

# Methionine Requirement and Commercial Methionine Sources in Growing Pigs

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## ■ Introduction

Methionine is a limiting amino acid in commercial swine diets and commonly supplemented as dry DL-methionine (DL-Met, 99%) or as liquid DL-methionine hydroxy analogue-free acid (liquid MHA-FA, containing 88% of active substance). New and intriguing research has been published in poultry and swine as to what is the nutritional effectiveness of liquid MHA-FA relative to DL-Met, and what are the reasons for the difference. However, experiments are not always conducted in a “meaningful” way, or data are sometimes analyzed incorrectly. In the present paper, relevant study requirements and new scientific data on relative effectiveness of methionine sources in pigs are summarized and discussed.

## ■ Comparing Different Nutrient Sources

Although numerous studies have been conducted to compare the efficacy of liquid MHA-FA relative to DL-Met, results of several of these studies have been either inconclusive or seem to be inconsistent due to differences in animal age, length of trial, degree of Met+Cys deficiency, or simply due to a lack of sensitivity of the respective bioassays. When comparing bioavailability or bioefficacy of any essential nutrient, one can only expect to detect differences when the basal diet is clearly deficient in the nutrient to be tested (Huyghebaert, 1993; Lemme et al., 2002). Additionally, appropriate statistical methods like linear slope-ratio or simultaneous nonlinear regression analysis (Littell et al., 1997) must be employed to interpret the results.

## ■ What is a Correct Scientific Study Design? The “CVB Study” (2003)

After quite some time of delays due to legal controversy, the Dutch CVB (Jansman et al., 2003. Centraal Veevoederbureau – “Central Bureau for Livestock Feeding”, The Netherlands, Documentation Report No. 29, 55 pp. “The CVB Study”) has officially published its study on relative efficacy of methionine sources in pigs and poultry. The objective of the CVB Study was an independent assessment of all available experiments in poultry and pigs on the relative efficacy of liquid MHA-FA vs. DL-Met. Clear technical rules were defined in a detailed scientific project plan to select appropriate experiments and how to evaluate the results. The results presented in the desk study were based on available trial data published in the scientific literature and - what's equally important - the protocol for conducting the study had been agreed in advance by both Novus International, Inc. and Degussa as co-sponsors of this independent review. According to the agreed protocol, studies comparing methionine sources should meet the following criteria:

- Comparison of the biological efficacy of DL-Met and liquid MHA-FA within the same study.
- Provision of a clear description of the test products (DL-Met and liquid MHA-FA).
- Provision of data on performance studies with relevant animal species in the framework of the study (pigs, poultry, incl. turkey).
- Provision of information on the animals used: species, gender, age (poultry), and body weight (pigs).
- At least three levels of supplementation of the test products to the same basal diet, thus comparing at least four experimental treatments, including the basal diet, per test product.
- Use of a basal, methionine deficient diet that is adequately described in terms of ingredient composition and analysed or calculated content for at least crude protein and methionine and cystine.
- Provision of an adequate description of the experimental procedure, meaning a clear description of the experimental units, the number of animals per unit, the duration of the trial, the feeding schedule, or feeding level.
- Provision of numerical data for the response criteria as mean values or least square mean values (LSM) per treatment.

A huge number of 193 experiments were considered initially, however, many did not match the selection criteria. Eventually, 35 data sets in broilers, 9 in layers, 10 in turkeys, and 7 in pigs were accepted and evaluated. **The CVB Desk Study came to the conclusion that the average bioefficacy of liquid**

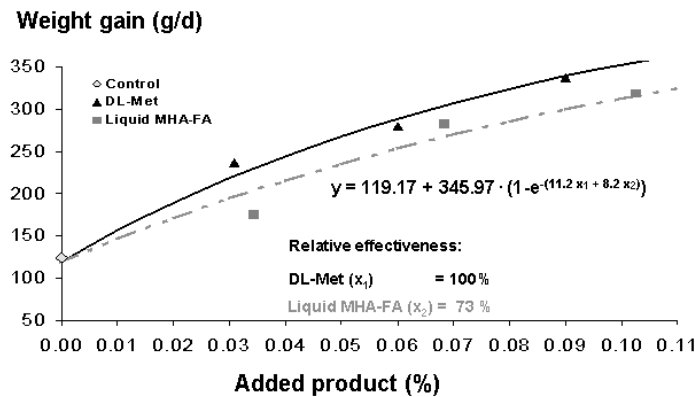
**MHA-FA compared to DL-Met on a weight-by-weight basis was 67.8% in broiler chickens and 72.2% in pigs.** It was also stated that the estimate calculated for broilers has a much higher accuracy, related to the higher number of studies on which the estimate is based. This study indeed represents an independent, scientific evaluation, and the most solid basis currently available. Interestingly, a sponsor tried to stop the publication of this report in Dutch Courts and failed to do so because the judges could not find any evidence why (as the sponsor claimed) the researchers had not followed the previously mutually agreed study protocol or had not acted in accordance with scientific standards, and to that end strongly confirmed the validity of the report.

