MetAMINO® ATLAS 2022

EVONIK
Leading Beyond Chemistry

Content

Editorial

Dear reader,

Welcome to our first edition of the MetAMINO® ATLAS.

Please join us on our journey around the globe to five continents and eleven countries to discover the repeatability of 15 performance trials comparing the relative effectiveness of MetAMINO® – Evonik's DL-methionine (DL-Met) – with methionine hydroxy analog free acid or calcium salt products (MHA-FA/Ca) under different climatic, geographic and farm conditions.

The MetAMINO® ATLAS provides a balanced selection of academic research and field trials conducted in experimental settings as well as commercial farms with broiler chickens, laying hens, swine and aqua species.

With growing populations and shrinking land resources, the challenge of meeting the increasing demand for milk, eggs, meat, and fish calls for decisive measures. Enhancing livestock performance with nutritional supplements such as essential amino acids is one of the most effective approaches science has developed.

In this context, precise knowledge about the relative nutritive value of DL-Met compared with liquid MHA-FA and MHA-Ca salt is an important prerequisite for cost-effective purchasing, feed formulation, and animal production.

For this reason, a significant amount of research has been conducted to investigate the relative bioavailability of supplementary methionine sources in animal diets. These studies[1], reference upon request, consistently report that 65 units of DL-Met achieve comparable performance to 100 units of MHA-FA, resulting in a relative bioavailability of 65 percent MHA-FA compared to DL-Met.

The MetAMINO® ATLAS provides further evidence to these studies, as you can see on the following pages. Evonik is committed to supporting its business partners in making the right decisions for sustainable and economical livestock operations and to obtaining the best possible results with MetAMINO®.

We trust that the MetAMINO® ATLAS will be beneficial for your business, please enjoy reading!

Sincerely,

Dr. Jan-Olaf Barth Nils Niedner

"Seeing is believing. Please have a look and decide for yourself. And if you would like to run a trial – let us know. We are ready. "

DR. JAN-OLAF BARTH
Head of Product Line
Efficient Nutrition
Animal Nutrition
Business Line

NILS NIEDNER
Director
Product Management
MetAMINO®

HIGHLIGHTS
Performance Trials

9 experimental trials

6 commercial trials

Conducted on **5** continents

11 countries

15 performance trials

7 broiler

4 laying hen

3 swine and

1 fish trial(s)

EXECUTIVE SUMMARY

Across all trials and all species comparable animal performance criteria were achieved when 100 units of MHA-products were replaced with 65 units of MetAMINO® resulting in a relative bioavailability ratio of 65% when comparing MHA-FA to MetAMINO®.

All 15 experiments provide evidence that DL-Met is considerably more efficient than hydroxy analogues not only with respect to weight gain and feed conversion but also in terms of protein retention.

For practical application in least cost feed formulation this bioavailability should be reflected in the nutrient matrix of ingredients as well as the product purchasing price ratio of the respective methionine sources.

- **Hydroxy analogues of methionine** (free acid MHA-Fa; calcium salt MHA-Ca) were **on average 35 % less effective than DL-Met**
- This means that **35% less product needs to be moved**, stored and processed **with DL-Met**
- **Instead of 3 full truck loads** of MHA-FA **only 2 trucks of DL-Met are needed**
- Application of those result for **practical purchase decisions suggest a 35% lower price for liquid MHA-FA** relative to the price of DL-Met

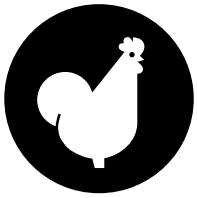
[1]*Jansman et al. 2003; Lemme and Petri 2003; Rademacher et al. 2007; Elwert et al. 2008; Sauer et al. 2008; Lemme 2010; Htoo and Rademacher 2012; Lemme et al. 2012; Lemme et al. 2020*

Section 1
Trials

“Utilization of Methionine Sources for Growth and Met+Cys Deposition in Broilers”

Trial conducted at Schothorst Feed Research, The Netherlands, 2020

Trial location:
The Netherlands

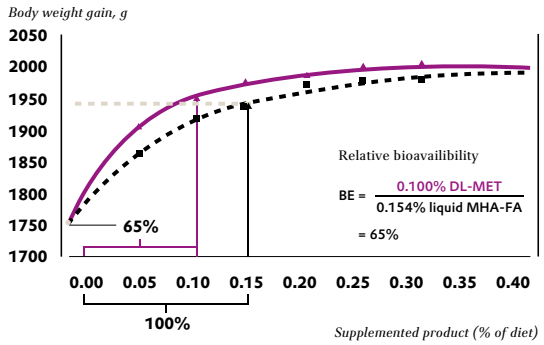


Project team leaders:
Dr. V. Naranjo,
Dr. J. C. de Paula Dorigam,
Dr. A. Lemme

TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

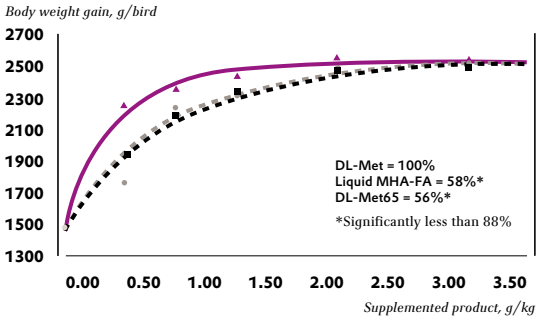
ANIMALS	1,920 male Ross 308 broilers
FEED	Corn-wheat-peas-soybean meal based starter, grower and finisher diets
DESIGN	Simultaneous dose response trial including 3 Met products to determine the relative bioavailability of the tested products
FEEDING	Negative control deficient in Met+Cys; 5 graded levels of DL-Met (MetAMINO®) 5 graded levels of liquid MHA-FA,5 graded levels of DL-Met65 (MetAMINO® diluted to 65% purity)
PARAMETERS	Body weight gain, feed intake and feed conversion ratio, carcass yield breast meat yield and productivity efficiency factor
DURATION	1 –35 days old
LOCATION	Schothorst Feed Research

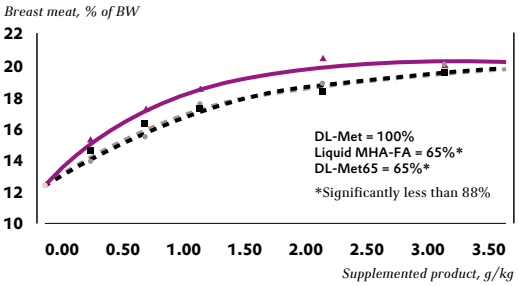
RELATIVE BIOLOGICAL AVAILABILITY: HOW MUCH PRODUCT IS NEEDED FOR SAME ANIMAL PERFORMANCE

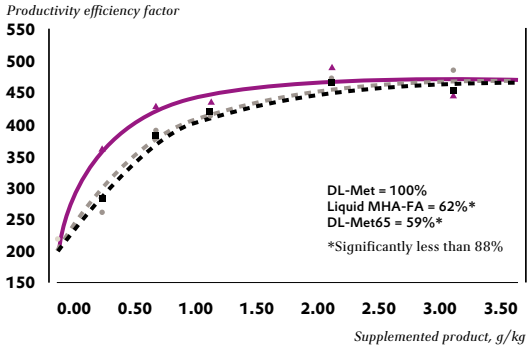


Basal DL-Met liquid MHA-FA

GRAPH 1, 2, 3. RELATIVE BIOAVAILABILITY OF LIQUID MHA-FA AND DL-MET65 COMPARED TO DL-MET (MetAMINO®) WITH RESPECT TO BODY WEIGHT GAIN, BREAST MEAT YIELD AND PRODUCTIVITY EFFICIENCY







Basal DL-Met

EUROPE / THE NETHERLANDS
Experimental Trial

TRIAL DESIGN

- The trial was designed (Table 1) to allow examination of dose responses for three products including MetAMINO® – Evonik's DL-methionine (DL-Met) – liquid methionine hydroxy analog free acid (MHA-FA) and diluted DL-Met65 (650 g MetAMINO® + 350 g Starch)/kg) added to a methionine + cystine (M+C) deficient basal diet.

TRIAL OBJECTIVES

- To determine the bioavailability of liquid MHA-FA relative to DL-Met.
- To validate the experimental and mathematical approach to determine the relative bioavailability (RBA) of nutrients by including DL-Met65.

TRIAL RESULTS

- Each tested product resulted in significant improvements of all performance criteria (graphs 1–3; Lemme *et al.*, 2020, Animals 10, 2240).
- Across all performance criteria liquid MHA-FA was on average 63 percent as effective as MetAMINO® (partly shown in graphs 1–3).

LITERATURE SURVEY PROVIDES ULTIMATE EVIDENCE

The paper on this trial published in Animals (Lemme *et al.*, 2020, Animals 10, 2240) also included a literature survey considering a total of six experiments comparing simultaneous dose-responses of liquid MHA-FA, DL-Met and DL-Met65. This analysis revealed:

- an average availability of 63 percent for liquid MHA-FA relative to DL-Met confirming Evonik's recommendation of an RBA of 65 percent for MHA-products supported by a recent EFSA opinion (doi:10.2903/j.efsa.2018.5198).
- an average bioavailability of 62 percent for DL-Met65 relative to DL-Met confirming the expected value of 65 percent suggested by the dilution of DL-Met to a purity of 65 percent. With that the experimental and mathematical approach is validated.

CONCLUSION

- The trial as well as the literature survey revealed that 1 kg of liquid MHA-FA can be replaced with 650 g of DL-Met to achieve the same broiler performance.
- Determined RBA of DL-Met65 was close to expected figure of 65 percent. This is in line with other studies which also tested DL-Met65 against DL-Met and, therefore, validates the experimental and mathematical approach to determine the RBA of MHA-products.
- Application of these results for practical purchase decisions suggest a 35 percent lower price for liquid MHA-FA compared to DL-Met!

FEEDBACK

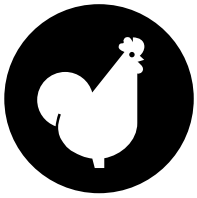
"This trial, is the ultimate proof that the method is valid. We are ready for our recommendation to be challenged as already more than 180 customer trials have proved our recommendation valid."

Dr. A. Lemme,
Technical Director Consultancy of Evonik Operations GmbH

“Nutritional value of MHA-FA and DL-methionine (MetAMINO®) in common Greek broiler diets”

Trial conducted by Evonik, and Hellenic Agricultural Organization – DEMETER, Greece, 2018

Trial location:
Paralimni, Greece

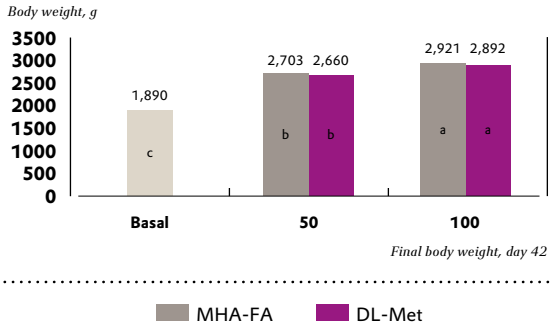


Project team leaders:
G. Symeon, M. Anastasiadou, V. Dotas, A. Athanasiou, M. Mueller

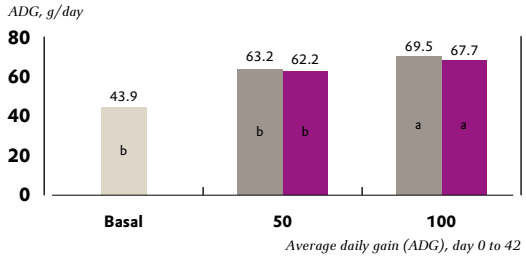
TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

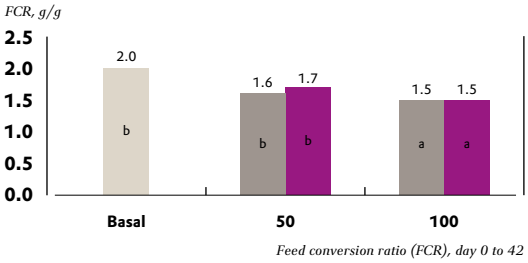
ANIMALS	420 mixed sex Cobb 500 broilers
DIETS	Wheat-soybean meal-based diets
DESIGN	Completely randomized, five treatments á seven replicates with 12 birds each
FEEDING	Control deficient in M+C, two levels of supplementation with MHA-FA, DL-Met replaced MHA-FA at a product-base ratio of 65 %
PARAMETERS	Body weight gain, average daily gain, feed intake, and feed conversion ration, yield on carcass, breast meat and commercial parts
DURATION	42 days
LOCATION	Research Institute of Animal Science in Paralimni Giannitson

GRAPH 5. FINAL BODY WEIGHT AT DAY 42



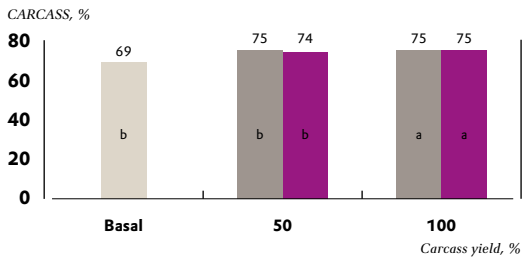
GRAPH 1. AND 2. LIVE PERFORMANCE FROM 0 TO 42 DAYS OF AGE

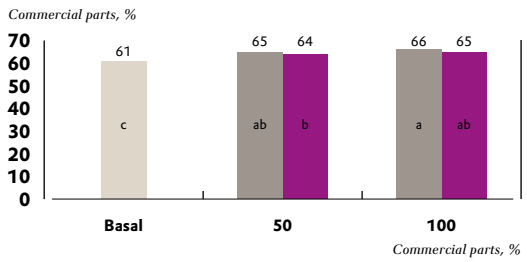




MHA-FA DL-Met

GRAPH 3. AND 4. CARCASS YIELD, AND COMMERCIAL PARTS (BREAST, AND LEGS)





MHA-FA DL-Met

EUROPE / GREECE
Experimental Trial

TRIAL DESIGN

- The trial was carried out in collaboration with the Hellenic Agricultural Organization – Demeter at their Research Institute of Animal Science in Paralimni Giannitson, Greece. It was arranged according to a completely randomized design comprising five dietary treatments and seven replicates (Table 1).
- The trial design allowed the comparison of a commercial diet deficient in methionine + cystine (M+C) with two diets gradually supplemented with MHA-FA. Supplementation levels met either half the gap or filled the gap between deficient diet and respective M+C recommendations. Furthermore, the added amount of MHA-FA was replaced with 65 percent of MetAMINO® – Evonik's DL-methionine (DL-Met) – at both levels, eventually resulting in five dietary treatments.

TRIAL OBJECTIVES

- The objective of this study was to determine the nutritional value of MHA-FA relative to MetAMINO® in common Greek broiler diets on a product basis. Additionally, the European data base of comparable trials should be extended, and further completed with a study from Greece.

TRIAL RESULTS

- A dietary M+C deficiency results in performance losses.
- A graded supplementation with either MHA-FA or DL-Met increased performance.
- Comparing both products, the same performance was observed within the same recommendation level.
- Addition of both products also increased slaughter traits.

CONCLUSIONS

- The results confirmed the necessity to supplement commercial broiler diets with methionine.
- Supplementation of feed with the most common methionine sources, DL-Met, and MHA-FA, increased animal performance.
- The use of these products with their correct nutritional value provides decisive criteria from a nutritional, and costing, standpoint.
- This trial proved that 650 g of DL-Met can successfully replace 1 kg MHA-FA without any drop in animal performance.

FEEDBACK

"Results proved that the product-based, nutritional value of 65 percent for MHA-FA compared to DL-methionine seems to be correct."

