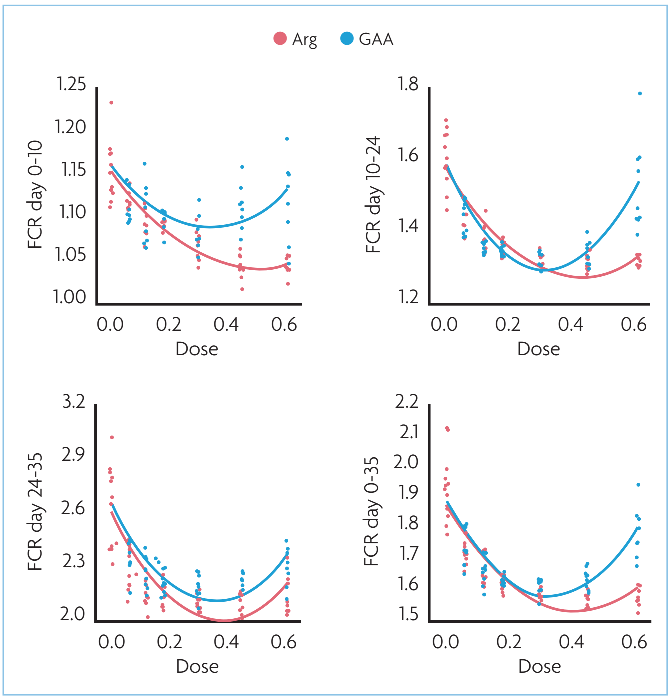


Fig. 5. Efficacy of GAA compared with Arg for slaughter parameters estimated using a quadratic polynomial model. Live weight at slaughter (top left), the carcase weight (top right), the breast weight (below left) and the leg weight (below right).