CJ Products

L-Methionine

Introduction

Trial report

- Effect of feed grade L-Methionine on growth performance and gut health in nursery pigs compared with conventional DL-Methionine

- Effects of supplemental L-Methionine on growth performance and redox status of turkey poults compared with the use of DL-Methionine

Introduction

Why young animals prefer L-Methionine?

BLL(Baby Loves L-Methionine)

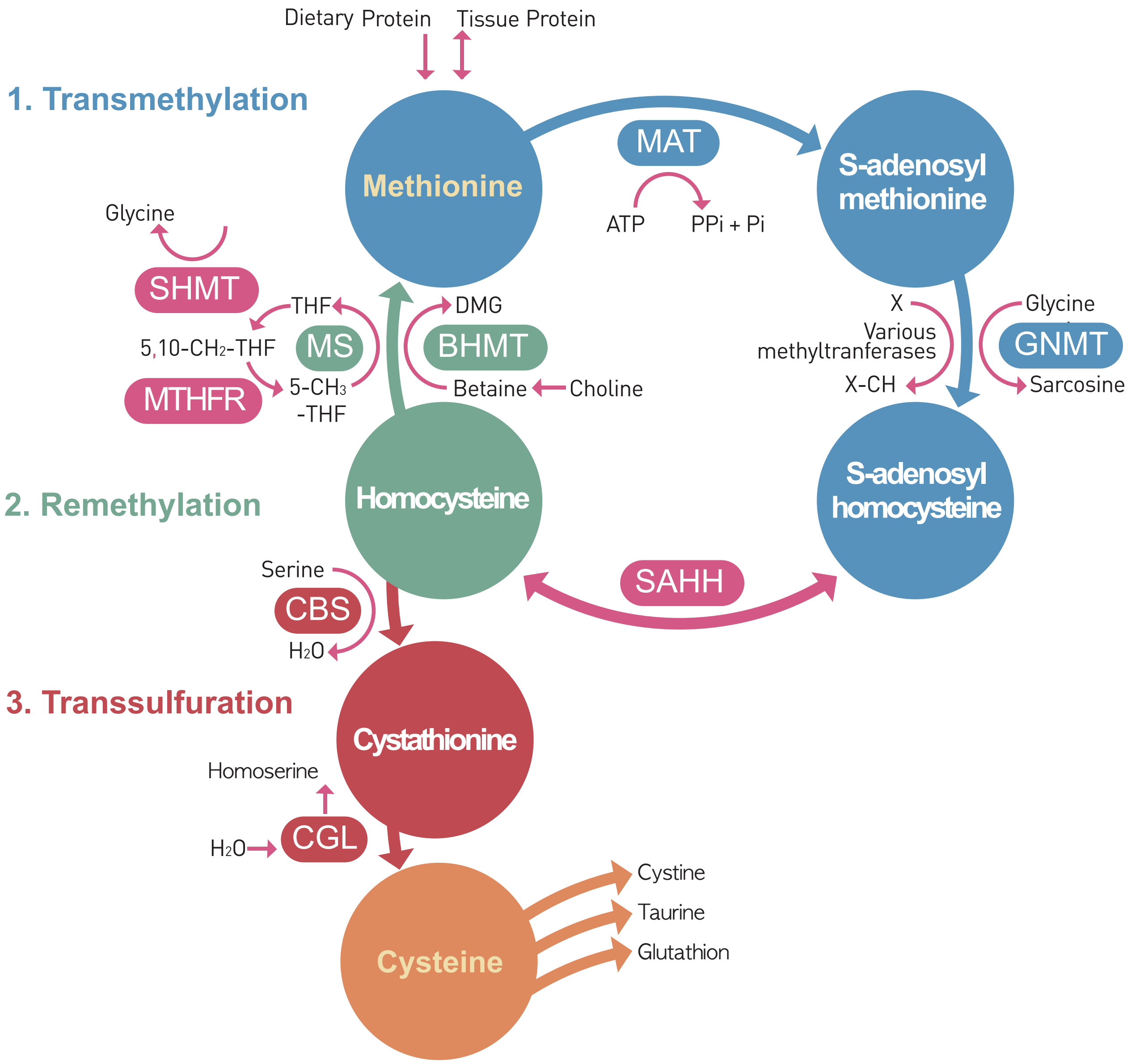
In order for D-amino acids to be oxidized *in vivo* by D-AAO and D-AspO, they first must be absorbed from the intestine, enter into the bloodstream and be transported to the liver and kidneys. Research showed that the expression of these enzymes are very low for young animals (D'Aniello et al., 1993). Therefore, L-Met is the only biologically functional form of Met readily utilized by the intestinal cells of young animals.