Dr. George Symeon,
Hellenic Agricultural Organization – DEMETER

“About 126,000 laying hens don’t lie: The nutritional value of DL-MHA-FA is 65 % of that of MetAMINO®”

Trial conducted in cooperation with University of Osnabrück, Germany, and an egg producer, 2018

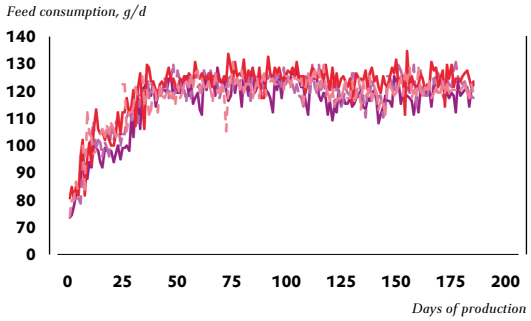
Trial location:
Germany

Project team leaders:
A. Lemme, Prof. H. Westendarp, M. Naatjes, F. Tallen, T. Baumeister, C. de la Cruz

TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

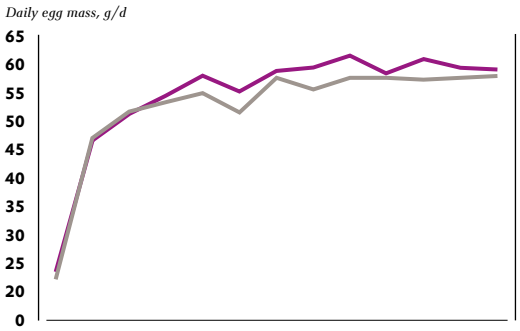
ANIMALS	126,000 ISA-Dekalb White laying hens
DIETS	Wheat – corn – triticale – sunflower meal – soybean meal based
HOUSING	Two houses with two floors separated in six aviaries each: Total 24 aviaries
FEEDING	House 1: 1.300 kg/t liquid MHA-FA House 2: 0.845 kg/t MetAMINO® **Ratio House 2: House 1 → 65 %** • Total of 122 batches were produced • Analyses confirmed intended product inclusions
PARAMETERS	Feed consumption, egg production and size, egg size distribution
DURATION	20 to 44 weeks
LOCATION	Commercial farm

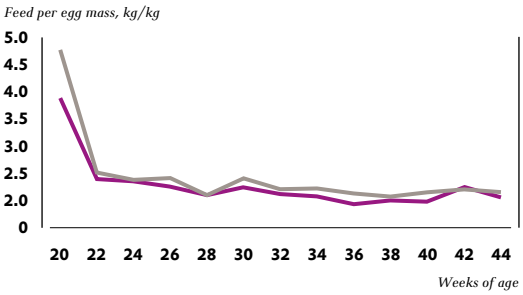
FEED CONSUMPTION OF LAYING HENS FED EITHER 1.3 kg/t LIQUID MHA-FA OR 0.845 kg/t MetAMINO®



DL-Met, 0.845 kg/t — floor 3 — floor 4
liquid MHA-FA, 1.3 kg/t — floor 5 — floor 6

DAILY EGG MASS AND FEED CONVERSION RATIO OF LAYERS OVER 24 WEEKS





DL-Met, 0,845 kg/t — fl. MHA-FA, 1,3 kg/t

ECONOMIC CALCULATION

	Operator	liquid MHA-FA	MetAMINO®
Number of hens		**126,000**	126,000
Period, days	X	180	180
Daily feed consumption, g	X	117.9	116.3
Total feed consumption, t	=	2,673.97	2,637.68
Dosing of product, kg/t	X	1.3	0.845
Required product, kg	=	3,476.2	2,228.8
Purchasing price of product, €/kg	X	2.00	2.50
Product cost, €	=	6,952.4	5,572.0
Savings, €	–		**–1,380**
Difference total feed intake, t			–36.29
Cost difference at 260€/t feed			–9,435
Total savings product+feed, €			**10,816**

EUROPE / GERMANY
Commercial Trial

TRIAL DESIGN

- Liquid methionine hydroxy analog free acid (MHA-FA) and MetAMINO® – Evonik's DL-methionine (DL-Met) – were added to commercial layer feed in a 100:65 ratio. MHA-FA supplemented feed was provided to one layer house with two floors and six aviaries per floor for 180 days, while MetAMINO® supplemented feed was given to the other house.

TRIAL OBJECTIVES

- The objective of this study was to demonstrate that replacement of liquid MHA-FA with MetAMINO® in a 100:65 ratio will not negatively impact performance of laying hens kept under commercial conditions in an aviary system.

TRIAL RESULTS

- Replacing 1.3 kg/t liquid MHA-FA with 845 g/t MetAMINO® had no adverse impact on egg production and egg size (data not shown) and, consequently, on daily egg mass, feed consumption and feed conversion ratio when fed over 180 days to 63,000 ISA Dekalb white layers. Overall, DL-Met fed layers consumed 36.3 t less feed.
- Egg size distribution was not affected by treatment nor was body weight of hens (1.64 kg/bird). Also, plumage quality determined with a 4-grade scale did not differ between treatments (data not shown).

CONCLUSIONS

- 1.3 kg/t of liquid MHA-FA can be replaced with 0.845 kg/t MetAMINO® (65 percent of liquid MHA-FA dose) to achieve the same layer performance.
- Bird quality (body weight, plumage) and egg quality (size distribution) is not affected by replacing liquid MHA-FA with MetAMINO® in a 100:65 ratio.
- Replacing liquid MHA-FA with MetAMINO® in a 100:65 ratio saved €1,380 based on product price related to 63,000 laying hens fed over 180 days. Adding cost savings of lower feed consumption with MetAMINO® would amount to €10,816.

FEEDBACK

"Again, the animals verified that MHA can be replaced by DL-Met on a ratio of 100:65, independent of testing the effectiveness in broiler, turkey, layer, fish or pigs."

Dr. Maike Naatjes,
Evonik Operations GmbH

“Performance comparison between PROXYMet™ and MHA-FA in layers at peak performance”

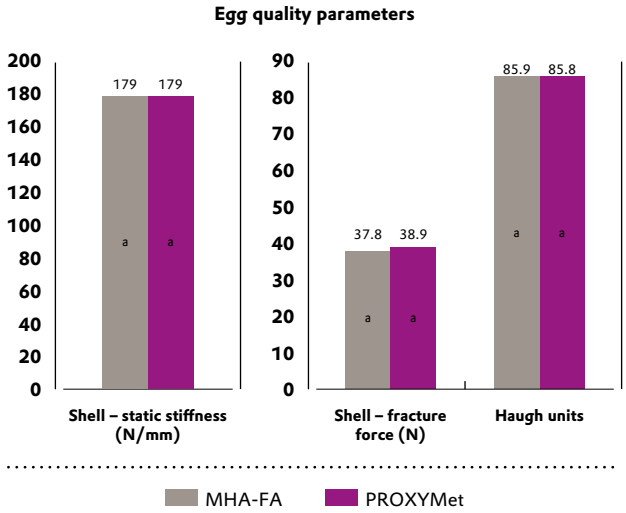
Trial conducted by Evonik and Zootests SAS, Ploufragan, France, 2018

Trial location:
Zootests SAS, Ploufragan, France

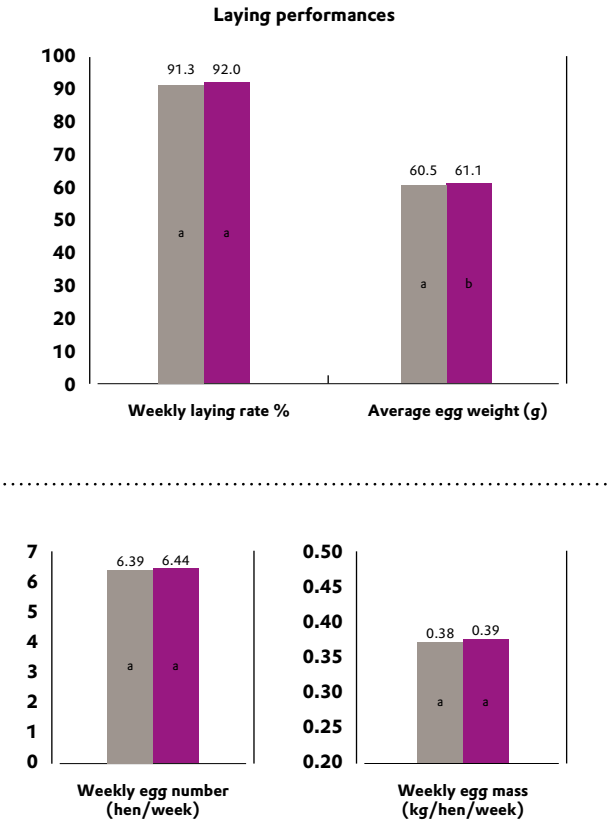
Project team leaders:
C. Alleno, C. Combeau, M. Lepoudere, M. Mueller

TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS	
ANIMALS	560 layers Rhode Island (Novobrown)
DIETS	Corn-wheat-soybean meal-based diets
DESIGN	Randomized design of two treatments á 14 replicates of 20 birds each
FEEDING	• T 1: 0.17 % MHA-FA added • T 2: 0.17 % PROXYMet™ added
PARAMETERS	Laying rate, egg weight, egg number, daily feed intake, body weight, feed conversion ratio, mortality, egg quality traits
DURATION	From 26 to 35 week of life
LOCATION	Zootests’ experimental farm at La Motte

GRAPH 4. EGG QUALITY PARAMETERS



GRAPH 1, 2, 3. LAYERS PERFORMANCES FROM 26 TO 35 WEEKS



EUROPE / FRANCE
PROXYMet™ Experimental Trial

TRIAL DESIGN

- This trial started with a pre-test period (from 21 to 24 weeks of life) to adapt the layers to the facilities' conditions and to monitor, as well as ensure, equal performance in both groups.
- During the test period birds received the same diet (French standard), being only different in methionine sources added: T 1 – contained 0.17 percent liquid methionine hydroxy analog free acid (MHA-FA), and T 2 – contained 0.17 percent PROXYMet™ (MetAMINO® – Evonik's DL-methionine (DL-Met) – diluted to a concentration of 650 g DL-Met per kg).

TRIAL OBJECTIVES

- The objective of this study was to determine the effect of replacing MHA-FA with PROXYMet™ on a product-based ratio of 1:1.
- Relevant laying and live performance parameters were statistically assessed.

TRIAL RESULTS

- Replacing MHA-FA with PROXYMet™ in layers feed resulted in the same laying performance, but in higher egg weights in the PROXYMet™ supplemented birds (Graph 1).
- Consequently, average weekly egg mass per hen was also higher in the birds fed PROXYMet™ (Graph 2).
- The lower feed consumption of T2 group (PROXYMet™) led to an improved feed conversation ratio in this treatment (Graph 3).
- Shell strengths measured by shell stiffness, and fracture force, as well as Haugh units, revealed no differences between both treatments (Graph 4).

CONCLUSIONS

- PROXYMet™ successfully replaced MHA-FA in layer diets in this trial.
- The layers being fed PROXYMet™ performed at least at the same levels, and for some parameters performance was improved.
- Significant savings in feed cost can be achieved by exchanging 100 parts of MHA-FA with 65 parts of DL-methionine.

FEEDBACK

"PROXYMet™ is an easy-to-handle, and convincing tool to test and prove the correct replacement ratio between MHA-FA and DL-methionine"

Christophe Alleno,
General Manager of Zootests SAS

“Performance comparison between MetAMINO® and MHA-Ca at a quantitative ratio of 65:100 in brown layers in enriched cages”

Trial conducted by Evonik, International Poultry Testing Station (CR), 2018

Trial location:
Ustrasice/Czech Rep.

Project team leaders:
Dr. Machander, Dr. Müller, Dr. Lemme, DVM. de la Cruz

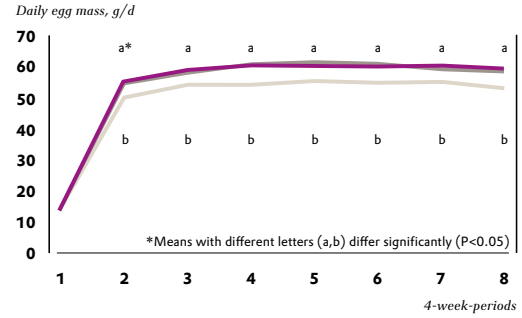
TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

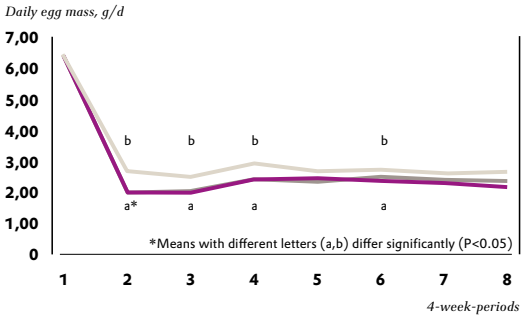
ANIMALS	1,440 Isa-Brown layers
DIETS	Corn-wheat-soybean meal based diets
DESIGN	Completely randomized design with 5 treatments/9 replicates/30 hens each
FEEDING	T1) Control with no supplemented methionine, deficient in M+C T2) supplemented with 1.2 kg/t MHA-Ca (sub-optimal M+C req) T3) supplemented with 2.4 kg/t MHA-Ca (optimal M+C req) T4) supplemented with 0.78 kg/t MetAMINO® (sub-optimal M+C req) T5) supplemented with 1.56 kg/t MetAMINO® (optimal M+C req)
PARAMETERS	Egg production, egg weight, feed intake, egg mass, feed conversion ratio, internal egg quality, eggshell quality, egg size classification.
DURATION	32 weeks (18 to 50 wk of age)
LOCATION	Experimental farm

a = T1 Basal

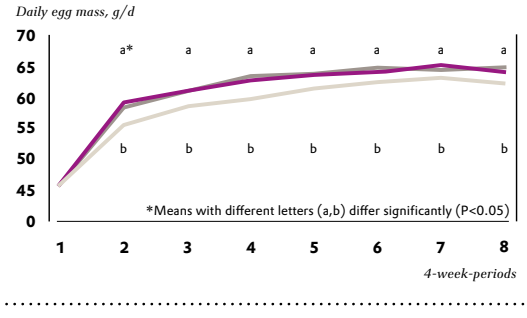
b = T2 MHA-Ca, 1.2 kg/t, suboptimal
T3 DL-Met, 0.78 kg/t, suboptimal
T4 MHA-Ca, 2.4 kg/t, adequate
T5 DL-Met, 1.56 kg/t, adequate

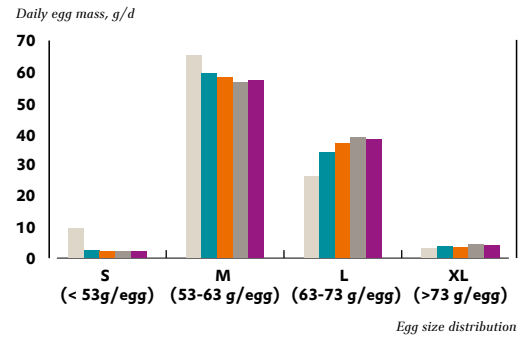
GRAPH 1. AND 2. EGG MASS & FCR OF LAYERS OVER A PERIOD OF 32 WEEKS





GRAPH 3. AND 4. EGG WEIGHT & EGG SIZE CLASSIFICATION OF LAYERS OVER A PERIOD OF 32 WEEKS





EUROPE / CZECH REPUBLIC
Experimental Trial

TRIAL DESIGN

- The trial was designed (Table 1) in cooperation with the International Poultry Testing Station and carried out under European conditions (enriched cages).

TRIAL OBJECTIVES

- The objective of the study is to provide further scientific evidence of the interchangeability of methionine hydroxy analog calcium salt (MHA-Ca) with MetAMINO® – Evonik's DL-methionine (DL-Met) – (DL-Met 99 percent) at a 100:65 ratio and that this ratio works well at different supplementation levels on brown layers in colony enriched cages, without compromising animal performance.

TRIAL RESULTS

- Diets deficient in methionine + cystine (M+C) negatively affected the performance of layers. Supplemented methionine is essential for optimized performance of laying hens.
- There were no significant differences in performance (Graphs 1 – 3) between corresponding MHA-Ca and MetAMINO® treatments.
- Differences between the two M+C (diet T2/T4 vs. T3/T5) levels are only very small and can be seen at best in small numerical differences in egg mass (Graph 1) and feed conversion ratio (Graph 3). However, examining egg size classification (Graph 4), a small shift in proportions from "small" toward "large" can be seen for the higher supplement level.
- Overall, it can be confirmed that substituting MetAMINO® for MHA-Ca at a quantitative ratio of 65:100 (MetAMINO®: MHA-Ca) had no negative effects on any of the performance parameters, or egg quality criteria in laying hens and so confirms the outcome of previous trials in the regions in laying hens in production: (de la Cruz, 2018; Santiago, 2017).

