EVALUATING 15% HIGHER BIO-EFFICIENCY OF L-METHIONINE IN BROILERS RAISED UNDER SEMI-COMMERCIAL CONDITIONS

*Bart Matton & Behnam Saremi
CJ BIO Europe GmbH

Lotte Stokvis
Schothorst Feed Research, Lelystad, the Netherlands
External Author

ABSTRACT

Background :

A new fermentation-based L-Methionine (L-Met) has been developed by CJ BIO containing minimum 95% L-Met, called BESTAMINO™ L-Met e. Earlier research has shown a higher bio-efficiency of L-Met compared to chemically synthesized Methionine (Met) sources such as DL-Methionine (DL-Met) containing a minimum of 99% of DL-Met and DL-Methionine hydroxy analogue, known as DL-2-hydroxy-4-(methylthio) butanoic acid or DL-HMTBA 88%. This study aimed to evaluate, under semi-commercial conditions, the effects on performance and carcass characteristics when broilers received 15% less supplementary Met originating from L-Met e compared to DL-Met fed birds receiving SID Met+Cysteine (Cys)/SID Lysine (Lys) levels according to Ross 308 recommendations. Body weight (BW), feed intake (FI), feed conversion ratio (FCR), and water intake (WI) were measured over the starter (d 0-10), grower (d 10-22), and finisher phase (d 22-37). Additionally, litter quality (LQ, d 22 and 27) and footpad dermatitis (FPD, d 30 and 35) were scored, and carcass characteristics were determined (d 36).

Results:

Over the entire period (d 0-37), the L-Met e diet led to heavier (2,297 vs. 2,264 grams; P = 0.047) birds than the DL-Met diet. Also, the DL-Met diet led to a higher WI (P = 0.035) and W:F (P = 0.016) than the L-Met e diet. The L-Met e diet led to better LQ at d 22 (P = 0.011). FPD was only different at d 30, with better scores for the L-Met e fed birds (P < 0.001). The L-Met e diet led to a higher breast meat (% BW; P = 0.028).

Conclusions :

Attributing 15% higher bio-efficiency to L-Met e compared to DL-Met positively impacts the performance and carcass parameters of the birds.

Keyword L-methionine; DL-methionine; efficacy; performance; water to feed ratio

*1st author

BACKGROUND

Recently, CJ BIO developed a new L-methionine (L-Met) source, called L-Met e. BESTAMINO™ L-Met e contains a minimum of 95% of L-Met and is registered in the EU under 3c305ii (EU regulation 2022/1493). L-Met is produced through fermentation and has become available on the market about 10 years ago compared to other methionine sources being for longer on the market but produced through chemical synthesis. BESTAMINO™ L-Met products produced uniquely by CJ BIO have been subject to a Life-Cycle-Assessment (LCA) of which the results were recently published by Kim et al. (2024) and which shows a lower global warming potential compared to DL-Met. Additionally, L-Met is considered more bioavailable compared to its chemical counterparts since the L-isomer is directly available for the animal (Figure 1). Other methionine sources, such as DL-Met, contain a racemic mixture of 50% L- and 50% D-isomer. The latter needs to be converted into L-isomer as the animal cannot build the D-isomer in its protein. This process happens through D-amino acid oxidase and transaminase in the liver, kidney, and duodenum (Zhang et al., 2018). The third methionine source, DL-Methionine hydroxy analogue, known as DL-2-hydroxy-4-(methylthio) butanoic acid or DL-HMTBA 88%, is a low pH aqueous solution and needs L-2-hydroxy acid oxidase, D-2-hydroxy acid dehydrogenase, and transaminase to get to the L-isomer of Met. Because L-Met is directly available to the animal, several studies have shown the higher bioavailability (Esteves-Garcia and Khan et al., 2018; Shen et al., 2015). A recent meta-analysis by Asasi and coauthors (2024) is confirming the higher bioavailability of L-Met compared to DL-Met for broilers aged d 0-21. Using a linear regression analysis, the bio-efficacy was 4.37% to 5.03% higher for FCR and ADG ($P < 0.01$), respectively. In contrast, the non-linear exponential model showed an 8.67% up to 23.43% higher bio-efficacy for the L-Met group for ADG ($P = 0.01$) and FCR ($P = 0.09$), respectively. In order to translate the literature which is showing higher bioavailability for L-Met compared to DL-Met to a commercial concept, a trial was performed. In a semi-commercial setting, using 13,120 birds and feeding a practical formulation, two groups were compared. The control group received SID Met+Cysteine (Cys)/SID Lysine (Lys) levels according to Ross 308 recommendations containing DL-Met 99%, while the treatment group received 15% less supplementary Met originating from L-Met e.