The growth and development of the gastrointestinal tract requires a variety of functions of AA metabolism, including protein synthesis, cell signaling, antioxidative function, and immune function (Shoveller et al., 2003). Metabolism of essential AA by the mucosal cells is quantitatively greater than AA incorporation into mucosal protein (Stoll et al., 1998).

Methionine is also a precursor for Cys, which plays a key role in maintaining protein function and redox status. In addition, Met serves as an indirect precursor of GSH (through Cys), taurine, and sulfur, which are also major cellular antioxidants (Brosnan and Brosnan, 2006). Therefore, the functional role of Met in the gastrointestinal tract, especially its antioxidative effect, may be the key effects on the gastrointestinal tract health of a rapid growing animal and consequently impact its growth potential (Shen et al., 2014).

The Theory of BLL

- D-form amino acids must be oxidized (racemization) to mobilize in the body (i.e. anabolism and catabolism).
- This oxidization process requires enzyme rection. (racemase; e.g. D-AAO, D-Asp0).
- D-AAO occurrence (activation) is increasing as animals grow.



MAT	Methionine adenosyltransferase
GNMT	Glycine N-methyltransferase
SAHH	S-Adenosylhomocysteine hydrolase
CBS	Cystathionine ß-synthase
CGL	Cystathionine Y-lyase
MTHER	Methylenetetrahydrofolate reductase
MS	Methionine synthase
BHMT	Betaine : homocysteine Methyltransferase
SHMT	Serine hydroxymethyltransferase
THF	Tetrahydrofolate
DMG	Dimethylglycine
PPi	Pyrophosphate

Pathway	Key Function	Key Substrate
Transmethylation	Methyl donor	Glycine
Remethylation	Synthesis of Methionine	Betaine
Transsulfuration	Synthesis of Cysteine	Serine

Fig. 1. Metabolic pathway of Methionine

Metabolic pathway of Methionine

The first step is the **transmethylation** of methionine to homocysteine via the intermediate forms of S-adenosyl-L-methionine(SAM) and S-adenosyl homocysteine(SAH). Homocysteine combines with serine to form cystathionine. Finally, cystathionase is catalyzed into cysteine (Vasdev S et al., 1999). Homocysteine is **remethylated** to methionine by two enzymes, methionine synthase(MS) and betaine-homocysteine methyltransferase(BHMT). The former reaction uses a methyl group from 5-methyl tetrahydrofolate(THF), which is derived from methylenetetrahydrofolate reductase(MTHFR). The latter reaction uses betaine that is derived from choline (Ziad A. 2003 and Friedrich C. 2015). Homocysteine is converted to cysteine through the **transsulfuration** pathway, catalyzed by cystathionine β-synthase(CBS). The cysteine is then used to make glutathione and taurine. They are a powerful antioxidant under oxidative stress.

After Met is converted into the non-essential amino acid (Cys), the final product of Cys degradation is succinyl CoA which then enters the Kreb's cycle.

Differences in digestive mechanism among Methionine sources

● Converting to L-Met from D-Met and HMTBa

Three types of methionine sources aer commercially used in feeds; L-Met, DL-Met and MHA-FA. All animals can utilize only L-Met, D-Met and MHA can be used, only after being converted into the L-Met through two-step enzyme reaction in the body.