CONCLUSIONS

- 1 kg of MHA-Ca can be replaced with 650 g of DL-Met to achieve the same level of laying performance.
- Supplemented methionine is essential for optimized performance.
- The study revealed significant financial savings and improved farm profitability for the MetAMINO® treatment.

FEEDBACK

"The replacement ratio of 100:65 of MHA-Ca with DL-methionine is also supported by a recent EFSA report concluding that HMTBa shows a lower bioefficacy than DL-methionine (EFSA J., vol., 16, issue 3, 2018, e05198)."

Carlos de la Cruz,
Senior Manager Technical Consultancy, Evonik

"Supplementing MetAMINO® and liquid MHA-FA at a ratio of 65:100 on a product basis to a Met-deficient diet in 9 to 25 – 30 kg weaned pigs"

Trial conducted by Evonik in collaboration with IFIP (French Pig and Pork Institute), 2016

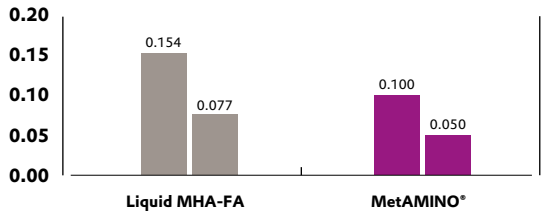
Trial location:
Le Rheu Cedex, France

Project team leaders:
Didier Gaudré, Mathieu Lepoudere, Caroline González-Vega

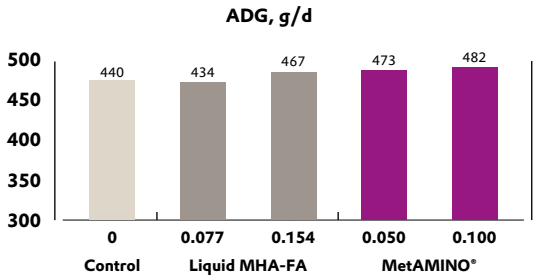
TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

ANIMALS	240 (28 d old; 9.25 kg) weaned pigs (Large white x Pietrain boars and Large White x Landrace sows)
DIETS	Cereals, soybean meal and extruded soybean meal basal diet
DESIGN	Randomized design with 5 trt/6 reps/8 pigs per pen (4 boars and 4 gilts)
FEEDING	A Met-deficient basal diet, used for the control treatment, was supplemented with two graded levels of MetAMINO® (0.050 and 0.100 %) or liquid MHA-FA (0.077 and 0.154 %) on a product basis at MetAMINO® to MHA-FA of 65:100
PARAMETERS	Body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR).
DURATION	40 days
LOCATION	IFIP (French Pig and Pork Institute), France

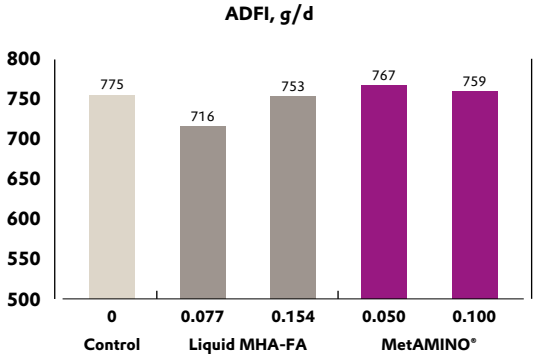
GRAPH 1. INCLUSION OF MetAMINO® VS. LIQUID MHA-FA AT 65 TO 100



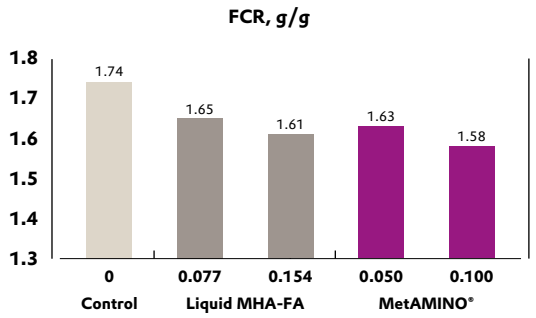
GRAPH 2. EFFECT OF METHIONINE SOURCE ON AVERAGE DAILY GAIN FROM DAY 0 TO 40



GRAPH 3. EFFECT OF METHIONINE SOURCE ON AVERAGE DAILY FEED INTAKE FROM DAY 0 TO 40



GRAPH 4. EFFECT OF METHIONINE SOURCE ON FEED CONVERSION RATIO FROM DAY 0 TO 40



EUROPE / FRANCE
Experimental Trial

TRIAL DESIGN

- A dose response performance trial was conducted involving five treatments, each treatment containing a pre-starter and a starter diet.
- A methionine-deficient basal diet was used for the control treatments.
- Trial diets were based on the control diet supplemented with two graded levels of MetAMINO® – Evonik's DL-methionine (DL-Met) – 0.050 and 0.100 percent, or liquid methionine hydroxy analog free acid (MHA-FA), 0.077 and 0.154 percent, on a product basis at MetAMINO® to MHA-FA of 65:100.

TRIAL OBJECTIVES

- The objective was to test the hypothesis that pigs (9 to 30 kg body weight) fed diets using a relative bioavailability (RBV) of 65 percent for MHA-FA compared with MetAMINO®, results in similar growth performance.

TRIAL RESULTS

- To test the hypothesis, a methionine-deficient basal diet, used for the control treatment, was supplemented with two graded levels of MetAMINO® (0.050 and 0.100 percent) or liquid MHA-FA (0.077 and 0.154 percent) on a product basis at MetAMINO® to MHA-FA of 65:100 (Graph 1).
- For the overall period, pigs fed diets supplemented with either MetAMINO® or MHA-FA had numerically greater average daily gain (ADG) than pigs fed methionine deficient diet (Control diet; Graph 2). Comparing methionine sources, pigs fed MetAMINO® at 0.050 percent (sub-optimal methionine + cystine (M+C) requirements) had greater ($P < 0.05$) ADG than pigs fed 0.077 percent MHA-FA (sub-optimal M+C requirements), but no differences were observed between pigs fed MetAMINO® at 0.100 percent and MHA-FA at 0.154 percent (both diets with optimal M+C requirements).
- Average daily feed intake was not affected by dietary treatments (Graph 3). Whereas, as expected, feed conversion ratio (FCR) was significantly improved ($P < 0.05$) in pigs fed supplemented diets with MetAMINO® and MHA-FA compared to pigs fed a methionine deficient diet (Control diet; Graph 4). Also, as confirmation of the hypothesis, no differences in FCR were observed between pigs fed 0.050 percent MetAMINO® and 0.077 percent MHA-FA, or in pigs fed 0.100 percent MetAMINO® and 0.154 percent MHA-FA. Thus, these results indicate that regardless of the level of methionine in the diet, using a RBV of 65 percent for MHA-FA compared with MetAMINO®, results in similar growth performance.

CONCLUSIONS

- At marginal (sub-optimal M+C requirements), or adequate (optimal M+C requirements) levels of dietary methionine, no differences in any of the evaluation performance parameters were seen between MetAMINO® compared to MHA-FA for a MetAMINO® to liquid MHA-FA ratio of 65:100.
- The above information needs to be considered for cost effective purchasing of DL-Met sources and to optimize feed formulation costs.

FEEDBACK

"From the test results, it can be concluded that 1 kg of MHA-FA can be replaced with 0.65 kg DL-methionine while Key Animal Performance Parameters remain unchanged."

Didier Gaudré, *piglet & growing pig nutrition expert, Institut du porc (IFIP) swine institute*

“Direct comparison of DL Methionine and MHA-FA confirms 65 % Bioefficacy”

Trial in collaboration with Jiran at QOM Poultry Farm Facility, 2017

Trial location:
Qom, Iran

Project team leaders:
Dr. Ali Afsar

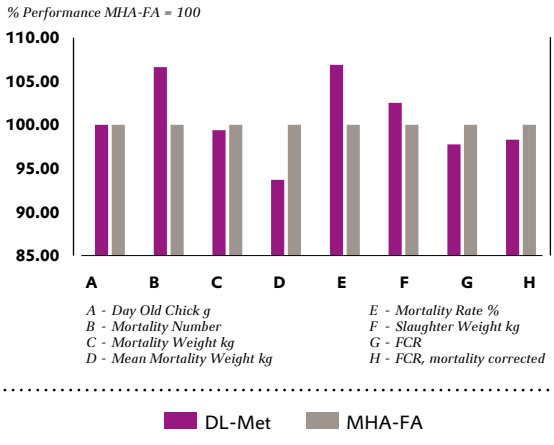
TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

LOCATION	Trial facility of Qom Poultry, Iran
ANIMALS	11000 ROSS 308, 50% FEMALE, 50 % MALE
DIETS	Corn-soybean based diets; 4 phases: starter 1 (0–10), starter 2 (11–17), Grower (18–27), Finisher (28 to 45)
DURATION	Trial covered the period 0 – 45 day
DESIGN	Single house, split longitudinally, separate feeding and drinking systems
TREATMENTS	MHA-FA – Standard formulation with DL-Met – As for MHA, but MHA-FA replaced with DL-Met using 65 % BE value
PARAMETERS	Weight gain, feed intake, mortality rate, FCR and FCR corrected for mortality and EEF

TABLE 2. FINANCIAL BENEFITS WHEN SWITCHING FROM MHA-FA TO MetAMINO®

	MHA-FA	MetAMINO®	Difference
Mean Feed Cost €/T	326.22	325.55	–0.3 %
Total Income €	17281.50	17806.50	+3.0 %
Income over Feed Cost €	9909.10	10382.10	+4.8 %

GRAPH 1; PERFORMANCE COMPARED TO MHA-FA



MIDDLE EAST AFRICA/IRAN
Commercial Trial

TRIAL DESIGN

- A controlled environment broiler house was divided into two equal parts with a total of 11,000 (5,500 to each side) mixed-sex day-old-Ross 308 broiler chicks. The basal corn-soybean meal (SBM) diet was supplemented with either liquid methionine hydroxy analog free acid (MHA-FA) or MetAMINO® – Evonik's DL-methionine (DL-Met) – to achieve two test diets. Corn gluten meal (CGM) was added to the starter diets. The inclusion level of DL-Met was set at 65 percent of MHA-FA inclusion levels in all four phases.

TRIAL OBJECTIVES

- The objective of the present study was to demonstrate that each 1 kg of MHA-FA in feed for broiler chickens could be replaced with only 650 g DL-Met with no adverse impact on bird performance.

TRIAL RESULTS

- Replacing 100 parts of MHA-FA with 65 parts of DL-Met did not affect growth performance of broilers.
- Birds fed diets supplemented with 65 parts of DL-Met had a numeric improvement of 2.5 percent in final body weight and a reduced feed conversion ratio (FCR) of four points compared to birds fed 100 parts of MHA-FA.
- These results confirm previous reports that have shown the relative bioavailability of MHA-FA is approximately 65 percent in relation to DL-Met on a product basis.

CONCLUSIONS

- 1 kg of MHA-products can be replaced with 650 g of DL-Met to achieve the same level of growth performance at standardized ileal digestibility (SID) amino acid levels and at lower SID amino acid levels.
- Such an approach improves overall profitability by reducing feed costs whilst maintaining poultry meat income.
- In this example, total income was improved by 3 percent; whilst income over feed cost increased by almost 5 percent.

FEEDBACK

"Another trial that provides firm, real-life evidence that using DL-methionine can boost profitability, so important in these difficult times."

Dr. Ali Afsar, *Technical Manager, Evonik Iran*

“Performance response to MetAMINO® and MHA-FA fed at ratio of 65:100 in layers”

Trial conducted by Evonik and Tianfukangye Livestock Technology Co., Ltd., 2017

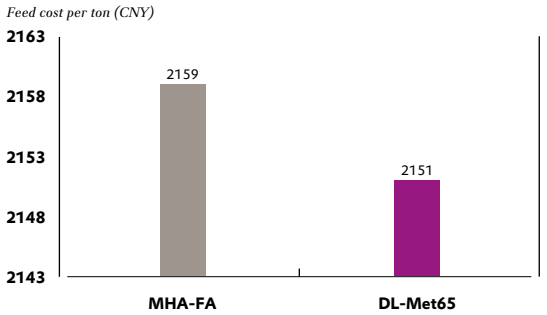
Trial location:
Xinjiang / China

Project team leader:
Stevin Jie

TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

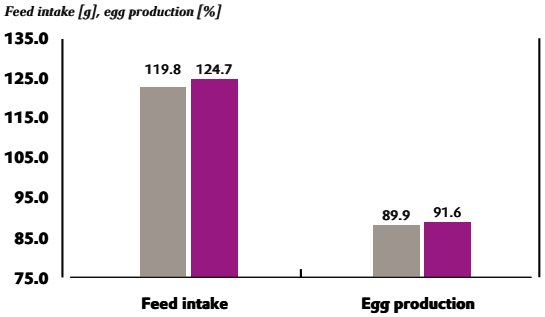
ANIMALS	1,010 Hy-Line Pink layers
DIETS	Corn-soybean meal based diet
DESIGN	488 birds in DL-Met65 group, 522 birds in MHA-FA group
FEEDING	MHA-FA group formulated according to breeder’s recommendations, DL-Met65 group replaced MHA-FA by 65 % DL-Met on product basis
PARAMETERS	Feed intake, egg production, egg weight, egg mass, feed to egg mass ratio
DURATION	57 to 61 weeks old
LOCATION	Commercial farm

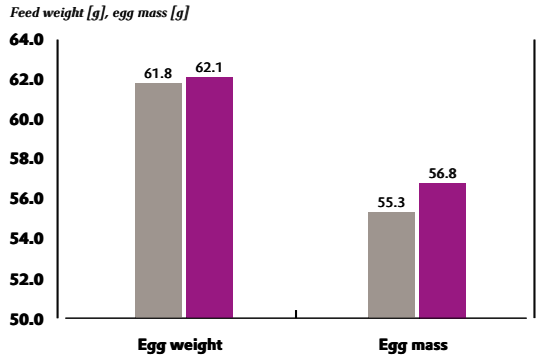
GRAPH 3. SAVING WITH DL-METHIONINE VS. MHA-FA

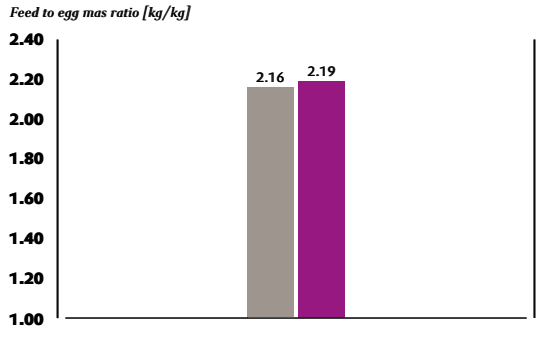


DL-Met 22 CNY/kg vs MHA-FA 18 CNY/kg

GRAPH 1. AND 2. LAYER PERFORMANCE FROM 57 TO 61 WEEKS OF AGE







MHA-FA DL-Met65

ASIA PACIFIC / CHINA
Commercial Trial

TRIAL DESIGN

- The trial was jointly designed (Table 1) and carried out in collaboration with a layer customer in China.

TRIAL OBJECTIVES

- The objective of this study was to determine the effect of replacing methionine hydroxy analog free acid (MHA-FA) (MHA-FA, 88 percent) with 65 parts of MetAMINO® – Evonik's DL-methionine (DL-Met) – (DL-Met, 99 percent) on performance of layers from 57 to 61 weeks of age and feed cost when switching from liquid MHA to MetAMINO® (Graph 3).

TRIAL RESULTS

- Replacing 100 parts of MHA-FA with 65 parts of MetAMINO® did not affect performance (Graph 1 "Feed intake and egg production" and Graph 2 "Egg weight, egg mass and feed over egg mass ratio") of layers under commercial conditions.
- Switching from MHA-FA to MetAMINO® reduces the feed cost of ¥8/ton under the ingredient prices during trial and based on an average supplementation rate of 0.22 percent of MHA-FA versus 0.143 percent (0.22 percent x 65 percent) of MetAMINO®.