MATERIALS AND METHODS

The trial was conducted by Schothorst Feed Research (Lelystad, the Netherlands) and 13,120 Ross 308 broilers (as hatched) were housed in 8 replicates (each 820 birds) per treatment, 16 pens in total (47.5 m^2/pen). Diets were formulated close to commercial diets (corn, wheat, and soy) and birds had unrestricted access to feed and water. The diets either contained a regular DL-Met with 10.8, 9.9, and 8.8 g/kg Met+Cys and 14.2, 12.8, and 11.1 g/kg Lys in starter, grower, and finisher diets, respectively, or, the new L-Met e was added considering a 15% higher efficacy for L-Met e i.e. 4.74, 4.08, and 3.15 kg/ton DL-Met (min. 99% DL-Met) vs. 4.20, 3.61, and 2.79 kg/ton L-Met e (min. 95% L-Met content) in starter, grower, and finisher, respectively. The resulting SID Met+Cys/Lys ratios and free Met analysis plus other nutrients of both treatments can be found in Table 1.

Body weight (BW), feed intake (FI), feed conversion ratio (FCR), and water intake (WI) were measured over the starter (d 0-10), grower (d 10-22), and finisher phase (d 22-37). Additionally, litter quality (LQ, d 22 and 27) and footpad dermatitis (FPD, d 30 and 35) were scored, and carcass characteristics were determined (d 36). LQ was visually scored as described by Dersjant-Li et al. (2015). A score of 1 indicates very poor and wet litter, whereas a score of 10 indicates perfectly dry and friable litter. Footpad lesion scoring was based on the Welfare Quality Assessment, which ranges from 0 to 4, with 0 showing no pododermatitis and 4 severe pododermatitis. Performance data were analyzed by ANOVA using Genstat (2019). The LQ and FPD scores were analyzed by ordinal regression with a log transformation of the data.

Table 1 Calculated nutrient composition of the experimental starter (d 0-10), grower (d 10-22), and finisher (d 22-37) diets.

	DL -Met diets			L -Met e diets		
Calculated nutrients (g/kg)	Starter	Grower	Finisher	Starter	Grower	Finisher
DM	882.6	881.4	880.3	882.4	881.2	880.2
Ash	59.1	50.3	45.6	59.1	50.3	45.6
Crude protein	213.9	200.0	187.0	213.3	199.6	186.8
Crude fibre	25.4	25.2	24.8	25.4	25.2	24.8
Crude fat (h)	55.0	60.5	64.4	55.0	60.5	64.4
AMEn (kcal/kg)	2,975	3,050	3,100	2,975	3,050	3,100
SID Lys	13.2	11.8	10.2	13.2	11.8	10.2
SID Met+Cys/SID Lys (g/g)	0.76	0.78	0.80	0.71	0.73	0.75
SID Met/SID Lys (g/g)	0.56	0.57	0.56	0.51	0.51	0.51
Free Methionine (%)	0.43	0.35	0.28	0.37	0.31	0.25

RESULTS AND DISCUSSION

Performance results and carcass characteristics can be found in Table 2 and Table 3, respectively. Although the L-Met e diet led to six grams lower BW (295 vs. 301 g/bird; P = 0.014) than the DL-Met in the starter phase. In the grower phase, there was no difference in BW and BWG between the groups, a cautionary finding, the DL-Met diet led to a higher WI (P = 0.002) and water to feed ratio (W:F; P < 0.001) compared to the L-Met e diet. In the finisher phase, the L-Met e diet led to heavier birds (P = 0.047) with a difference of 33 g per bird on average. Over d 0-37, the L-Met e diet led to heavier (2,297 vs. 2,264 grams; P < 0.05) birds on d 37 than the DL-Met diet. Furthermore, the DL-Met diet led to a higher WI (P = 0.035) and W:F (P = 0.016) than the L-Met e diet. L-Met e fed birds deposited more breast meat (%BW) compared to DL-Met fed birds (20.84 vs 20.35%; P = 0.028). Albeit not significant, abdominal fat (%BW) was also slightly reduced in the L-Met e group (P = 0.570). The L-Met e diet led to better LQ at day 22 (P = 0.011), although at day 27 the LQ was similar between the pens with birds fed either the L-Met e or DL-Met diet. FPD was only different at d 30, with better scores for the L-Met e fed birds (P < 0.001). The impact of higher WI and W:F on FPD and LQ was not visible at later ages (Figure 2, Figure 3).