The α-carbon of D-Met, D-MHA and L-MHA is oxidized to yield keto-Met (Dibner, J. J. and C. D. Knight, 1984) and Keto-Met is then coverted by L-phenylalanine dehydrogenase(L-PheDH) into L-Met in the liver.

Figure 2. shows the two-step process of conversion of D-Met to L-Met. At the first step, D-AAO enzyme is needed to oxidizes D-Met to keto-Met(2-Oxo-4-Methylthiobutyric acid). At the second step, L-PheDH is needed to hydrolyze keto-Met and to L-Met.

These steps are energy consuming processes and competition for amino group in the second step can affect conversion ratio of D-Met to L-Met.

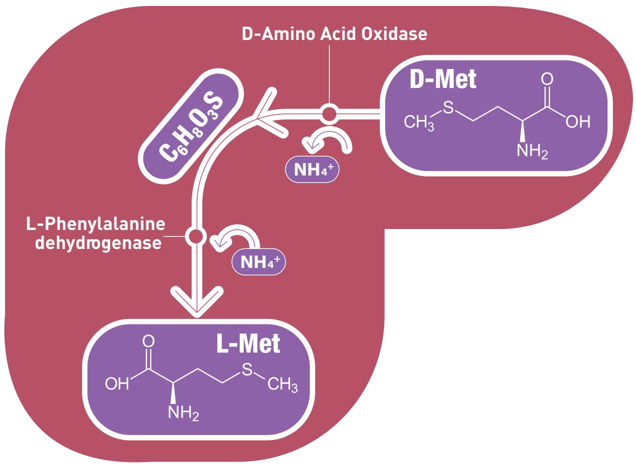


Fig. 2. The converting process from D-Methionine to L-Methionine

CJ Trial report

Effect of feed grade L-Methionine on growth performance and gut health in nursery pigs compared with conventional DL-Methionine

Source : J. Anim. Sci. 2014.92:5530-5539

Objective

Two experiments were conducted to test if supplementation of L-Met has beneficial effects on growth performance and gut health in nursery pigs compared with DL-Met

Materials and Methods

Experiment 1 — 26d of age (5d postweaning)

	Basal Diet	T1 L-Met	T2 L-Met	T2 L-Met	T1 DL-Met	T2 DL-Met	T2 DL-Met
containing Met % of the NRC	55%	70%	85%	100%	70%	85%	100%
Met supplement	-	0.048%	0.096%	0.144%	0.048%	0.096%	0.144%
Pens / Treatment	8	8	8	8	8	8	8
Pigs / Pen	3	3	3	3	3	3	3
Total				168			

Experiment 2 — 26d of age (5d postweaning)

	T1 DL-Met	T2 L-Met
Met supplement	0.145%	0.145%
Pigs / Treatment	10	10
Total	20	

Results

Experiment 1

Pigs fed diets supplemented with L-Met tended to have greater ADG and reduced plasma urea nitrogen (PUN) than pigs fed diets supplemented with DL-Met.

- The RBA of L-Met to DL-Met was calculated as 144% and 123% for the overall ADG and G:F, respectively.

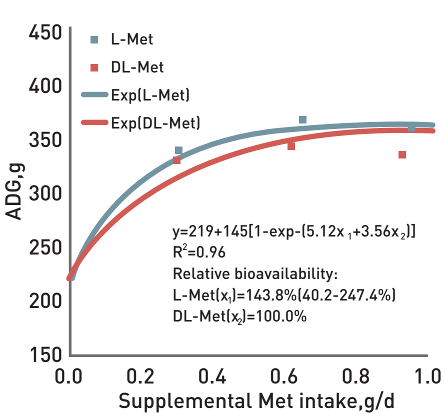


Fig. 1. Average daily gain of pigs with increasing intake levels of either supplemental L-Met or DL-Met from d 0 to 20 in Exp. 1