CONCLUSIONS

- 1 kg of MHA-products can be replaced with 650 g of MetAMINO® to achieve the same level of performance…
- … and significant savings in feed formulation and methionine costs.
- The practical example (Graph 3) replacing MHA-FA at CNY 18/kg with DL-Met at CNY 22/kg results in a saving of CNY 8/ton of feed.

FEEDBACK

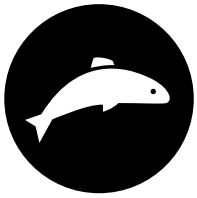
"No negative effect was shown when 65 parts of DL-methionine replaced 100 parts of MHA in layer diets."

Tianfukangye Livestock Technology Co., Ltd

“Effects of DL-Met and MHA-Ca on growth, feed utilization and taurine synthesis in common carp (Cyprinus carpio)”

Trial conducted by Evonik, South China Normal University, 2018

Trial location:
Guangdong/China



Project team leaders:
Prof. Ye Chaoxia,
Dr. Sarah He,
Dr. Masagounder Karthik

TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

ANIMALS	1,350 common carp with 3.7 g initial body weight
DIETS	Soybean meal (28 %), peanut meal (10 %), wheat flour (20 %) & wheat middling (22 %) based diets
DESIGN	9 diets; 5 tanks/diet; 30 fish/tank – Basal diet deficient in methionine, 0.46 % – Basal diet with 0.1 %, 0.2 %, 0.3 % and 0.4 % DL-Met – Basal diet with 0.1 %, 0.2 %, 0.3 % and 0.4 % MHA-Ca
FEEDING	Apparent satiation twice per day
PARAMETERS	Growth performance, feed utilization, and taurine synthesis
DURATION	8 weeks
LOCATION	South China Normal University

TABLE 2. BIOAVAILABILITY ANALYSIS BETWEEN DL-MET AND MHA-CA

Parameter	Regression equations	DL-Met	MHA-Ca
Final body weight (g/fish)	FBW = 17.54 + 3.05 [1-exp(−0.057 (DL-Met+0.418 MHA-Ca))], R2 = 0.59	100 %	42 %
FCR	FCR = 1.45−0.22 [1-exp(−0.087 (DL-Met+0.471 MHA-Ca))], R2 = 0.71	100 %	47 %
Protein efficiency ratio*	PER = 1.89+0.31 [1-exp(−0.078 (DL-Met+0.44 MHA-Ca))], R2 = 0.65	100 %	44 %
Muscle taurine %	Muscle Taurine = 0.19+0.005 (DL-Met + 0.52 MHA-Ca), R2 = 0.68	100 %	52 %

* Protein efficiency ratio (PER, %) = 100 x (body weight gain) / (protein intake)

FIG 1. COMMON CARP PERFORMANCE FED WITH DIFFERENT LEVELS (% DIET) OF DL-MET AND MHA-CA

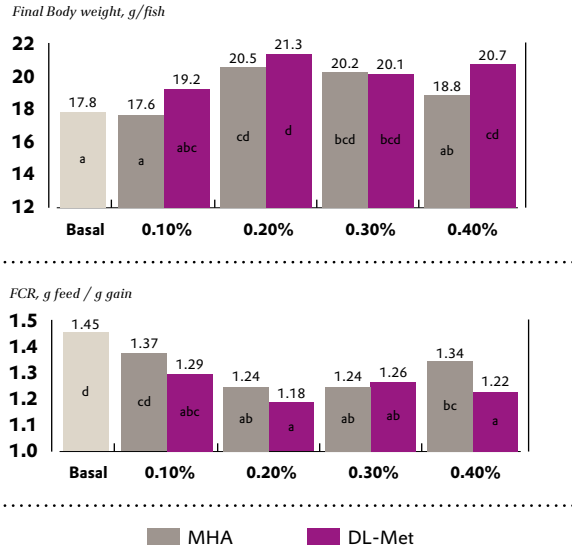
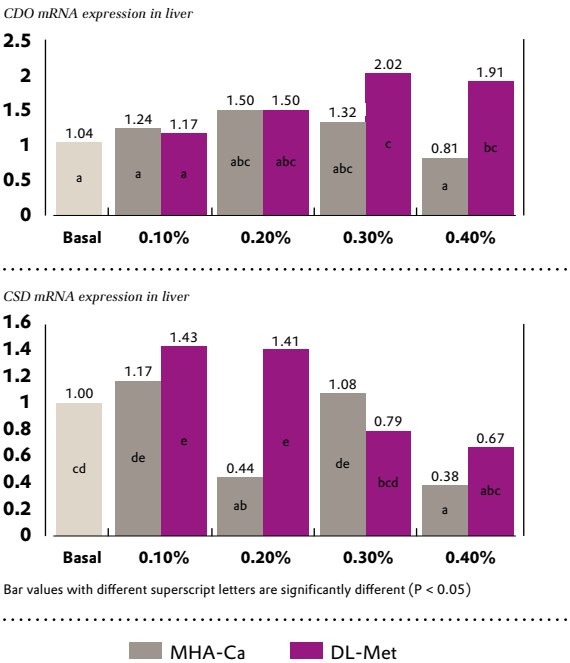


FIG 2. RELATIVE mRNA EXPRESSION OF GENES OF ENZYMES RESPONSIBLE FOR TAURINE SYNTHESIS IN THE LIVER OF COMMON CARP FED WITH DL-MET AND MHA-CA



Bar values with different superscript letters are significantly different (P < 0.05)

ASIA PACIFIC / CHINA
Experimental Trial

TRIAL DESIGN

- The trial was designed (Table 1) and carried out in collaboration with Prof. Ye Chaoxia from South China Normal University, one of the most well-respected universities in China in the field of agriculture and animal nutrition.

TRIAL OBJECTIVES

- The objective of this study was to determine the effects of MetAMINO® – Evonik's DL-methionine (DL-Met) – (DL-Met, 99 percent) and methionine hydroxy analog calcium salt (MHA-Ca, 84 percent) on growth, feed utilization, and taurine synthesis in common carp.

TRIAL RESULTS

- Diets deficient in methionine negatively affected growth performance and feed utilization of common carp. Dietary DL-Met and MHA-Ca supplementation significantly improved the body weight and feed conversion ratio (FCR) of common carp (Figure 1). A two-way ANOVA test revealed that DL-Met produces better growth, body weight, FCR and protein efficiency than MHA-Ca ($P < 0.01$).
- Cysteine dioxygenase (CDO) and cysteine sulfinate decarboxylase (CSD) are the two key enzymes responsible for the biosynthesis of taurine from cysteine via cysteine sulfinic acid and hypotaurine production. DL-Met fed fish exhibited higher expression CDO and CSD genes in the liver compared with the MHA-Ca fed fish ($P < 0.05$) (Figure 2), indicating higher taurine synthesis by DL-Met than by MHA-Ca.

FOR MORE INFORMATION, PLEASE SEE OUR VIDEO

CONCLUSIONS

- Both MetAMINO® and MHA-Ca supplementation improved growth performance, feed utilization and taurine synthesis in common carp, however, MetAMINO® showed better effects than MHA-Ca.
- Multi-exponential regression analysis showed that MHA-Ca was less utilized by common carp than MetAMINO® with bioavailability values being 42 percent to 52 percent on a weight-for-weight basis depending on performance parameters (Table 2).

FEEDBACK

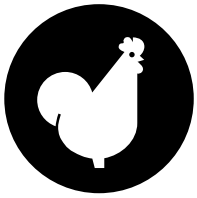
"The trial scientifically proved that MHA-Ca was less utilized by common carp than DL-Methionine with bioavailability values of 42 percent to 52 percent on a weight-for-weight basis."

Dr. Sarah He,
R&D Manager Aqua,
Evonik (China) Co., Ltd

“Uncover the beliefs to change them”

Trial conducted by Evonik in collaboration with customer, 2018

Trial location:
Kolkata, India

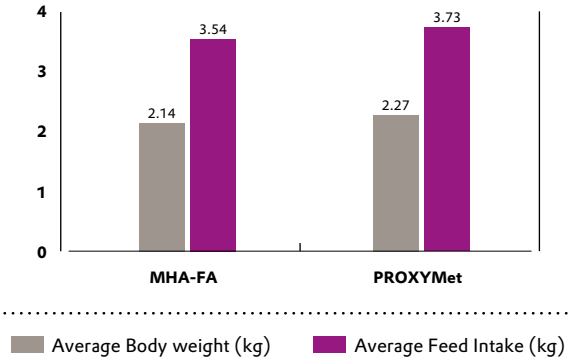


Project team leaders:
Mr. Utpal Adhikari &
Dr. Sushil Patil

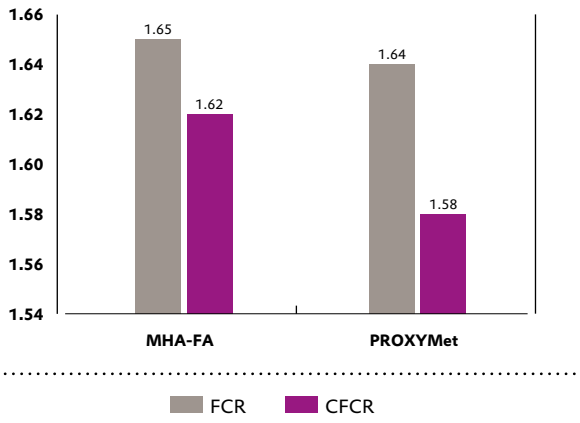
TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

ANIMALS	14,000 mixed Vencobb 400 broilers
DIETS	Corn-soy based commercial Prestarter, Starter and Finisher diets
DESIGN	2 houses, 1 house/treatment, 7,000 birds received MHA-FA diet, 7,000 birds received PROXYMet™ diet
FEEDING	Birds were fed Prestarter (d 1–12), Starter (d 13–25), Finisher 1 (d 26–35) and Finisher 2 diets (d 35-culling) in crumble/pellet form. **Trt 1.** MHA-FA as per the current customer practice **Trt 2.** MHA-FA replaced by PROXYMet™ on a w/w basis
PARAMETERS	Body weight (kg), Feed Intake (kg), FCR, CFCR (FCR corrected to 2 kg), % Mortality
DURATION	d 0 to 42
LOCATION	Customer trial farm

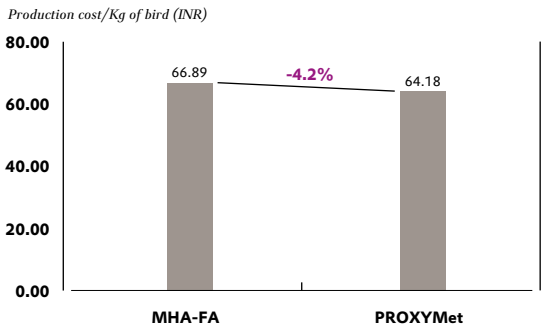
GRAPH 1. AVERAGE BODY WEIGHT AND FEED INTAKE



GRAPH 2. FEED CONVERSION RATIO



GRAPH 3. BENEFIT WITH DL-METHIONINE VS. MHA-FA



ASIA PACIFIC/INDIA
PROXYMet™ Commercial Trial

TRIAL DESIGN

- Commercial PROXYMet™ (containing 65 percent DL-methionine and 35 percent limestone) trials conducted with four different broiler integrators covering over 175,000 birds spread over 36 farms at multiple locations in India showed similar performance as MHA-FA. All the birds within a trial were on similar diets, except MHA-FA in the control group which was replaced by PROXYMet™ on a weight to weight (wt/wt) basis in the treatment group.
- 14,000 mixed Vencobb broiler chicks were placed under two treatment groups with 7,000 birds in each treatment. One treatment group received diets supplemented with MHA-FA and the other treatment group received diets supplemented with PROXYMet™ on a wt/wt basis.

TRIAL OBJECTIVES

- The objective of this study was to carry out a comparative evaluation of PROXYMet™ and MHA-FA on a wt/wt basis as the supplemental source of methionine in diets of commercial broilers.

TRIAL RESULTS

- Average body weight and feed intake was found to be numerically higher in the PROXYMet™ group. Body weight corrected feed conversion ratio (FCR) was lower by four points in PROXYMet™ supplemented diets compared to MHA-FA.
- The production cost calculated for per kg of bird was lower by INR 2.71 in the PROXYMet™ group, compared to the MHA-FA group.
- When bioavailability figures comparing MHA-FA and DL-Met derived from scientific studies are challenged under practical field conditions, the answer is that 650 g DL-Met can replace 1 kg of MHA-FA in broiler diets without affecting the broiler performance.
- As the relative biological values of the other three trials were in the same magnitude, it can be concluded that the replacement ratio of 100:65 (MHA-FA:DL-Met) is also valid under different trial conditions.

FIND THE PROXYMet™ VIDEO

CONCLUSIONS

- Under practical field conditions, 650 g DL-Met can replace 1 kg of MHA-FA in broiler diets while broiler performance remains constant.
- The lower efficacy of the methionine analogs may be related to partial polymerization (Nufer, 1966) with poor availability (Van Weerden *et al.*, 1992; Mitchell and Lemme, 2008), lower efficiency of transporters and partial metabolism by intestinal microbes (Maenz and Engele-Schaan, 1996).

FEEDBACK

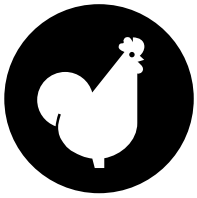
"The customer was very satisfied with the outcome of the trial, as the replacement of 100 units of MHA-FA with 65 units of MetAMINO® will result in extra methionine savings."

Utpal Adhikari,
Business Manager,
Evonik India Pvt Ltd

“Think different, change your perception”

Trial conducted by Evonik in collaboration with customer, 2018

Trial location:
Maharashtra, India

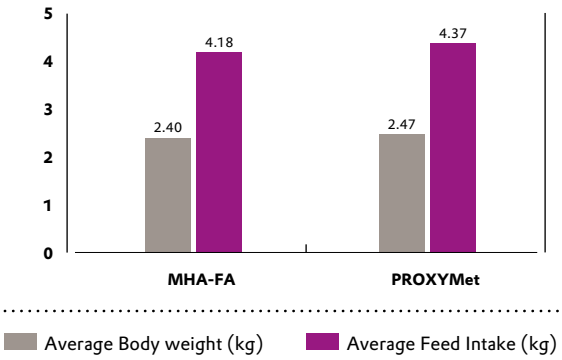


Project team leaders:
Mr. Umesh Shingote
& Dr. Sushil Patil

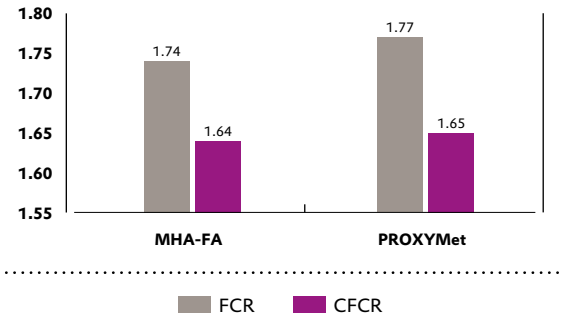
TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

ANIMALS	108,629 mixed Vencobb 400 broilers
DIETS	Corn-soy based commercial starter, grower and finisher diets
DESIGN	20 houses, 10 houses/treatment, 54,553 birds received MHA-FA diet, 54,076 birds received PROXYMet™ diet
FEEDING	Birds were fed Prestarter (d 1–14), Starter (d 15–28), and Finisher diets (d 29-culling) in crumble/pellet form. **Trt 1.** MHA-FA as per the current customer practice **Trt 2.** MHA-FA replaced by PROXYMet™ on a w/w basis
PARAMETERS	Body weight (kg), Feed Intake (kg), FCR, CFCR (FCR corrected to 2 kg), % Mortality
DURATION	Both treatments run over one full production cycle (d 0 to 42–56)
LOCATION	Commercial contract growing farms

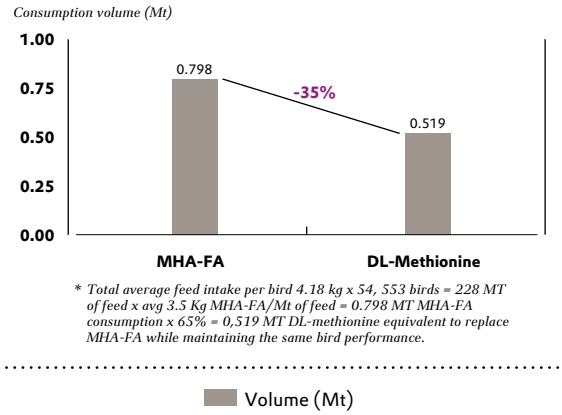
GRAPH 1. AVERAGE BODY WEIGHT AND FEED INTAKE



GRAPH 2. FEED CONVERSION RATIO



GRAPH 3. METHIONINE CONSUMPTION CAN BE REDUCED BY 35% WHEN REPLACING MHA-FA WITH DL-MET



** Total average feed intake per bird 4.18 kg x 54, 553 birds = 228 MT of feed x avg 3.5 Kg MHA-FA/Mt of feed = 0.798 MT MHA-FA consumption x 65% = 0,519 MT DL-methionine equivalent to replace MHA-FA while maintaining the same bird performance.*

ASIA PACIFIC/INDIA
PROXYMet™ Commercial Trial

TRIAL DESIGN

- Evonik developed PROXYMet™, containing 65 percent MetAMINO® – Evonik's DL-methionine (DL Met) – and 35 percent of an inert material (calcium carbonate) to allow customers to easily prove to themselves the "65 percent" concept. The principle then is that methionine hydroxy analog free acid (MHA-FA) can be directly replaced in feeds on a 1:1 basis, as PROXYMet™ is already diluted to 65 percent. Having therefore demonstrated that the 65 percent bio-efficacy comparison works well, Evonik can then assist customers to apply this principle in order to realize the full savings when switching to MetAMINO®.
- The trial was carried out under the commercial rearing conditions. Birds under each treatment group were placed in ten different houses of varying capacity in a gap of one to three days depending on the hatch date.