### ■ **Recent Research on Methionine Sources in Pigs – What is a “Meaningful” Experiment?**

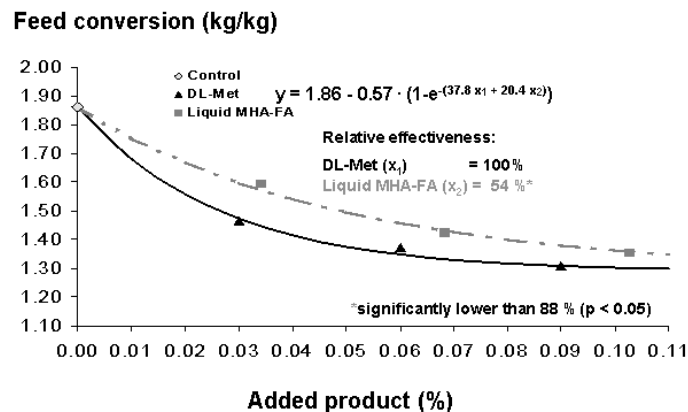
Conducting methionine dose-response experiments in pigs is more difficult than in poultry because methionine is usually not first limiting, practical supplementation levels are rather small, number of animals or replicates per treatment is limited, and variation in pig trials is usually higher than in broiler experiments. Nevertheless, there are excellent dose-response experiments available in pigs.

#### **A Dose-Response Trial at SHUR-GAIN AGRESEARCH, Canada**

One example is the trial by Brennan (2000), an experiment which was conducted at the SHUR-GAIN AGRESEARCH Station in Ontario, Canada. A total of 245 piglets with an initial body weight of 6.3 kg were allotted to 7 treatments for an experimental period of 28 days. Pigs were housed in groups of 5 pigs per pen and had free access to water and feed. A basal corn-soy diet was formulated to contain 17.5% crude protein, 0.61% Met+Cys and 0.21% Met, which is 59% of the methionine requirements, but adequate in all other nutrients and energy, according to NRC (1998). Three graded inclusion levels of each DL-Met (0.030, 0.060, 0.090%) and liquid MHA-FA (0.0342, 0.0684, 0.1026%) were added to the basal diet. The corresponding supplemental levels of DL-Met and liquid MHA-FA were based on an equimolar comparison of the two commercial methionine sources. Experimental data were subjected to regression analysis. Piglets responded significantly to the supplements, i.e. effectiveness was tested in the sensitive range. In order to reach the same response in weight gain, liquid MHA-FA was only 73% as effective as DL-Met (**Figure 1**). Feed conversion showed a marked and significant difference in response to the methionine source: the effectiveness of liquid MHA-FA was only 54% relative to DL-Met (**Figure 2**). The difference in feed conversion was significant at  $P < 0.05$ .



**Figure 1. Weight gain of piglets fed increasing levels of either DL-Methionine or liquid MHA-FA from 1 to 28 days after weaning in Canada (Brennan, 2000)**



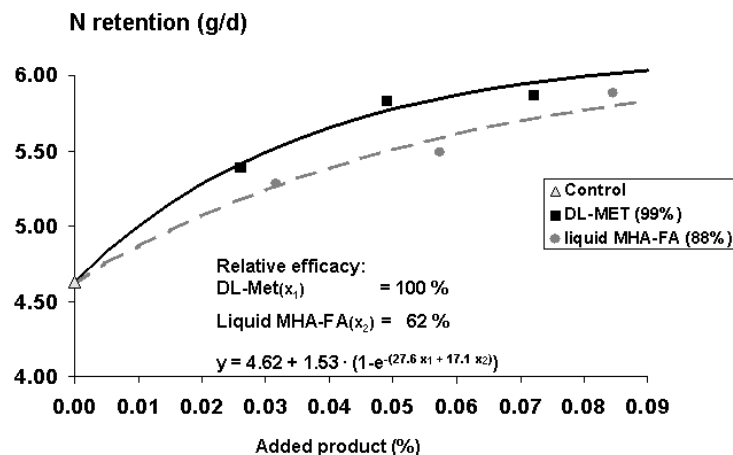
**Figure 2. Feed conversion of piglets fed increasing levels of either DL-Methionine or liquid MHA-FA from 1 to 28 days after weaning in Canada (Brennan, 2000)**

Variability in pigs makes interpretation of results from short-term feeding trials often difficult. Consequently, the more precise and highly sensitive N-balance trial seems more appropriate for the determination of nutrient requirements.