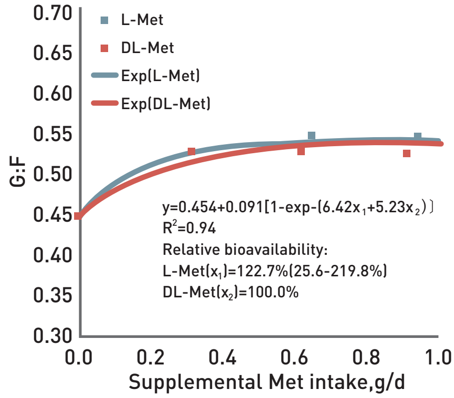


Fig. 2. Gain:feed ratio of pigs with increasing intake levels of either supplemental L-Met or DL-Met from d 0 to 20 in Exp. 1

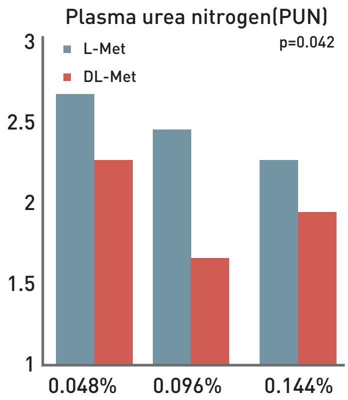


Fig. 3. Plasma urea nitrogen of pigs fed graded levels of either L-Met or DL-Met in contrast to the basal diet (BD) in Exp. 1

Experiment 2

Pigs fed a diet supplemented with L-Met had duodenum tissue with greater concentrations of glutathione (GSH) and greater villus height and width compared with pigs fed DL-Met.

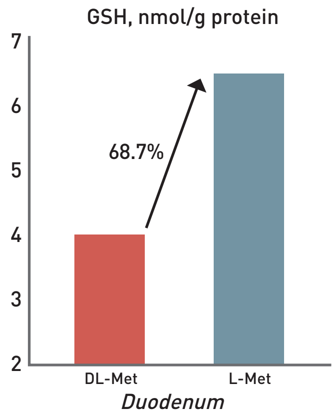


Fig. 4. Glutathione (GSH) concentrations in duodenum of pigs fed diets supplemented with either DL-Met or L-Met in Exp. 2

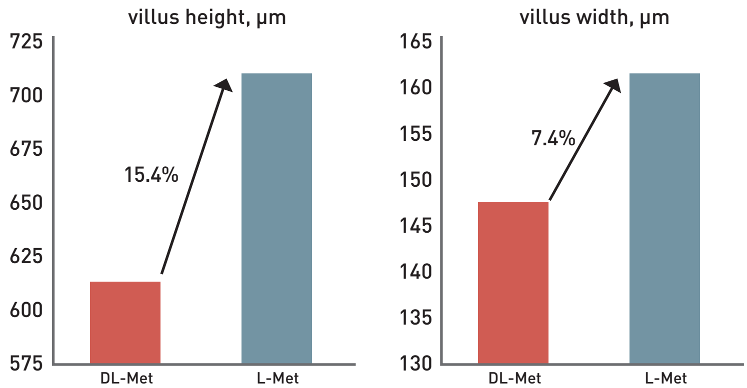


Fig. 5. Morphology of duodenum in pigs fed diets supplemented with either DL-Met or L-Met in Exp. 2

Conclusion

Compared with DL-Met, the use of L-Met as a dietary source of Met in nursery pig diets enhanced morphology of the duodenum in association with reducing oxidative stress and improving GSH production in mucosa cells.
The beneficial effect of supplementing L-Met compared to DL-Met in nursery pigs resulted in a potential enhancement of ADG and reduction of PUN.
Therefore, L-Met appears to be an effective source of Met compared with DL-Met for newly weaned pigs.