TRIAL OBJECTIVES

- The objective of this study was to conduct a comparative evaluation of PROXYMet™ and MHA-FA on a weight to weight (wt/wt) basis as the supplemental source of methionine in diets of commercial broilers.

TRIAL RESULTS

- Average body weight and feed intake was found to be numerically higher in the PROXYMet™ group.
- Body weight corrected feed conversion ratio (FCR) was found to be similar between birds fed MHA-FA and PROXYMet™ supplemented diets.

CONCLUSIONS

- 1 kg MHA-FA can be substituted on a wt/wt basis with 1 kg PROXYMet™.
- This means under practical field conditions, 650 g of MetAMINO® can replace 1 kg of MHA-FA in broiler diets.
- The above findings are consistent with the lower bioefficacy of MHA-FA as reported by the European Food Safety Authority (EFSA, 2018).

FEEDBACK

"The customer field trial proved that 65 percent DL-Methionine gave similar performance as MHA-FA and they will consider this finding while making future buying decisions."

Umesh Shingote,
Business Manager,
Evonik India Pvt Ltd

“Bioavailability of MHA-Ca compared with MetAMINO® for Nitrogen (N) retention of nursery pigs”

Collaborative trials by Evonik, Institute of Animal Sciences for Southern Vietnam and University of Kentucky, 2020

Trial location:
Ho Chi Minh City/Vietnam
Lexington/USA

Project team leaders:
Prof. Dr. Lindemann,
Prof. Dr. Kinh; Dr. Htoo,
MSc Ramos

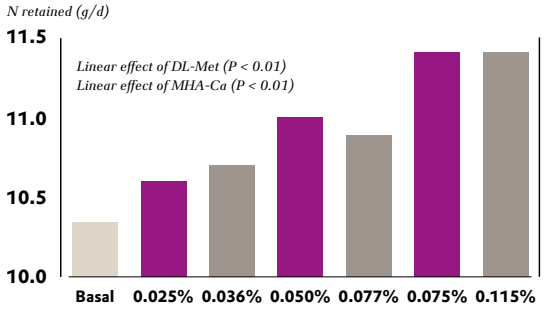
TABLE 1. ANIMALS AND DIETARY TREATMENTS

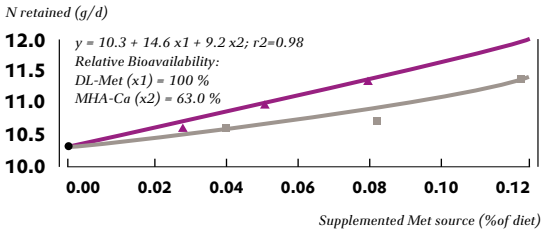
EXPERIMENT 1 (IASVN INSTITUTE, VIETNAM)	
ANIMALS	42 barrows (Duroc × (Large white/Landrace); initial BW of 15.0 kg)
DIETS	Corn-soy based commercial starter, grower and finisher diets
EXPERIMENT 2 (UNIVERSITY OF KENTUCKY, USA)	
ANIMALS	40 barrows (Hampshire × (Landrace/Yorkshire); initial BW of 15.5 kg)
DIETS	A Met-deficient basal diet (0.22 % total Met) supplemented with 2 graded levels of DL-Met or MHA-Ca at DL-Met to MHA-Ca ratio of 65:100 on product basis to create 5 diets

GENERAL N-BALANCE TRIAL DESIGN (EXP. 1 AND 2)

DESIGN	Pigs were kept individually in metabolism crates; 6 pig replicates per treatment
FEEDING	3.5 % of average BW (fed 3 times/day) and free access to water
DURATION	12 days (After 7-d adaptation to diet, feces and urine were collected for 5 days)
MEASURE-MENTS	Feed intake, N retained (g/d) = N intake – (fecal N + urinary N); BW on d 0, 8 and 13
LOCATION	Experimental farm (Institute/University)

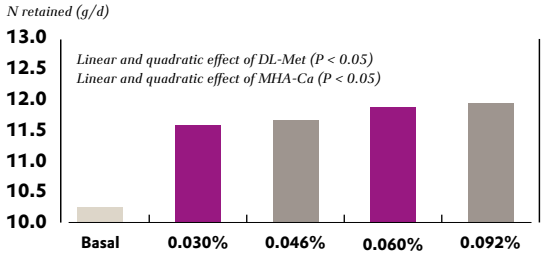
FIGURE 1 AND 2. BIOAVAILABILITY OF MHA-CA RELATIVE TO DL-MET BASED ON N RETENTION (g/DAY; EXP. 1)

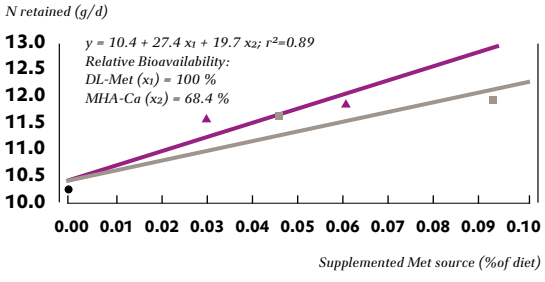




Control Basal MHA-Ca DL-Met

FIGURE 3 AND 4. BIOAVAILABILITY OF MHA-CA RELATIVE TO DL-MET BASED ON N RETENTION (g/DAY; EXP. 2)





Control Basal MHA-Ca DL-Met

ASIA PACIFIC/VIETNAM AND NORTH AMERICA/USA
Experimental (Twin) Trial

TRIAL DESIGN

- **Exp. 1** – The Nitrogen (N)-balance trial was jointly designed (Table 1) and carried out in collaboration with Prof. L. V. Kinh from the Institute of Animal Sciences for Southern Vietnam (IASVN), Ho Chi Minh City, Vietnam.
- **Exp. 2** – The N-balance trial was jointly designed (Table 1) and carried out in collaboration with Prof. M. D. Lindemann from the Department of Animal and Food Sciences, University of Kentucky, USA.

TRIAL OBJECTIVE

- The objective of the studies was to determine the relative bioavailability of methionine hydroxy analog calcium salt (MHA-Ca) compared with MetAMINO® – Evonik's DL-Methionine (DL-Met) – in growing pigs weighing approximately 15 to 18 kg, fed corn-soybean meal-based diets using the N-balance technique at two different locations, with two different pig genetics and under different climatic and housing conditions.

TRIAL RESULTS

- In Exp. 1, adding graded levels of DL-Met or MHA-Ca linearly decreased ($P<0.01$) fecal N output (graded DL-Met addition also decreased urinary N output), and increased ($P<0.01$) retained N (g/d) and N retention (percent intake). Using a linear slope-ratio procedure, a product-to-product relative bioavailability (RBV) of MHA-Ca compared to DL-Met of 63.0 percent was observed based on N retained expressed as g/d (Figures 1 and 2).
- In Exp. 2, graded levels of DL-Met or MHA-Ca addition to basal diet linearly decreased ($P<0.001$) urinary N output and increased ($P<0.001$) retained N (g/d) and N retention (percent intake). Based on a linear slope-ratio regression, the RBV of MHA-Ca to DL-Met was 68.4 percent based on N retained as g/d (Figures 3 and 4).
- From both experiments, an average bioavailability of 65.7 percent was estimated for MHA-Ca compared to DL-Met on a product basis in growing pigs. This is in agreement with Opapeju *et al.* (2010) and Kim *et al.* (2006) who estimated a bioavailability of 67 percent for MHA-Ca and 66 percent for liquid MHA analog free acid, respectively compared with DL-Met on a product-to-product basis in young pigs.

CONCLUSIONS

- The results of those twin studies demonstrated that based on N retention the average bioavailability for MHA-Ca was 65.7 percent on a product basis (being equivalent to 78.2 percent on an equimolar basis) compared to DL-Met in pigs, independent from the different pig genetics, the different climate and housing conditions.
- The average bioavailability of 65 percent on a product-to-product basis for MHA-Ca estimated in the current studies can be used in least cost formulation of swine diets to maximize income over feed cost.

FEEDBACK

"The twin trials scientifically proved that replacement of 100 parts of MHA-Ca with 65 parts of DL-methionine results in similar nitrogen retention in pigs."

Dr. L. V. Kinh, *Professor at the Institute of Animal Sciences for Southern Vietnam*

"Growth performance response to MetAMINO® and MHA-Ca fed at a ratio of 65:100 in nursery pigs"

Conducted at a Commercial Research Farm in the Midwest, USA, 2019

Trial location:
USA

Project team leaders:
Dr. Maria Mendoza

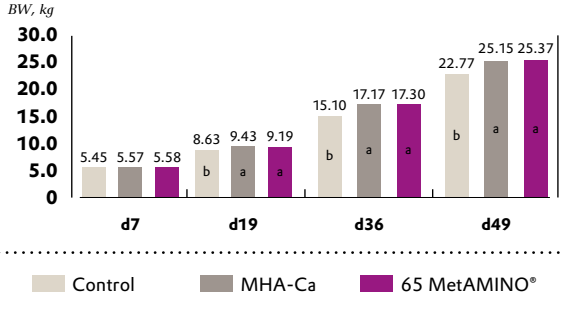
TRIAL DESIGN, METHODS AND MATERIALS

ANIMALS	1,296 pigs [PIC 1050 gilts and PIC line 359 barrows] 20 days old and initial BW of 5.02 ±0.20 kg
DIETS	Diets were corn-SBM-dried whey based and manufactured in separate batches for each treatment and each phase. 1- Negative control: 70% of the SID M+C:Lys req's achieved with grains and animal by-product ingredients **[Control]**. 2- 100 parts MHA-Ca: Treatment 1 + supplemented MHA-Ca to achieve 100% of the SID M+C:Lys req's **[MHA-Ca]**. 3–65 parts DL-Met: Treatment 1 + supplemented DL-Met [supplemented DL-Met = 0.65*(Supplemented MHA-Ca to achieve 100% of the SID M+C req's used in treatment 2)] **[65 MetAMINO®]**.
DESIGN	RCBD, 27 pigs/pen → 16 replicate pens/treatment (16 weight blocks) → barrows and gilts were balanced within the pen.
FEEDING	Feed was provided through the FeedLogic® system. Pigs had free access to feed and water. Feeding program consisted of 4 phases:

Phase	Body weight kg	Days on feed	Feed budget kg/pig
1	Weaning to 7	d 0 to 7	2
2	7 to 11	d 7 to 19	5
3	11 to 18	d 19 to 36	10
4	18 to 25	d 36 to 49	11

PARAMETERS	BW, ADFI, ADG, FCR, mortality and fecal score.
DURATION	49 days
LOCATION	Commercial research farm, Midwest, USA

GRAPH 1. BODY WEIGHT (KG)



GRAPH 2. GROWTH PERFORMANCE

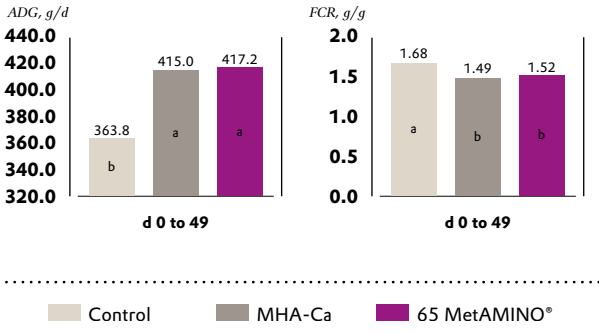


TABLE 1. ECONOMIC ANALYSIS

Item	Control	MHA-Ca	65 MetAMINO®
Initial BW, kg	5.02	5.02	5.02
Feeder pig price, $/kg[1]	3.34	3.34	3.34
Final BW	22.77	25.15	25.37
Feeder pig price, $/kg[2]	3.27	3.27	3.27
Revenue per pig, $/kg	57.68	65.48	66.19
Feed per pig, kg	30.38	30.68	31.48
Feed cost, $/kg[3]	0.273	0.278	0.276
Feed cost per pig, $	8.29	8.54	8.67
IOFC, $/pig	49.39	56.93	57.51
Marginal Contribution MetAMINO® over MHA-Ca, $/pig			**0.58**
Profit in 10,000 pigs, $			**5,792**
Pig losses, %	1.31	0.63	1.25
Net Profit in 10,000 pigs counting pig losses, $			**5,756**

[1]Price is the average price of Q1 2020 for feeder pigs of 5.4 kg BW taken from the USDA Feeder Pig Quarterly Report.
[2]Price is the average price of Q1 2020 for feeder pigs of 18.14 kg BW taken from the USDA Feeder Pig Quarterly Report.
[3]The feed price is a weighed price based on feed intake in each phase and the cost of feed of each phase. Cost of the control diet were USD/MT 606.01, 460.73, 213.15, and 202.46 for phase 1, 2, 3, and 4, respectively. The cost of the MHA-Ca and MetAMINO® diets were estimated by the addition of the cost of the control diet plus the analyzed contented of MHA-Ca and MetAMINO® multiply by the price of the ingredient ($1.68 and $2.1 per kg of MHA-Ca and DL-Met, respectively).

NORTH AMERICA / USA
Commercial Trial

TRIAL DESIGN

- The trial was conducted in a large research commercial setting to represent the US swine production system.

TRIAL OBJECTIVES

- To determine the effect of replacing 100 parts of methionine hydroxy analog calcium salt (MHA-Ca, 84 percent) with 65 parts of MetAMINO® – Evonik's DL-methionine (DL-Met, 99 percent) – compared to a standardized ileal digestible (SID) methionine + cystine (M+C) deficient control diet on growth performance of nursery pigs from day 0 to 49 post-weaning.
- To corroborate under commercial conditions the relative bioefficacy of MHA-Ca to DL-Met using a simplified approach rather than a dose response trial.

TRIAL RESULTS

- In the study, the overall MetAMINO®: MHA-Ca ratio achieved in the diets was 66 percent, based on a weighted average of feed intake and analyzed supplemental MHA-Ca and DL-Met.
- Pigs fed the control diet had lower final body weight (BW) and average daily gain (ADG) and higher feed conversion ratio (FCR) compared to pigs fed MHA-Ca and MetAMINO® diets.
- Pigs fed the 100 parts MHA-Ca diets and the 65 parts MetAMINO® did not differ in final BW, ADG, ADFI and FCR (Graphs 1 and 2).
- An economic analysis (Table 1) showed that there is an advantage of US$ 0.58 per pig when pigs were fed the 65 parts of MetAMINO® diet compared to pigs fed the 100 parts MHA-Ca diets.