Three N-balance experiments, recently conducted in Germany, Hungary, and the US will be presented and discussed below.

### N-Balance Trial at Hohenheim University, Germany

In a trial in Germany, Zimmermann et al. (2004) used a total of 42 barrows (Piétrain x German Landrace) with an initial body weight of 11.5 kg. To evaluate the efficiency of the two methionine sources, a methionine deficient basal diet was formulated based on wheat, soybean meal, peas, barley, and tapioca and supplemented with three graded levels of DL-Met (0.025, 0.050 and 0.075%) or liquid MHA-FA (0.0285, 0.0570 and 0.0855%) on an equimolar basis. The basal diet contained 13.6 MJ ME/kg, 18.3% CP, 1.29% lysine, 0.79% threonine and 0.25% tryptophan. Methionine and Met+Cys were set at 0.22% and 0.51%, respectively, with methionine being about 73% of the methionine requirement according to NRC (1998). With increases in dietary methionine, nitrogen retention increased by 33%, which means that efficacy was tested in the sensitive range (**Figure 3**). Based on nitrogen retention, efficacy of liquid MHA-FA was only 62% compared with DL-Met.

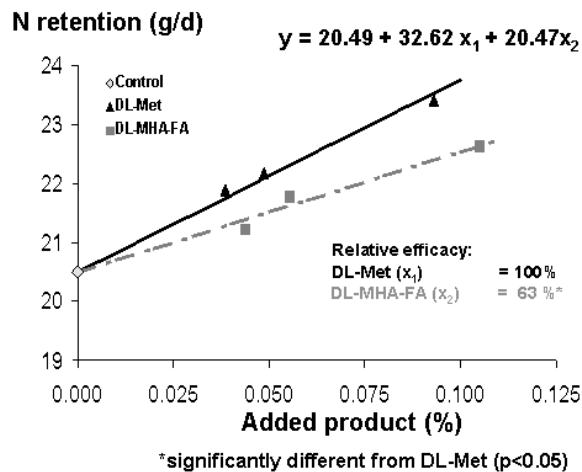


**Figure 3. Effectiveness of liquid MHA-FA relative to DL-Methionine is 62% in piglets (11-15 kg body weight) based on nitrogen retention in Germany (Zimmermann et al., 2004)**

### N-Balance Trial at Pannon University, Mosonmagyaróvár, Hungary

Schmidt (2000) used 12 barrows from 20 to 50 kg body weight in his experiment. Pigs were divided into two groups of 6 pigs each and used over 7 consecutive N-balance periods. Dietary treatments were fed pair-wise during

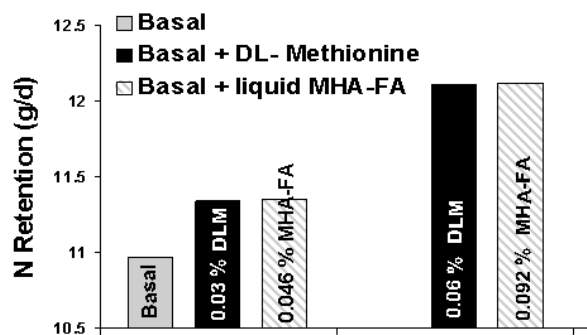
each experimental phase, i.e. each phase tested one dose of DL-Met vs. the corresponding dose of liquid MHA-FA. With pigs getting heavier throughout the trial period, feed allowance was stepwise increased. Seven dietary treatments were formulated, with a total of 12 observations per treatment. The animals were kept individually in metabolic crates. Faeces and urine were collected separately. A basal diet formulated based on wheat, barley, peas, field beans, and soybean meal was supplemented with three graded levels of DL-Met (0.039, 0.049 and 0.093%) or liquid MHA-FA (0.044, 0.055 and 0.105%) on an equimolar comparison basis. The basal diet contained 17.0% CP, 0.52% Met+Cys and 0.23% Met, which is below the methionine requirement, but adequate in all other essential nutrients and energy according to NRC (1998). Because of differences in feed intake between the different experimental periods, observed N-retention data were corrected to equal feed intake (1557 g/d) and N-retention was recalculated. The effectiveness of the two methionine sources was estimated from the corrected N-retention data using linear regression analysis (**Figure 4**). With increases in dietary methionine, N-retention increased by 12%, which means that effectiveness was tested in the sensitive range. Compared with DL-Met, the relative effectiveness of liquid MHA-FA was significantly lower at 63%.