Table 2 Performance in starter phase from d 0-10, in grower phase from d 10-22 and finisher phase from d 22-37 or the entire period from d 0-37: body weight (BW), body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR) and mortality.

	BW g	BWG g	FI g	WI ml	W:F ml/g	FCR g/g	Mortality %
Diet	**d 10**	**d 0-10**	**d 0-10**	**d 0-10**	**d 0-10**	**d 0-10**	**d 0-10**
DL-Met	301^{b}	260^{b}	330	561	1.70	1.270	1.54
L-Met-e	295^{a}	253^{a}	325	580	1.78	1.284	1.33
P-value	0.014	0.014	0.09	0.63	0.47	0.30	0.40
SEM	1.4	1.4	1.65	27.19	0.077	0.0085	0.17
Diet	**d 22**	**d 10-22**	**d 10-22**	**d 10-22**	**d 10-22**	**d 10-22**	**d 10-22**
DL-Met	1062	761	1004	1981^{b}	1.97^{b}	1.319	0.81
L-Met-e	1065	771	1000	1863^{a}	1.86^{a}	1.299	0.73
P-value	0.76	0.32	0.58	0.002	<0.001	0.14	0.55
SEM	6.3	6.1	4.50	17.25	0.013	0.0086	0.08
Diet	**d 37**	**d 22-37**	**d 22-37**	**d 22-37**	**d 22-37**	**d 22-37**	**d 22-37**
DL-Met	2264^{a}	1201	1960	3457	1.76^{b}	1.633	0.53
L-Met-e	2297^{b}	1231	1984	3332	1.68^{a}	1.612	0.75
P-value	0.047	0.11	0.11	0.07	0.016	0.38	0.34
SEM	9.6	11.4	9.00	41.87	0.019	0.016	0.15
Diet	**d 37**	**d 0-37**	**d 0-37**	**d 0-37**	**d 0-37**	**d 0-37**	**d 0-37**
DL-Met	2264^{a}	2222^{a}	3294	6000^{b}	1.82^{b}	1.482	2.88
L-Met-e	2297^{b}	2255^{b}	3309	5775^{a}	1.75^{a}	1.467	2.80
P-value	0.047	0.047	0.35	0.035	0.016	0.08	0.81
SEM	9.6	9.6	10.5	60.9	0.017	0.005	0.21

[a-b] Means within a column without a common superscript are significantly different.
SEM Standard error of the mean

Table 3 Carcass characteristics of the broilers on d 36: carcass weight (Carcass), leg weight (Leg), abdominal fat weight (Abd. Fat) and breast weight (Breast) expressed as percentage of body weight (% BW).

Diet	Carcass % BW	Leg % BW	Abd. Fat % BW	Breast % BW
DL-Met	66.15	21.02	0.163	20.35[a]
L-Met-e	66.30	20.94	0.147	20.84[b]
SEM	0.23	0.12	0.02	0.14
P value	0.65	0.63	0.57	0.028

[a-b] Means without a common superscript letter in a column differ significantly ($P \leq 0.05$).
SEM Standard error of the mean.

Figure 2 Litter quality on d 22 (P = 0.011), graphically presented as predicted values in % of pens with a certain score within a treatment, with lower scores indicating worse litter quality.