FIND AN EXECUTIVE SUMMARY OF THE TRIAL IN THIS VIDEO

CONCLUSIONS

- 1 kg of MHA-products can be replaced with 650 g of DL-Met to achieve the same level of growth performance…
- …and significant savings in feed formulation and methionine costs.
- Practical example (Table 2) replacing 100 parts MHA-Ca with 65 parts DL-Met results in an increased net profit of US$ 5,792 in production of 10,000 pigs

FEEDBACK

"The results of this trial suggest MetAMINO® can be fed at 65 percent of the concentration of MHA-Ca and perform similarly throughout the nursery period."

Dr. Maria Mendoza,
Technical Service Manager, USA

“Performance and carcass quality response to MetAMINO® and MHA-Ca fed at ratio of 65:100 in grower broilers”

Trial conducted by Evonik, Federal University of Parana (BR) and Customer, 2018

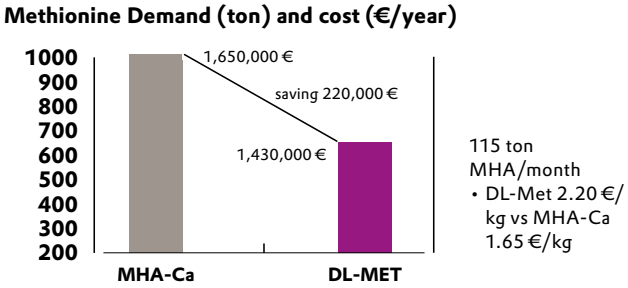
Trial location:
Parana / Brazil

Project team leaders:
Prof. Dr. Maiorka, MSc Goes, Dr. Naranjo, MSc Melo, Dr. Arruda

TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

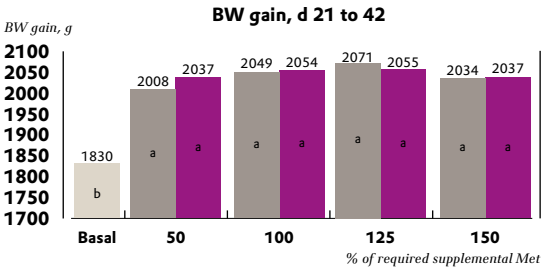
ANIMALS	1,944 male Cobb 500 broilers
DIETS	Corn-soy based commercial starter, grower and finisher diets
DESIGN	Completely randomized design with 9 trt/ 9rep/24 birds each
FEEDING	Negative control deficient in M+C; 4 supplemental levels of MHA-Ca (50, and 125%). DL-Met replaced MHA-Ca by 65% DL-Met on product basis for each supplemental level
PARAMETERS	Body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR). At 42d, carcass yield (CY) and breast meat yield (BMY).
DURATION	21 to 42 days old
LOCATION	Experimental farm (University)

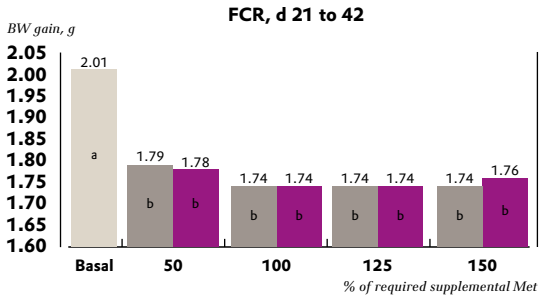
GRAPH 5. SAVING WITH DL-METHIONONE VS. MHA-FA



115 ton MHA/month
- DL-Met 2.20 €/kg vs MHA-Ca 1.65 €/kg

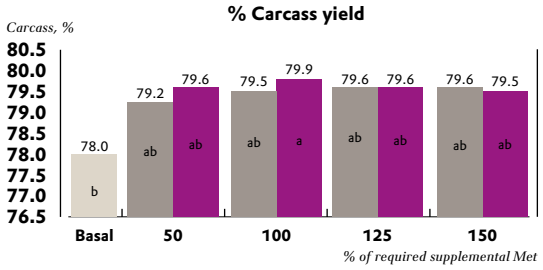
GRAPH 1. AND 2. BROILER PERFORMANCE FROM 21 TO 42 DAYS OF AGE

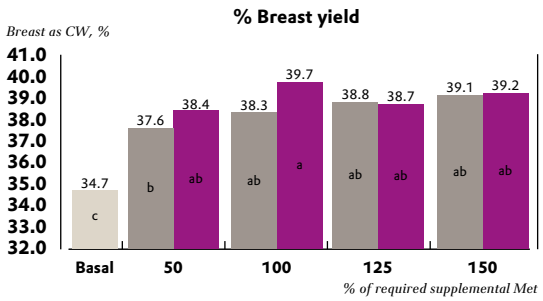




MHA-Ca DL-Met

GRAPH 3. AND 4. CARCASS AND BREAST YIELD





MHA-Ca DL-Met

LATIN AMERICA / BRAZIL
Experimental Trial

TRIAL DESIGN

- The trial was jointly designed (Table 1) and carried out in collaboration with one of the largest broiler integrators in Brazil, and in partnership with Prof. Alex Maiorka from the Federal University of Parana, one of the most well-respected universities in Latin America in the field of agriculture and animal nutrition.

TRIAL OBJECTIVES

- The objective of this study was to determine the effect of replacing methionine hydroxy analog calcium salt (MHA-Ca, 84 percent) with 65 parts of MetAMINO® – Evonik's DL-methionine (DL-Met, 99 percent) – in five different supplemented levels on growth performance and carcass parameters of broilers from 21 to 42 days of age …
- … following a practical commercial feeding regime of a large integration with 10 million broilers housed per month consuming over 30 kt feed per month and in turn to generate significant savings when switching from liquid MHA to MetAMINO® (Graph 5).

TRIAL RESULTS

- Diets deficient in methionine + cysteine (M+C) negatively affect growth performance and carcass yields of broilers.
- Replacing 100 parts of MHA-Ca with 65 parts of DL-Met did not affect growth performance (Graph 1 and Graph 2) and carcass parameters (Graph 3 and Graph 4) of broilers at all five different supplemented levels (dietary M+C level).
- Using 65 parts of DL-Met to 100 of MHA showed similar performance for all treatments (performance and carcass yield) and so confirms the outcome of previous trials in the regions: Rostagno & Barbosa (1995), Hoehler *et al.* (2005); Sangali (2012), Bertechini *et al.* (2016); Sakomura *et al.* (2016).

CONCLUSIONS

- 1 kg of MHA-products can be replaced with 650 g of DL-Met to achieve the same level of growth performance…
- …and significant savings in feed formulation and methionine costs.
- Replacing 1,000 metric tons of MHA-Ca at € 1.65 / kg with 650 metric tons DL-Met at € 2.20 / kg results in a saving of € 220,000.
- Additional savings come from an optimized feed formulation as DL-Met frees up diet space for the most economical raw materials.

FEEDBACK

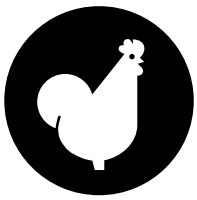
"The trial scientifically proved that broilers fed 65 parts of DL-methionine had similar growth and carcass performance to broilers fed 100 parts of MHA diets."

Dr. Alex Maiorka,
Professor at Federal University of Parana

“Relative bioavailability of MHA-FA compared to MetAMINO® in broilers”

Trial conducted by Evonik and the Federal University of Lavras-Brazil, 2019

Trial location:
Minas Gerais, Lavras/Brazil



Project team leaders:
Prof. Dr. A. Bertechini, Dr. V. Naranjo, Dr. J. C. Dorigam

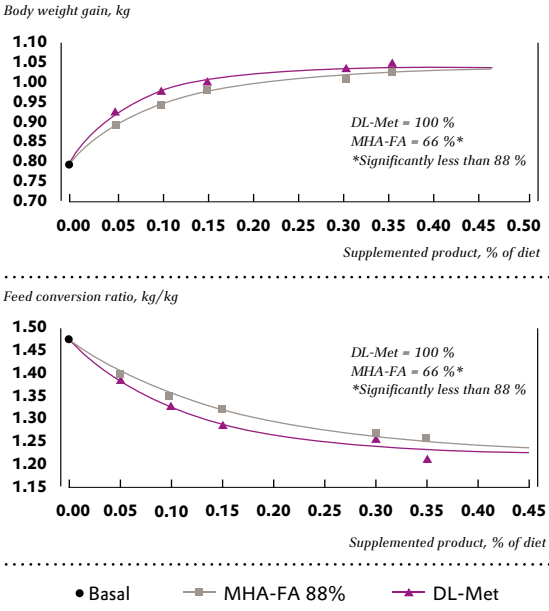
TABLE 1. TRIAL DESIGN, METHODS AND MATERIALS

ANIMALS	1,650 male Cobb 500 broilers
DIETS	Corn-soybean meal based grower and finisher diets
DESIGN	Completely randomized design with 11 trt/ 6 rep/25 birds each
FEEDING	Negative control deficient in M+C; 5 supplemental levels of MetAMINO® 5 supplemental levels of liquid MHA-FA
PARAMETERS	Body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR)
DURATION	1 to 42 days old
LOCATION	Experimental farm (Universidade Federal de Lavras)

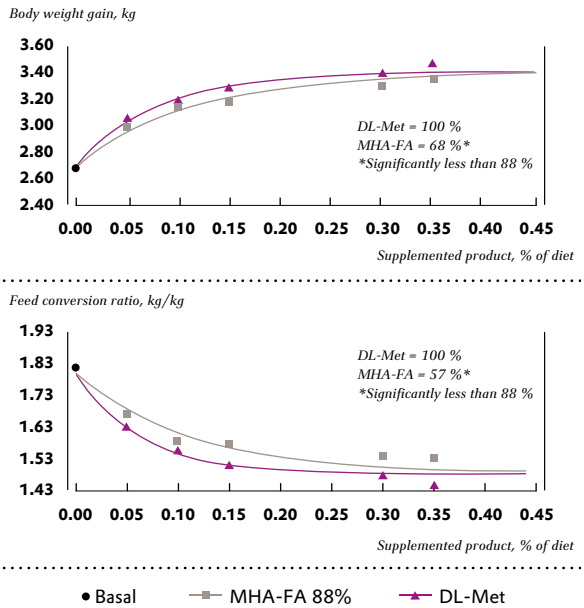
Treat.	Addition DL-Met	Addition HMTBA	Replicates	Birds per replicates Floor pens
1 NC	---	---	6	25
2	0.050%	---	6	25
3	0.100%	---	6	25
4	0.150%	---	6	25
5	0.300%	---	6	25
6	0.350%	---	6	25
7	---	0.050%	6	25
8	---	0.100%	6	25
9	---	0.150%	6	25
10	---	0.300%	6	25
11	---	0.350%	6	25

*NC negative control (basal diet without methionine supplementation)

GRAPH 1. AND 2. RELATIVE BIOAVAILABILITY OF MHA-FA COMPARED TO DL-MET (MetAMINO®) FOR WEIGHT GAIN AND FEED CONVERSION FROM 1–21 DAYS



GRAPH 3. AND 4. RELATIVE BIOAVAILABILITY OF MHA-FA COMPARED TO DL-MET (MetAMINO®) FOR WEIGHT GAIN AND FEED CONVERSION FROM 1–42 DAYS



LATIN AMERICA / BRAZIL
Experimental Trial

TRIAL DESIGN

- A dose response trial was designed to determine the relative bioavailability (RBA) of liquid methionine hydroxy analog free acid (MHA-FA) compared to MetAMINO® – Evonik's DL-methionine (DL-Met) – on a product basis with five incremental levels of each source, six x replicates with each 25 birds per floor pen (Table 1). Brazilian feeding conditions were used in broilers from one to 42 days of age.

TRIAL OBJECTIVES

- The objective was to determine the RBA of MHA-FA (88 percent) in relation to DL-Met (MetAMINO® min. 99 percent) in male broilers receiving diets based on corn and soybean meal on a product-to-product basis.

TRIAL RESULTS

- Multi-exponential regression analysis revealed that the RBA of MHA-FA compared to DL-Met on a product-to-product basis were:
  - 66 and 69 percent for body weight gain (BWG) and feed conversion ratio (FCR) respectively from 1 to 21 days post hatch (Graphs 1 and 2).
  - 68 and 57 percent for BWG and FCR respectively from one to 42 days post hatch (Graphs 3 and 4).
- These results indicate that the average RBA of MHA-FA compared to DL-Met is 65 percent on a product-to-product basis. These results confirm that bioavailability of MHA-FA is significantly lower than its active substance content of 88 percent and similar to previous research estimates of 65 percent.

CONCLUSIONS

- Multi-exponential regression analysis revealed a mean bioavailability of MHA-FA relative to DL-Met on a product basis of 65 percent in this trial.
- These results confirm that RBA of MHA-FA compared to DL-Met is significantly lower than its claimed active substance content of 88 percent and similar to previous research estimates of 65 percent.
- The above information needs to be considered for cost effective purchasing of DL-Met sources and to optimize feed formulation costs.

FEEDBACK

"Prof. Bertechini reports a relative efficiency of 67 percent for liquid MHA-FA (88 percent) in his book called Nutrição de Monogástricos (pg. 141)"

Dr. Antonio Bertechini,
Professor at Federal University of Lavras

PROXYMet™

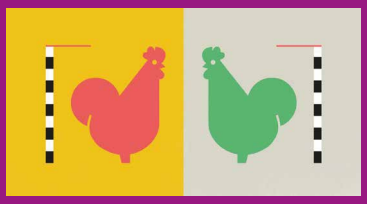
One small trial. One giant leap for your methionine savings.

OPTIMAL ANIMAL NUTRITION IS ALL ABOUT MAKING THE RIGHT DECISION.

Knowing the relative nutritive value of methionine hydroxy analog products (liquid MHA-FA and MHA-Ca salt) compared with DL-methionine (DL-Met) is an important prerequisite for cost-effective purchasing, feed formulation, and animal production. Evidence accumulated over the years has shown the average relative bioefficacy of methionine hydroxy analog products as compared to DL-Met to around 65 percent on a weight basis (Jansman *et al.*, 2003; Lemme *et al.*, 2012 and Lemme, 2020).

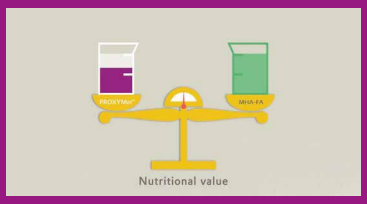
STEP 1

We'll set up a test run in your commercial operation under real conditions, with PROXYMet™ provided free of charge. Simply replace the liquid MHA-FA with PROXYMet™, one to one. Everything else stays the same: the same feed composition, the same diet specification, the same procedure.



STEP 2

In one production cycle, you'll see comparable animal performance as before. This means that with PROXYMet™ – containing just 65 percent MetAMINO® – you'll obtain comparable nutritional value as you get from 100 percent MHA-FA. This proves that on average the bioefficacy of MHA-FA is 65 percent relative to MetAMINO®.



STEP 3

So switch to MetAMINO® completely, achieve optimal results and realize lasting savings. Thanks to its 100 percent bioefficacy, MetAMINO® supports optimal livestock growth, meat yield, and performance. Its superior quality makes it more efficient and cost-effective than liquid forms. It's significantly easier to transport, store, and process than its liquid counterpart MHA-FA.

SEEING IS BELIEVING.

We know that. To allow customers to more easily prove to themselves the 65 percent concept, Evonik developed PROXYMet™. This is simply MetAMINO® diluted to 65 percent using an inert material (calcium carbonate). The principle then is that MHA-FA/Ca products can be directly replaced in feeds on a 1 to 1 basis, as PROXYMet™ is already diluted to 65 percent. Having therefore demonstrated that the correct bio-efficacy comparison is around 65 percent, Evonik can then assist customers to apply this principle using MetAMINO®.

START YOUR PROXYMet™ TEST RUN TODAY!