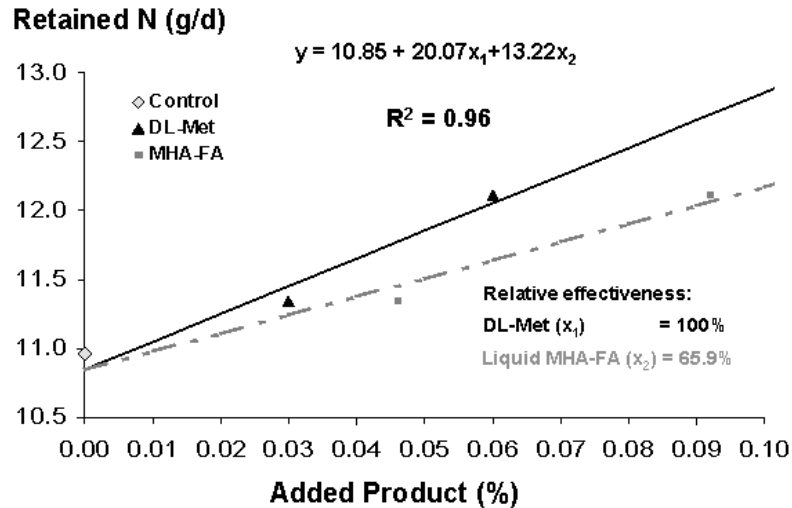
**Figure 4. Effectiveness of liquid MHA-FA relative to DL-Methionine is 63% based on nitrogen retention in pigs (20-50 kg body weight) in Hungary (Schmidt, 2000)**

### N-Balance Trial at the University of Kentucky, Lexington, USA

Lindemann (2004) designed an experiment using two graded levels of each DL-Met (0.03, 0.06%) and liquid MHA-FA (0.046, 0.092%) supplemented to a methionine deficient basal diet based on corn, soybean meal, dried whey, and blood plasma. A total of 36 barrows with a mean body weight of 16.8 kg were used in three consecutive N-balance experiments with 10 pigs in each study being assigned as two blocks (replicates) of the five dietary treatments. To evaluate the efficiency of the two methionine sources, a basal diet was formulated to cover the requirements for energy and nutrients, except for methionine. The basal diet was supplemented with either DL-Methionine or liquid MHA-FA at a 65/100% ratio between DL-Met and liquid MHA-FA. The average initial body weight of pigs was 17.7 kg at the start of the N balance trial and about 21.0 kg at the end of the collection period. The results of this experiment show that the basal diet was clearly deficient in methionine, since there was a significant improvement in N retention due to methionine supplementation. With increases in dietary methionine, N retention increased significantly, which means that the effectiveness of the products was tested in the sensitive range (**Figures 5 & 6**). There were no differences between the two methionine sources at the 65/100% supplemental ratio at both supplemental levels (**Figure 5**). Compared with DL-Met, the relative effectiveness of liquid MHA-FA for N retention was only 66% in this experiment (**Figure 6**).



**Figure 5. Effect of DL-Methionine and liquid MHA-FA fed at a ratio of 65 : 100 on nitrogen retention within each supplemented level is identical in the USA (Lindemann, 2004)**



**Figure 6. Liquid MHA-FA showed an effectiveness of 66% relative to DL-Methionine in piglets based on nitrogen retention in the USA (Lindemann, 2004)**

## ■ Conclusions

DL-methionine is the feed industry standard for methionine additions. In comparison, liquid methionine hydroxy analogue (liquid MHA-FA) is not utilized as well by the animal. This is especially evident when applying the sensitive and precise N balance technique to compare the two methionine sources in an animal experiment. The examples presented here result in an average relative efficacy of liquid MHA-FA of about 64%, which is close to the average figure reported by the “CVB Study” (Jansman et al., 2003) of approximately 68% for broiler chickens. Hence, swine producers should only consider using liquid MHA-FA, if the price does not exceed about 66% (based on Lemme and Petri, 2003, average across all animal species and performance criteria) of the DL-Met price in order to maximize profitability.

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