Relative bioavailability of methionine hydroxy analog calcium salt compared to DL-methionine in broilers under heat stress

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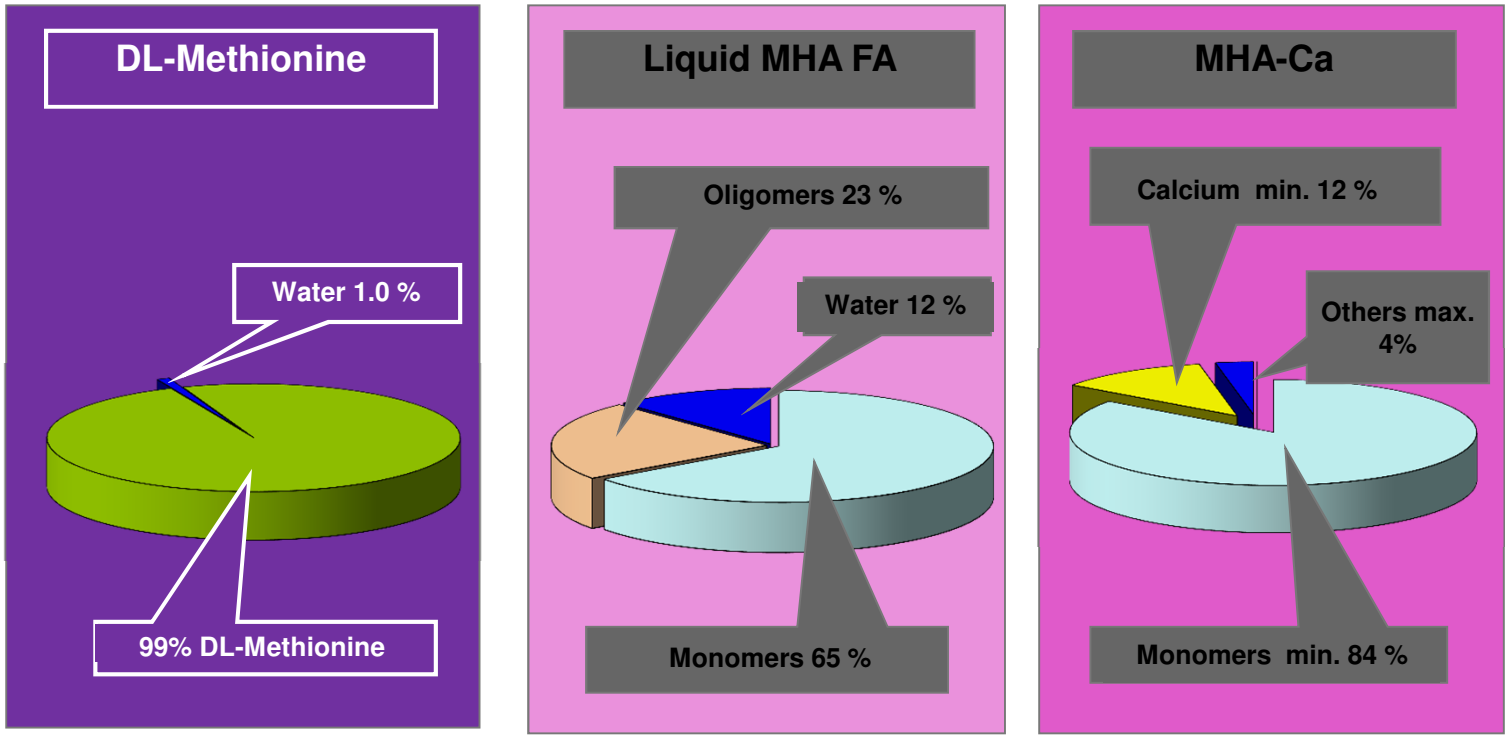
- Objective
- Materials and Methods
- Results and Discussion
- Conclusions

Introduction

- Methionine is an essential and first limiting amino acid in poultry
- In order to meet the bird's Met need, nutritionists commonly supplement methionine in broiler diets in order to balance the dietary amino acids.
- Methionine products commercially available include DL-methionine, liquid methionine-hydroxy analogue (MHA-FA), & methionine hydroxy analogue calcium salt (MHA-Ca).