Getting started is as easy as one, two, three: Contact your local Evonik expert, for implementation support, conduct the free trial, and see the advantages of MetAMINO®. We are sure that you'll be convinced. We even give you a warranty on that. Application: replace 1 kg of MHA-FA or MHA-Ca by 1 kg PROXYMet™ in your feed formulation!

www.proxymet.com

Section 2
Articles & Abstracts

METHIONINE SOURCES:

"Methionine and methionine analogues are not the same"

Pradeep Krishnan and Girish Channarayapatna

DL-METHIONINE (DL-MET) AND 2-HYDROXY-4-METHYLBUTANOIC ACID (HMTBa) ARE FREQUENTLY USED AS FEED SUPPLEMENTS TO BALANCE ANIMAL DIETS FOR METHIONINE (MET) AND SULFUR AMINO ACIDS.

Modern feed formulation tends to reduce the crude protein content in the diet making the relative contribution of supplemental to natural Met larger. DL-Met, the racemic mixture of D- and L-isomer of Met is commercially available as a feed additive with 99 percent purity. Methionine Hydroxy Analogue Free Acid (MHA-FA, commonly known as liquid MHA, chemically abbreviated as HMTBa) is also a racemic mixture of its D- and L-isomer and consists of about 65 percent in monomeric form, 23 percent in the dimer/oligomeric form and the remaining 12 percent being water (Yang *et al.*, 2020).

Over the years, in many cases the nomenclature of commercial Met sources was used interchangeably wherein MHA-FA is mistermed as liquid Met which created confusion among the end users. This is clearly a misnomer as the products are chemically different. DL-Met is pure Met in dry form and MHA-FA is an acid in liquid form.

Despite the fact that DL- Met is 100 percent bioavailable (Dilger and Baker, 2007) and holds the largest share of Met market globally (https://www.industryarc.com/Research/Methionine-Market-Research-500036), the question about the nutritive value being characterized by the relative biological availability (RBA) of liquid MHA-FA or in other words, the replacement ratio of this product in animal diets is always a critical factor for cost-effective purchasing and diet cost optimization. Numerous studies involving different approaches and various animal species have been carried out in order to establish the relative efficacy of different Met sources compared to DL-Met. The historical perspective of some of the producers from these RBA studies (Table 1) are quite different from the current claims of the MHA-FA producers (IMAA Booklet, 2016). This position is backed up by many references and independent statements from the past which is summarized in Table 2. Although both products,

TABLE 1. HISTORICAL PERSPECTIVE ON RBA OF MHA-FA COMPARED WITH DL-MET ON A PRODUCT BASIS

RBA of MHA-FA	Rhone-Poulenc now Adisseo, Rhone-Poulenc, Animal Nutrition, 1989	Sumitomo Report (Okuno et al., 1989)	Evonik (Jansman et al., 2003; Sauer et al., 2008; Lemme et al., 2012)
	70 %	63 – 70 %	Average 65 %

TABLE 2. RBA OF MHA-FA ON PRODUCT BASIS FROM INDEPENDENT STATEMENTS AND REFERENCESIS

RBA of MHA-FA	Nutricao de Monogastricos, 2nd revised Edition; Bertechini, 2013 (Brazil)	Premier Atlas, 2011 (UK)	NRC for Fish and Shrimp, 2011 (USA)	CVB desk study, 2003 (NL/Europe)
	67 %	68 %	66 – 70.4 %	67 – 68 %

FIGURE 1. COMPARISON OF RBA OF MHA-FA RELATIVE TO DL-MET ON EQUIMOLAR AND PRODUCT BASIS (EFSA, 2018 – APPENDIX A PAGE 16)

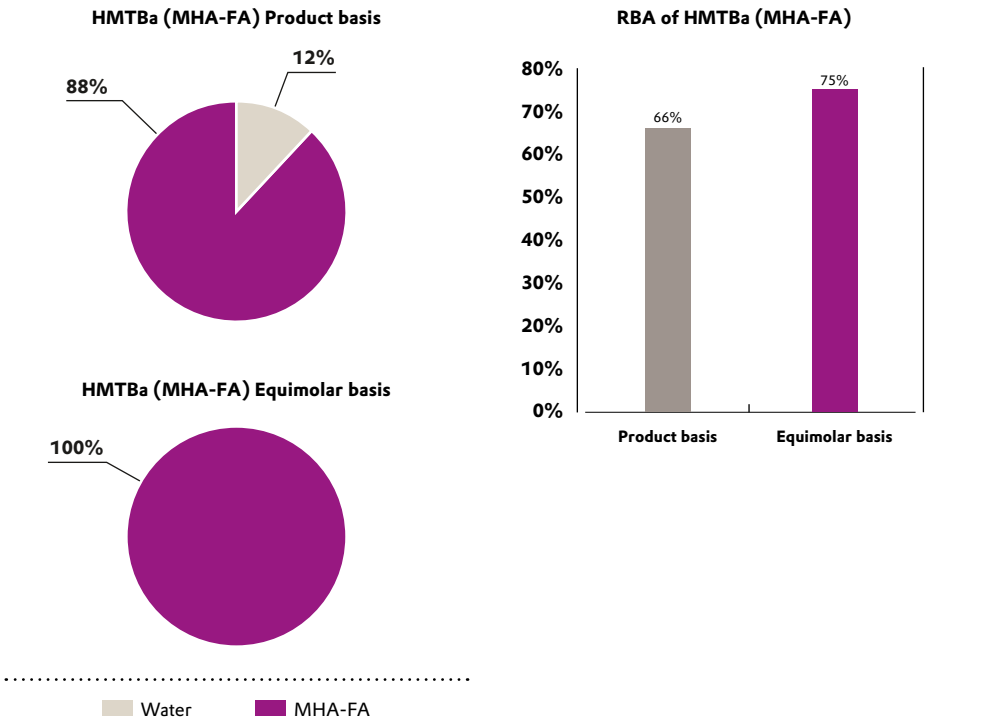
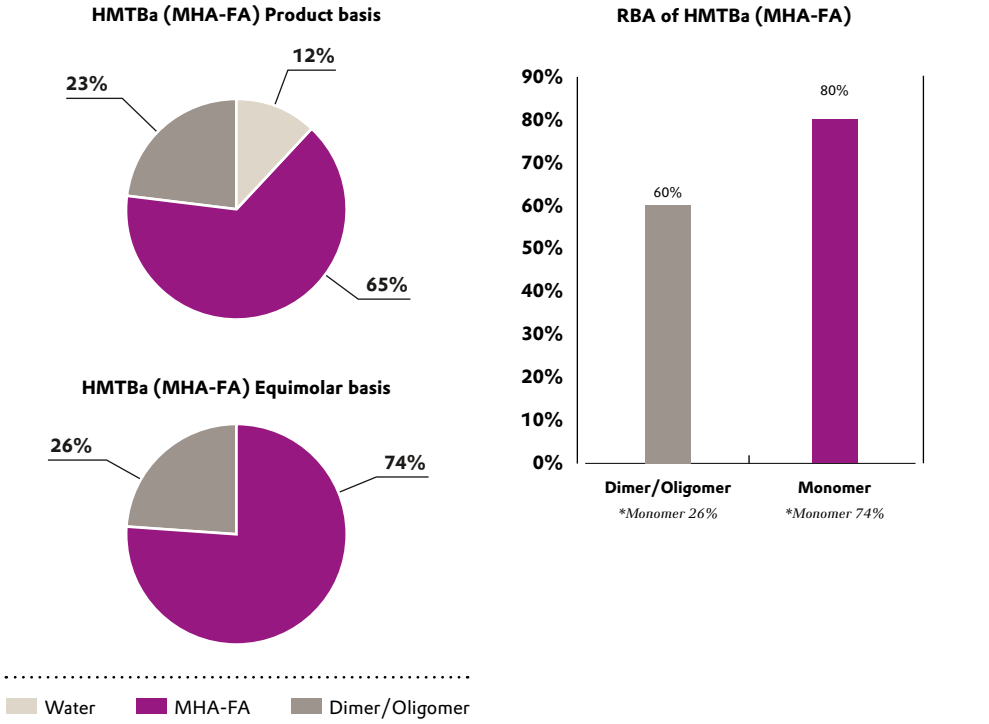


FIGURE 2. COMPARISON OF RBA OF MONOMERIC AND NON- MONOMERIC COMPONENTS OF MHA-FA RELATIVE TO DL-MET ON EQUIMOLAR BASIS (EFSA, 2018 – APPENDIX A PAGE 16)



DL-Met and MHA-FA haven't changed since the 1980s, the opinion of several producers about the nutritional value of the product has definitely changed. This change in opinion is most probably not due to a change in nutritional equivalence of both products which actually remains the same as in the past, but due to commercial preferences having nothing to do with the real interest of the feed compounders or end users.

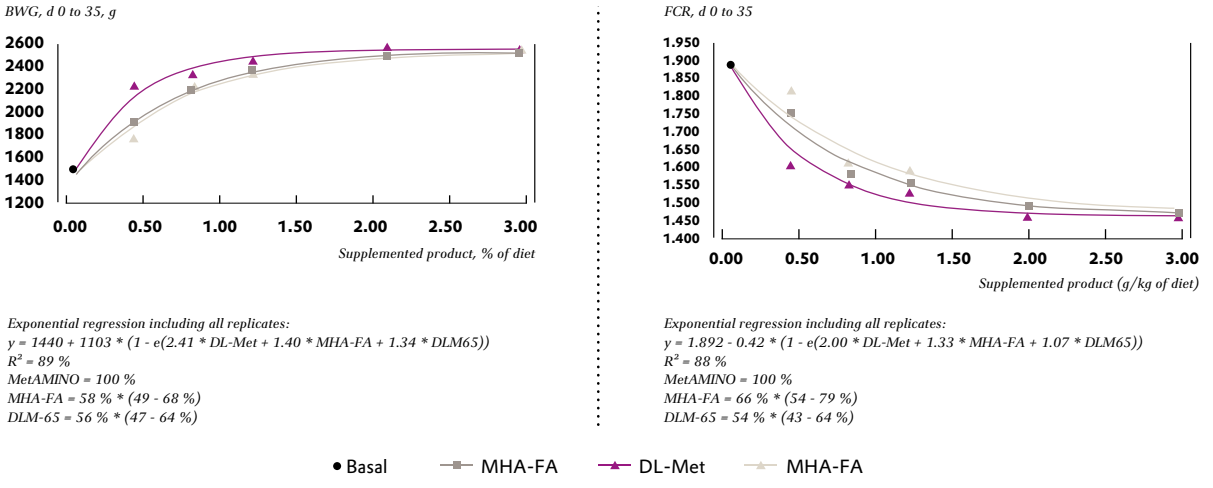
This historical perspective on Met sources is also supported by the recent European Food Safety Authority report (EFSA, 2018) which concludes that HMTBa shows a lower bioefficacy than DL-Met.

- The main reason for the lower bioefficacy as cited in EFSA report are
- (i) that the gut microbiota of the small intestine competes with the host more for HMTBa than for DL-Met
- (ii) HMTBa and its salts may contain besides the free acid/salt, significant amounts of dimers, trimers and oligomers, known to have a lower bioefficacy

Further, with reference to the studies in Appendix A, EFSA concludes that from such data, "there is convincing evidence that HMTBa/HMTBa-Ca, on an equimolar/isosulfurous basis, have a significant lower bioefficacy than DL-Met (75 percent vs 100 percent)", Figure 1. On a commercial product to product comparison that finding translates into an average bioefficacy of 65 percent, taking the water or calcium contents of the different Met analogue sources into account, Figure 1.

There is historical evidence from the United States Patent No. 3 272 860, wherein the polymerized acids (dimers, trimers and oligomers) have been described as "not useful as feed components (Nufer,1955). In addition, there is substantial evidence from the recent publication (Mitchell and Lemme 2008) that only marginal portion of the di- and oligomer fraction of HMTBa is absorbed. This is confirmed by the recent EFSA report (2018) that, on an equimolar/isosulfurous basis, the non-monomeric components (dimers, trimers and oligomers) in commercial HMTBa/HMTBa-Ca products have a significantly lower bioefficacy than

FIGURE 3. BWG AND FCR OF BROILERS FED INCREASING LEVELS OF DL-MET, DL-M65 AND MHA-FA



Exponential regression including all replicates:
*y = 1440 + 1103 * (1 - e(2.41 * DL-Met + 1.40 * MHA-FA + 1.34 * DLM65))*
R^2 = 89 %
MetAMINO = 100 %
*MHA-FA = 58 % * (49 - 68 %)*
*DLM-65 = 56 % * (47 - 64 %)*

Exponential regression including all replicates:
*y = 1.892 - 0.42 * (1 - e(2.00 * DL-Met + 1.33 * MHA-FA + 1.07 * DLM65))*
R^2 = 88 %
MetAMINO = 100 %
*MHA-FA = 66 % * (54 - 79 %)*
*DLM-65 = 54 % * (43 - 64 %)*

the monomeric fraction (53.6 percent to 69.4 percent vs 76 percent to 80.8 percent). From the scientific studies (Boebel and Baker, 1982; Koban and Koberstein, 1984; Saunderson, 1991 and Van Weerden *et al.*, 1992) cited in EFSA report, it can be concluded that bioavailability of non-monomers is on average ~ 20 percent lower than that of monomers (Figure 2).

The best way to evaluate potential differences in the efficiency of two products is just asking the target animal itself by animal feeding studies. The difficulty with this simple idea is that the results of such studies are strongly dependent on an adequate trial design and accurate interpretation of trial data. Numerous studies involving different approaches and various animal species have shown that the Met sources are clearly different in their bioefficacy. Several publications in the last decades have revealed a bioefficacy of about 65 percent for MHA-FA/MHA-Ca by testing both Met sources in simultaneous dose-response trials (Hoehler *et al.*, 1999; Elwert *et al.*, 2005; Lemme *et al.*, 2012 and Sangali *et al.*, 2014).

A recent broiler trial at Schothorst Feed Research, Netherlands confirms 2018 EFSA scientific opinion on Met sources. The results from this study (Naranjo and Lemme, 2018) demonstrated that the RBA of MHA-FA is significantly lower than its active content of 88 percent and close to 65 percent which agrees with previous publications. Performance parameters (body weight gain, BWG and feed conversion ratio, FCR) of broilers fed increasing levels of DL-Met (MetAMINO®), diluted DL-Met (DL-Met65) and MHA-FA from this dose response trial is summarized in Figures 3.

In the framework of Met usage in the animal production industry, time and again it's proved that, it requires only about 650 g of DL-Met to replace every kg of Met analogue (MHA-FA/MHA-Ca) to get the same nutritional effect (WPSA News Archive, 2018).

Overall, it can be stated that the majority of the studies with Met sources DL-Met and MHA-FA/MHA-Ca showed a clear difference in the nutritional value of MHA-FA/MHA-Ca, whilst DL-Met is always 100 percent, and therefore it does matter to the animal species. There are multiple reasons for the value difference and end users should take a deep insight when making their choice about the best source for best performance with best results.

Dr. Girish Channarayapatna

Dr. Pradeep Krishnan

*Dr. Pradeep Krishnan (pradeep.kishnan@evonik.com) is Technical Service Director and Dr. Girish Channarayapatna (girish.channarayapatna@evonik.com) is Senior Technical Service Director/Head, Precision Livestock Farming. Both with Evonik (SEA) Pte. Ltd., Singapore. References are available on request to the authors.