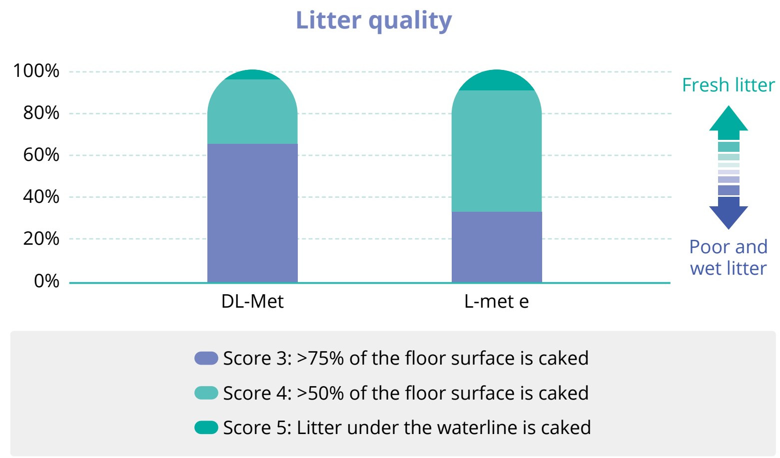
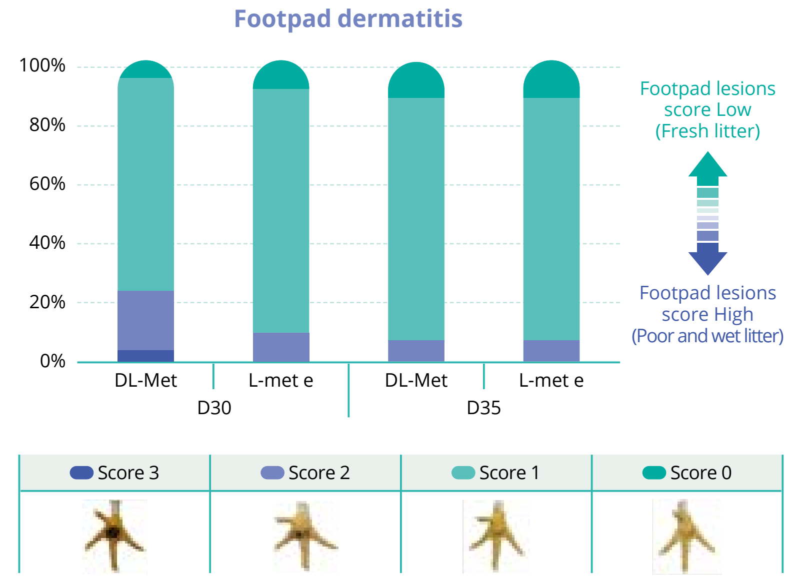


Figure 3 Footpad dermatitis scores on d 30 (P < 0.001) and d 35 (P = 0.871), graphically presented as predicted values in % of pens with a certain score within a treatment, with lower scores indicating less footpad dermatitis.



The slight underperformance of the birds fed the L-Met e diet in the starter phase could be related to the fact that 15% higher bioavailability of L-Met might be too optimistic for that age. However, we hypothesised to see a similar overall performance between the treatment groups applying 15% bio-efficiency, nonetheless the higher performance observed in this trial exceeds the calculated higher L-Met bio-efficiency. As the DL-Met group was fed on broiler recommendation levels, the higher bio-efficiency is most likely at the base of the higher performance as L-Met has direct uptake in the gastrointestinal tract, while conversion of D-Met into L-Met does not only require the D-amino acid oxidase complex, but also other amino acids such as valine and isoleucine in the transamination process (Gordon and Sizer, 1965).

Despite no differences in performance on d 22, the L-Met e diet led to better litter quality at this point in time most likely related to the decreased WI and W:F in this treatment compared to the DL-Met. This might be related to a higher nitrogen utilization in L-Met e group or a decreased amount of excess ammonia, due to the deamination of D-Met to keto methionine and subsequent excretion through urine, in birds fed L-Met e compared to DL-Met diets (Figure 1). Additionally, the better LQ might be due to the positive impact of L-Met on the gastrointestinal tract , although these effects cannot be separated in the current experiment. Due to the low litter quality observed on d 22 of the DL-Met group the temperature in the housing facility was increased to artificially help in drying the litter in all pens. This might have led to smaller differences between treatments and the consequent non-difference in LQ on d 27 between the groups. The better LQ on d 22 can also be linked to the better footpad dermatitis scores on d 30 for the L-Met e group. As with the LQ equalizing between the groups, also the FPD scores were equalizing at the end of the trial. Our trial also shows increased breast meat yield in the L-Met e group, which indicates that also carcass traits were not affected by a reduced Met supplementation based on L-Met e. This shows the higher BW is mostly located in the breasts and might indicate a beneficial effect of the L-Met e related to the increased bio-availability of amino acids for protein deposition.

CONCLUSION

Attributing 15% higher bioavailability to L-Met e positively impacts the growth performance, W:F ratio and breast muscle yield of the birds. L-Met e is a cost effective and highly efficient source of Met for broilers.

Figure 1 **Metabolism of different dietary methionine (Met) sources. Met isomer D-Met and Met precursor DL-2-hydroxy-4-(methylbio) butanoic acid (DL-HMTBA) must be converted to L-Met for utilization. Different enzymes and cofactors play roles in this process (adapted from Zhang et al., 2018).**