Properties of the different methionine sources



- Chemically, MHA is not an amino acid but it can be converted to Met in animals.
- However, studies in poultry have indicated that inferior digestion and transformation of MHA-FA to L-Met reduces their Met value (Koban and Koberstein, 1984; Lemme, 2001; Drew et al., 2005).

Physiological evidences why MHA is less effective compared to DLM

- **MHA is less efficiently incorporated into muscle tissue.**
- **Substantial fraction of MHA is lost via microbial degradation**
- **MHA-di and -oligomers are poorly absorbed**
- **Mechanism of absorption for MHA is less efficient**
- **MHA is not an amino acid and hence, losses during the process of bio-conversion are inevitable**

(Saunderson, 1991; Lingens and Molnar, 1996; Maenz and Engele-Schaan, 1996; Drew and Maenz, 2001; Mitchell, 1996)

Average relative biological efficacy of MHA-Ca and liquid MHA-FA in broilers and layers on weight-to-weight basis compared to DL-Met

Species	Parameter	MHA-Ca (Lemme, 2004; Elwert et al., 2008; Evonik, 2012a, b)		MHA-FA (Lemme et al., 2011)	
		No. of data sets	Relative effectiveness Wt./Wt. basis*	No. of data sets	Relative effectiveness Wt./Wt. basis**
Broilers + Layers	BWG and Egg mass	77	63.8	60	65.1
Broilers	FCR	74	63.2	43	61.5

* based on assumed purity of 85% for MHA-Ca

** based on assumed purity of 88% for MHA-FA

Rationale for the experiment

- Overall, the relative biological effectiveness of MHA-FA/MHA-Ca compared with DL-Met has been considered to be about 65% on a product-to-product basis.

- However, it is sometimes debated that methionine value of MHA-FA or MHA-Ca are higher than 65% during summer conditions.

- Evaluation of bioefficacy or nutritional value under heat stress condition comparing MHA-Ca with DL-Met are limited.

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Objective

- **Determine the bioavailability of MHA-Ca relative to DL-methionine under heat stress conditions using a simultaneous dose-response trial .**

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Experimental Design

- **Birds** : 450 male Arbor Acres Plus broilers
- **Housing** : 9 treatments with 10 replicates per treatment & 5 birds per replicate. Rice hull littered pens in an open house (temperature was recorded twice daily)
- **Period** : Starter (day 1 to 14), grower (day 15 to 28), & finisher (day 29 to 42)
- **Diets** : Corn-soybean meal based, mash feed
- **Treatments** : **1:** control, deficient in dietary Met+Cys, w/o supplementation of any Met sources

  2-5: control diet plus 4 graded levels of DL-methionine (0.03 %, 0.06 %, 0.10 % and 0.15 %)

  6-9: control diet plus 4 graded levels of MHA-Ca (0.03 %, 0.06 %, 0.10 % and 0.15 %)

Parameters : Body weight gain, feed intake, feed conversion ratio, carcass yield and breast meat yield

Basal Diets: Ingredient and nutrient compositions

Ingredients, %	Period		
	Starter 1-14 days	Grower 15-28 days	Finisher 29-42 days
Corn	52.94	55.79	55.62
SBM, 48 % CP	34.60	28.60	27.10
Rice bran	4.98	8.00	9.36
Soybean oil	3.53	3.73	4.40
L-Lysine*HCl	0.13	0.18	0.10
L-Threonine	0.08	0.10	0.06
Mineral & vitamin	3.69	3.55	3.31
Coccidiostat	0.05	0.05	0.05
Total	**100.00**	**100.00**	**100.00**

Nutrient Composition, % (calculated)	Period		
	Starter 1-14 days	Grower 15-28 days	Finisher 29-42 days
Energy, kcal ME/kg	3050	3100	3150
Crude protein	21.40	19.60	18.50
SID Lysine	1.15	1.05	0.95
SID Methionine	0.30	0.28	0.27
SID Met + Cys	0.60	0.55	0.53
SID Threonine	0.75	0.70	0.64
SID Arginine	1.32	1.19	1.12
SID Isoleucine	0.82	0.73	0.69
SID Valine	0.90	0.82	0.78
Calcium	0.90	0.85	0.80
Available Phosphorous	0.45	0.42	0.40