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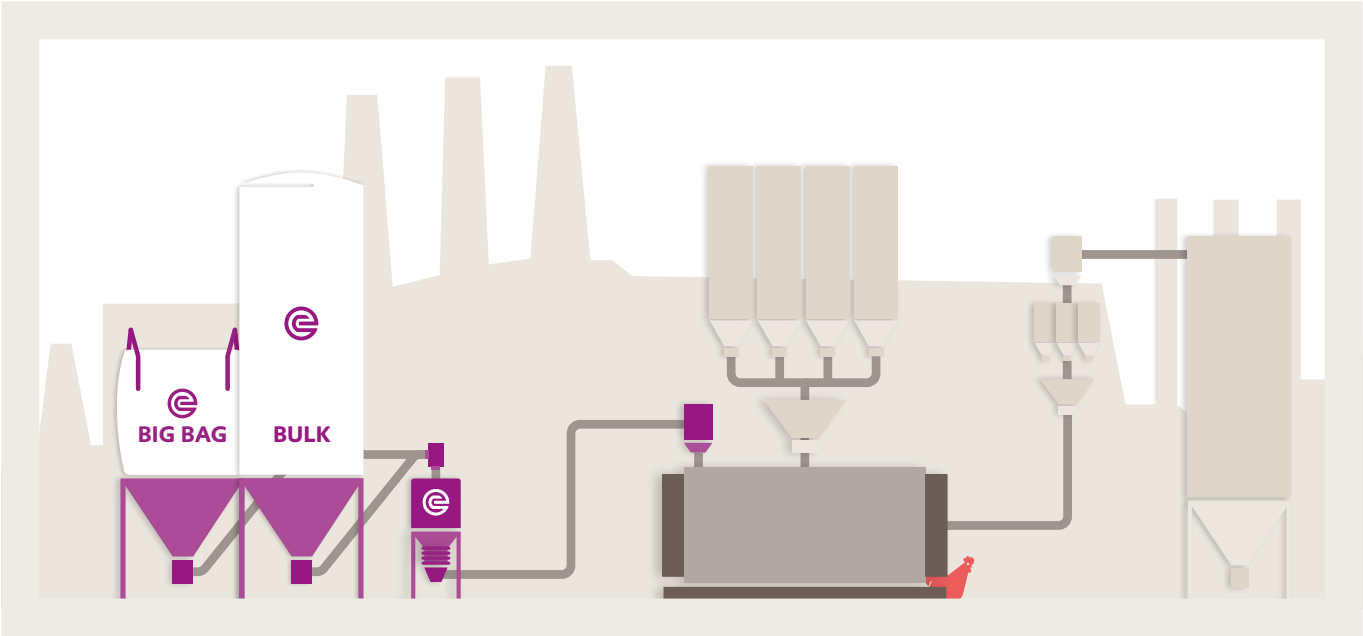
ASIAN POULTRY MAGAZINE – JANUARY 2021.



Handling and Dosing of MetAMINO®

AMINOSYS® DOSING SYSTEMS HELP OUR CUSTOMERS TO MANAGE THEIR PROCESSES, IT FITS FEED MILLS OF ANY SIZE AND LAYOUT.

- **FULLY AUTOMATED PROCESS**
- **HIGHEST-PRECISION DOSING**
- **COMPLETELY SCALABLE TO FIT**
- **COST SAVING**
- **GUARANTEE OF EXCELLENCE**

LEARN MORE ABOUT AMINO*Sys*®

Our **AMINO*Sys*®** dosing system provides our customers with several benefits. These include accurate and reliable amino acid dosage going into the mixer (+/ – 50 g per batch); storage, dosing and conveying of up to four products; and a fully automated dosing process (integrated into the feed mill process control system). We have long-term customer relationships (some for more than 30 years) on six continents and now have approximately 600 systems running and linked with approximately 60 million tons of feed production per year.

AMINO*Sys*® provides an advanced, flexible, and scalable handling solution for fully automated high precision dosing of amino acids from Evonik. This allows cost savings through reduced product handling and lower product losses. Evonik provides comprehensive on-site surveys, installation, and support services through its experts, who also train on-site staff and provide after-installation services. AMINO*Sys*® is available for 25 kg paper bags, big bags or full bulk silos and allows dosing and conveying of up to four products to two mixing lines.

MIXING HOMOGENEITY OF DRY AND LIQUID AMINO ACID SOURCES

Homogenously mixed feed is essential for livestock performance such as feed conversion, body weight gain and flock homogeneity. Mixing homogeneity, expressed as coefficient of variation (CV), ensures that all added nutrients like vitamins, trace minerals, amino acids, etc. are available in the right amount within each feed pallet.

For many years, Evonik has offered its **AMINO*Batch*®** service to carry out professional mixer profiles under field conditions with different mixers, filling levels and feed types.

The findings (Figure 1) from over 800 profiles (of which > 200 contain liquid amino acid sources and > 600 dry amino acids) revealed that on average the addition of liquid methionine hydroxy analog (MHA-FA) resulted in poorer mixing homogeneity in the final feed compared with the dry form of amino acids, such as DL-methionine. Only 19 percent of the feed mixture with dry amino acids show inadequate CVs > 10 percent while the number of their liquid counterparts with 36 percent is almost double as high. In other words, over 80 percent of the profiles with dry amino acids show optimum to acceptable results with CVs of 0 to 10 percent, while more than every 3rd profile with liquid MHA-FA is dissatisfying.

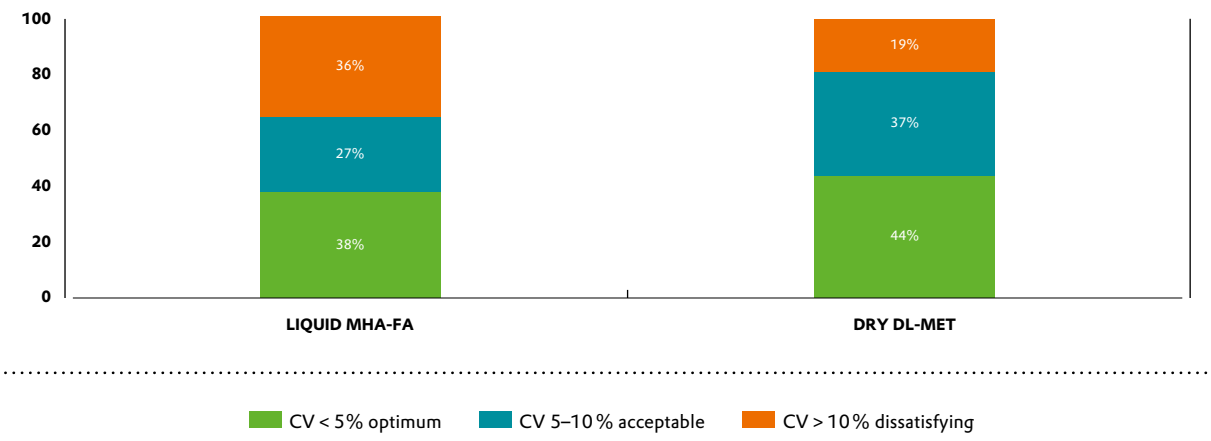
One widely used way to improve the feed homogeneity when dosing liquids e. g. MHA-FA is to extend mixing time by a few seconds per batch. But the extension for example of just a few seconds per batch can easily lead to a reduction of several thousand metric tons of feed throughput per mill per year. For further calculations please feel free to use our new MetAMINO® Benefit Calculator.

A more robust concept and less costly alternative to optimize mixing homogeneity of commercial feed is to keep the addition of liquid ingredients to a minimum while relying on dry additives.

LEARN MORE ABOUT AMINO*Batch*®

USE THE FEED MILL VALUE CALCULATOR TO SEE THE SAVINGS BETWEEN LIQUID AND DRY

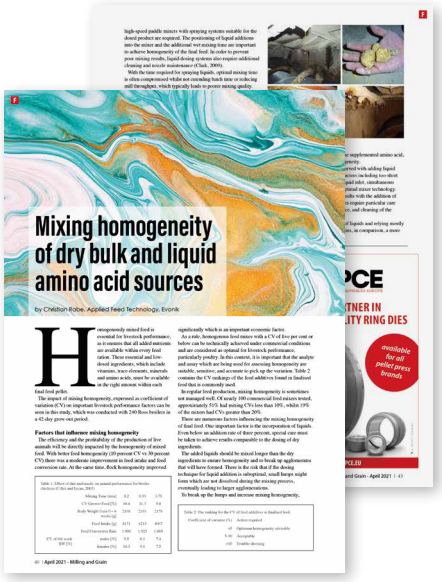
FIGURE 1: MIXING HOMOGENEITY (CV) FOR AMINO ACIDS ADDED DRY (N > 600) VERSUS LIQUID (N > 200)



TECHNICAL ARTICLES

A SELECTION OF DIFFERENT PUBLICATIONS OF THE LAST YEAR. BE IT SCIENTIFIC, COMMERCIAL OR DOCUMENTATION OF PRACTICAL CUSTOMER TRIALS.

We show the whole range of technical articles. Very scientific peer reviewed articles that go into great detail, but also technical articles that have appeared in global magazines and have been reduced to the essentials and of course there is also Facts & Figures, a section that deals with customer trials under commercial conditions.



Mixing homogeneity of dry bulk and liquid amino acid sources. Milling and Grain

Homogenously mixed feed is essential for livestock performance as it ensures that all added nutrients are available within every feed ration.

Christian Rabe, Applied Feed Technology, Evonik Operations GmbH

READ THE COMPLETE ARTICLE HERE

F&F 14189

Evonik Publication

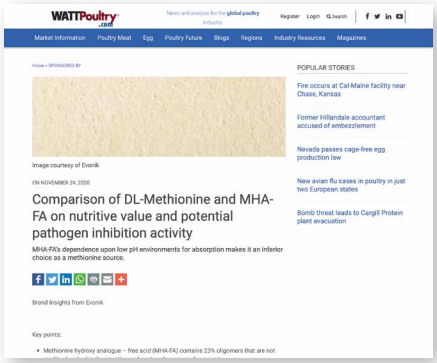
Supplementation of DL-Met or DL-HMTBa at different levels broilers in heat stress and related metabolic stress.

This study shows confirms DL-Met should be selected as the dietary Met source in broilers. MHA fed broilers were observed to have lower feed intake, a reduced antioxidant pool (glutathione), and higher fatty acid composition in tissues (as a marker of heat stress pathology) compared to DL-Met fed broilers.

R. Whelan. 2020.

FOR MORE INFORMATION PLEASE CONTACT OUR TECHNICAL SALES TEAM.

Handling Solutions Poultry Swine Aquaculture

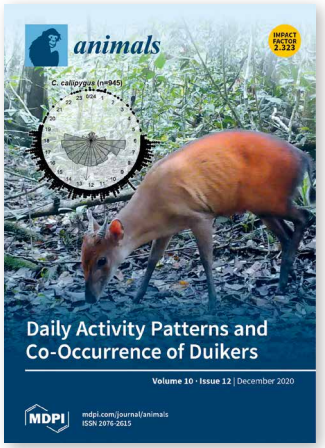


Comparison of DL-Methionine and MHA-FA on nutritive value and potential pathogen inhibition activity. WATTPoultry.com

A multitude of research studies have evaluated sources of methionine and effectively raised DL-Met to be the "gold standard" source for its 100 % availability.

Dr. Kyle Smith, Dr. James Wen, Dr. Maria Mendoza, Evonik Corporation, Kennesaw, GA, USA

READ THE COMPLETE ARTICLE HERE



Peer Reviewed

Utilization of Methionine Sources for Growth and Met+Cys Deposition in Broilers. Animals 10:2240

This evaluation of the utilization of supplemental Met sources for Met+Cys deposition in body protein provides further evidence for a higher efficiency and, thus, nutritional value of DL-Met over HMTBa.

A. Lemme, V. Naranjo and J. Dorigam. 2020.

READ THE COMPLETE ARTICLE HERE

F&F 14145

Evonik Publication

Feeding DL-Met supplemented diets to growing pigs increases the absorption of D- and L-Met compared to feeding L-Met or MHA supplemented diets

The study results show feeding diets supplemented with DL-Met increased the flux rate of both D-Met and L-Met in the jejunum and ileum of growing pigs. Comparatively feeding L-Met or MHA-FA supplemented diets does not improve transport of D-Met, L-Met or HMTBa.

Whelan R., and J. K. Htoo. 2020.

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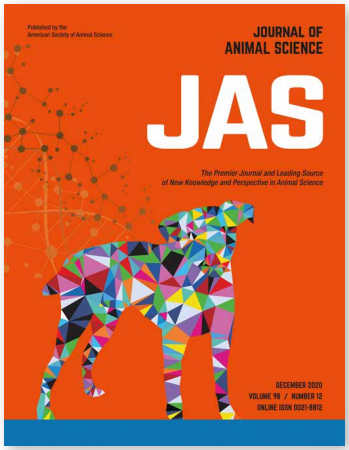


Peer Reviewed

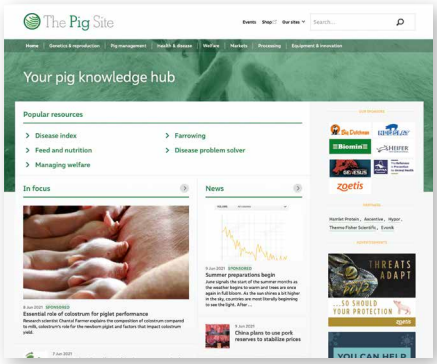
Bioavailability of the calcium salt of DL-methionine hydroxy analogue compared with DL-methionine for nitrogen retention and the preference of nursery pigs for diets based on the two forms of methionine. Journal of Animal Science 98(12): 1–10

This study demonstrates the mean RBV of MHA-Ca to DL-Met of 65.7 percent on a product-to-product (wt/wt) basis or 78.2 % on an equimolar basis.

Wang, M. Q., L. T. T. Huyen, J. W. Lee, S. H. Ramos, J. K. Htoo, L. V. Kinh, M. D. Lindemann. 2020.

READ THE COMPLETE ARTICLE HERE

The Pig Site



How to generate savings in swine feed: Re-validate and adjust nutritional value of methionine sources. The Pig Site

A US trial designed to feed MHA-Ca to achieve 100 % of the SID Met+Cys: Lys requirements. It was demonstrated that pigs can achieve the same performance with DL-methionine added at 65 % of MHA-Ca in the diet (on a w/w basis). Investigating the performance of the methionine sources at the SID Met+Cys: Lys level used in a swine operation has practical and relevant implications to generate savings.

Mendoza, M., J. C. González-Vega, and J. K. Htoo. 2020.

READ THE COMPLETE ARTICLE HERE

F&F 14143

Evonik Publication

Growth performance response to MetAMINO® and MHA-Ca fed at a ratio of 65:100 in nursery pigs

These trial results show pigs fed the control diet had lower final bodyweight and average daily gain, and higher feed conversion ratio compared to pigs fed MHA-Ca and MetAMINO® diets. An economic analysis showed there is an advantage of 58 cents per pig, when pigs were fed the 65 part of MetAMINO® diet compared to pigs fed 100 parts MHA-Ca diets.

M. Mendoza, C. Gonzalez Vega and J. Htoo. 2020.

FOR MORE INFORMATION PLEASE CONTACT OUR TECHNICAL SALES TEAM.

Methionine levels in whiteleg shrimp. International Aquafeed

A study to investigate and compare postprandial Methionine (Met) levels in relation to other amino acids in the hemolymph of whiteleg shrimp fed diets supplemented with AQUAVI® Met-Met or DL-Met.

Dr. Karthik Masagounder, Head Aqua and Swine Research, Evonik Operations GmbH, Germany and Dr. D Allen Davis, Professor, Auburn University, USA

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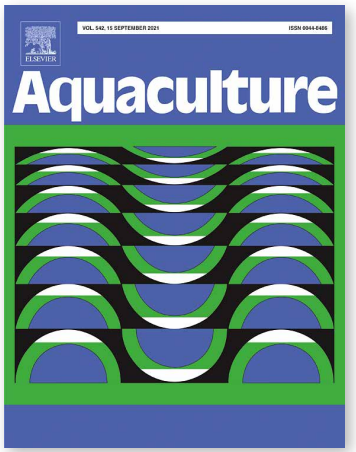

Peer Reviewed

Effects of DL-methionine and a methionine hydroxy analogue (MHA-Ca) on growth, amino acid profiles and the expression of genes related to taurine and protein synthesis in common carp. Aquaculture 532: 735962.

This study indicates that dietary DL-Met or MHA-Ca supplementation could increase free essential amino acids in serum, as well as improve taurine synthesis and protein synthesis in common carp. Multi-exponential regression analysis showed that MHA-Ca was less utilized by common carp than DL-Met with its bioavailability of 41–50 % relative to DL-Met on a weight-for-weight basis.

Zhou, Y., He, J., Su, N., Masagounder, K., Xu, M., Chen, L., Liu, Q., Ye, H., Sun, Z. and Ye, C. 2021.

READ THE COMPLETE ARTICLE HERE

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