CJ Trial report

Effects of supplemental L-Methionine on growth performance and redox status of turkey poults compared with the use of DL-Methionine

Source : Poult Sci. 2018 Jan 1;97(1):102-109

Objective

This study was conducted to test the effects of dietary supplementation of feed grade L-Met on growth performance and redox status of turkey poults compared with the use of conventional DL-Met

Materials and Methods

- Animal : 385 newly hatched Nicholas turkey poults
- Dietary treatments

	Basal diet (BD)	Basal + 0.17% DL-Met	Basal + 0.17% L-Met	Basal +0.33% DL-Met	Basal +0.33% L-Met
SCAA	60% of requirement	75% of requirement	75% of requirement	90% of requirement	90% of requirement
Cage	7	7	7	7	7
Poults/Cage	11	11	11	11	11
Total			385		

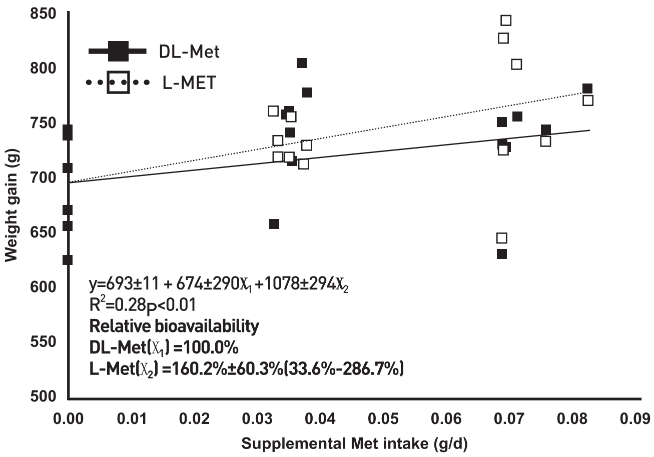
- Evaluation : 0, 7, 14, 21, and 28 day

Results

Table 1. Growth performance of turkey poults fed diets with supplemental methionine from d 0 to 28 of age.[1]

Item	Basal diet (BD)[2]	Basal + 0.17% DL-Met	Basal + 0.17% L-Met	Basal +0.33% DL-Met	Basal +0.33% L-Met	SEM	p value		
	60% of requirement	75% of requirement	75% of requirement	60% of requirement	60% of requirement		Lv[3]	Sc[4]	Lv × Sc
Initial BW (g)	59.8	59.4	60.3	59.4	59.4	0.4	0.59	0.44	0.57
Weight gain (g)	690	737	730	738	762	19	0.012	0.46	0.6
Feed intake (g)	1123	1230	1257	1212	1239	32	0.001	0.62	0.95
Feed to gain ratio	1.63	1.67	1.73	1.64	1.62	0.03	0.3	0.053	0.19

[1]Each mean represents 12 cages of 11 turkey poults per pen.
[2]BD = basal diet.
[3]Lv = supplemental levels (0, 0.17, and 0.33%) of Met.
[4]Sc = sources of Met (DL-Met and L-Met).



The overall model for WG acceptably fitted ($p < 0.01$) the observations (χ_1 = intake of supplemental of DL-Met, and χ_2 = intake of supplemental of L-Met).

In the multilinear regression analysis, x-axis represents supplemental Met intake (g/d).

Intercept (693) represents WG achieved with the basal diet. Increase of WG of L-Met was 160.2% of that of DL-Met as calculated by [Slope of L-Met (1078)/Slope of DL-Met (674)] × 100.

Values in brackets indicated the 95% confidence interval.

Fig. 1. Weight gain (WG) of turkey poults with increasing intake levels of either supplemental DL-Met or L-Met from d 0 to 28.

Conclusion

The relative bioavailability of L-Met was calculated as 160% for overall WG. These results indicate that turkey poults required 160 units of DL-Met to achieve the overall WG that were produced by 100 units of L-Met. These results support the original hypothesis that L-Met is better utilized by turkey poults compared with DL-Met.
In this study, the greater RBA in WG of turkey poults fed a diet supplemented with L-Met than DL-Met are speculated as one of the major reasons for the difference in F:G