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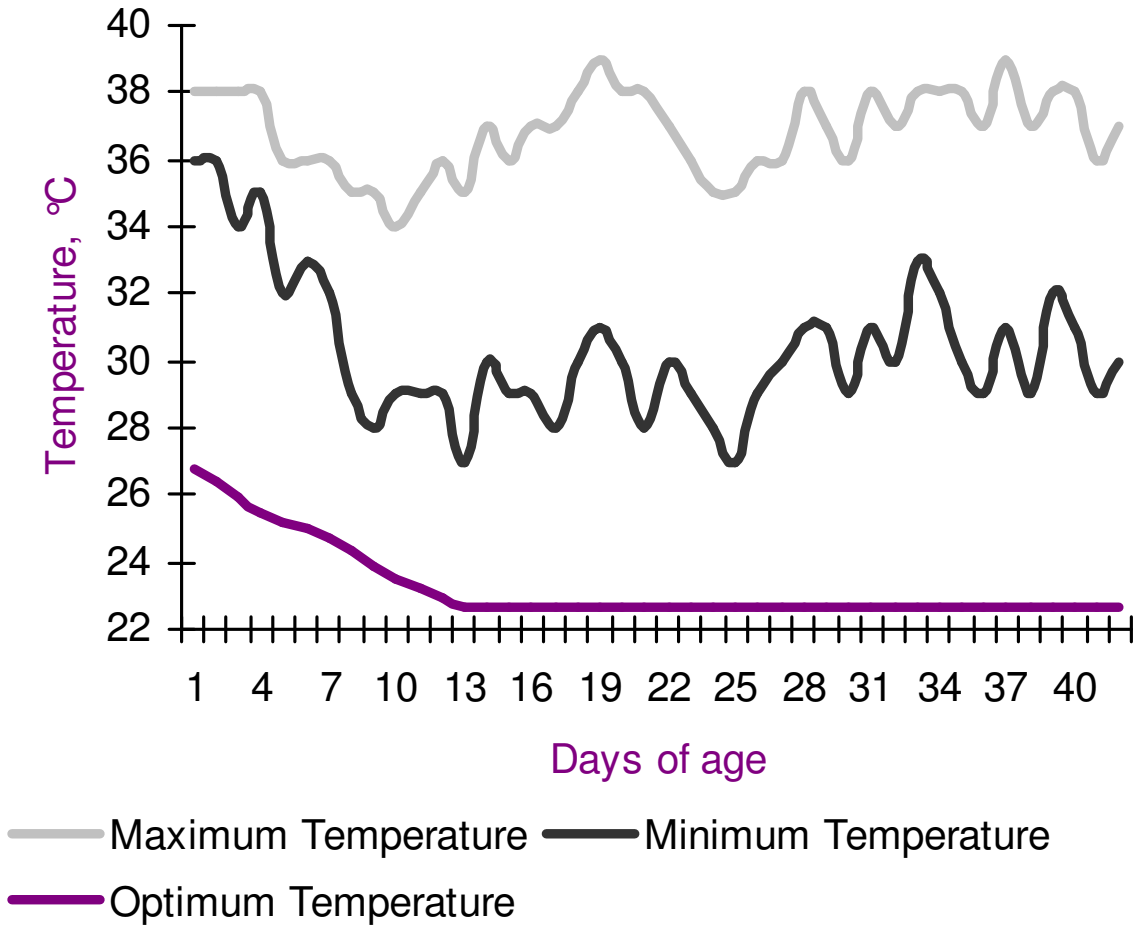
Recorded temperatures compared with the recommended optimum for Arbor Acres Plus (2009)



- Housing temperature in this trial was higher than optimal according to Arbor Acres performance guidelines.
- As a result FCR increased for all the treatments (2.1-2.4).
- However, currently obtained relative bioavailability values for MHA-Ca (~65 %) suggest no benefit of feeding MHA-Ca during a heat stress event.

Effects of DL-Met or MHA-Ca on growth performances of male Arbor Acres Plus broilers (1 to 42 days of age)

Trt.	Supplemental methionine source	Addition of product, %	Weight gain, g	Feed intake, g	FCR	Carcass yield, g	Breast meat yield, g
1	-	0.00	1658^{d}	3692	2.39^{a}	1220^{c}	365^{c}
2	DL-Methionine	0.03	1756^{bcd}	4006	2.29^{abc}	1260^{bcd}	390^{bcd}
3	DL-Methionine	0.06	1830^{abc}	3946	2.16^{bcd}	1350^{ab}	427^{ab}
4	DL-Methionine	0.10	1852^{abc}	3952	2.14^{d}	1325^{abc}	421^{ab}
5	DL-Methionine	0.15	1908^{a}	4021	2.11^{d}	1383^{a}	444^{a}
6	MHA-Ca	0.03	1731^{cd}	3964	2.29^{ab}	1268^{abc}	387^{bc}
7	MHA-Ca	0.06	1769^{bcd}	3940	2.23^{bcd}	1278^{abc}	402^{abc}
8	MHA-Ca	0.10	1839^{abc}	3978	2.17^{bcd}	1295^{abc}	402^{abc}
9	MHA-Ca	0.15	1873^{ab}	4009	2.14^{cd}	1353^{ab}	433^{ab}

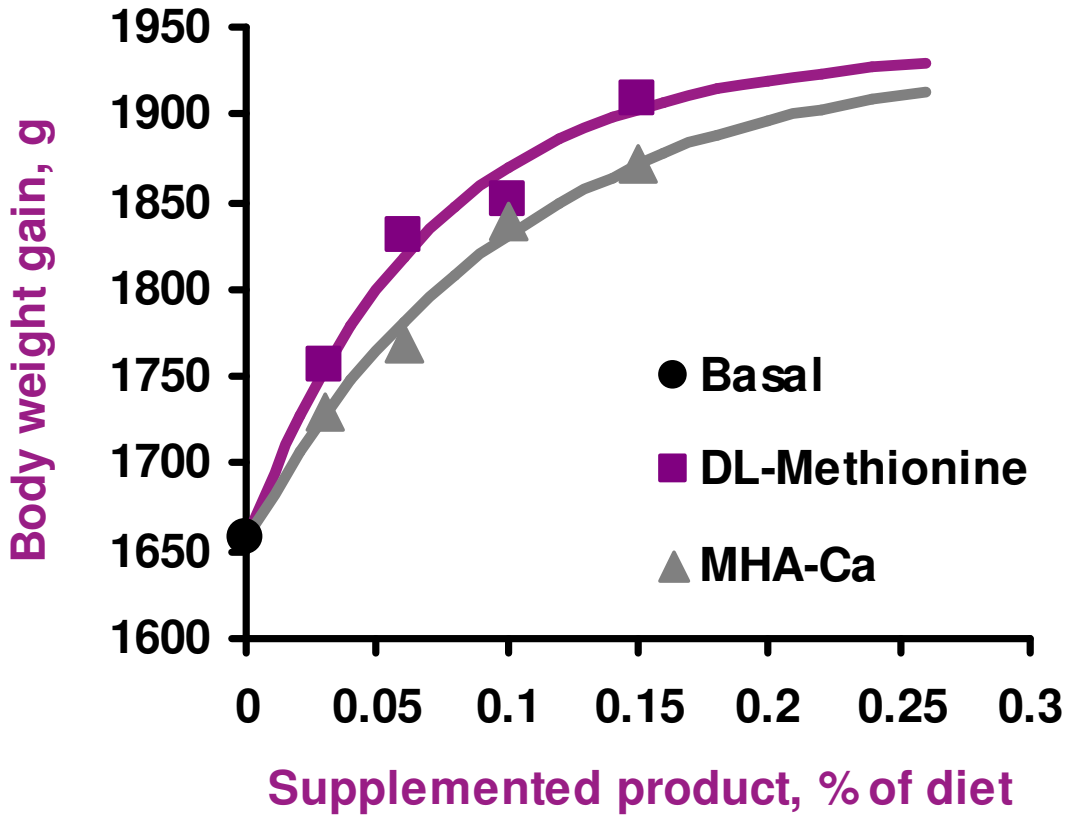
* Means with different superscripts within the same column differ significantly ($P < 0.05$).

MHA-Ca was 68 % as effective as DL-Met on product basis for weight gain in broilers

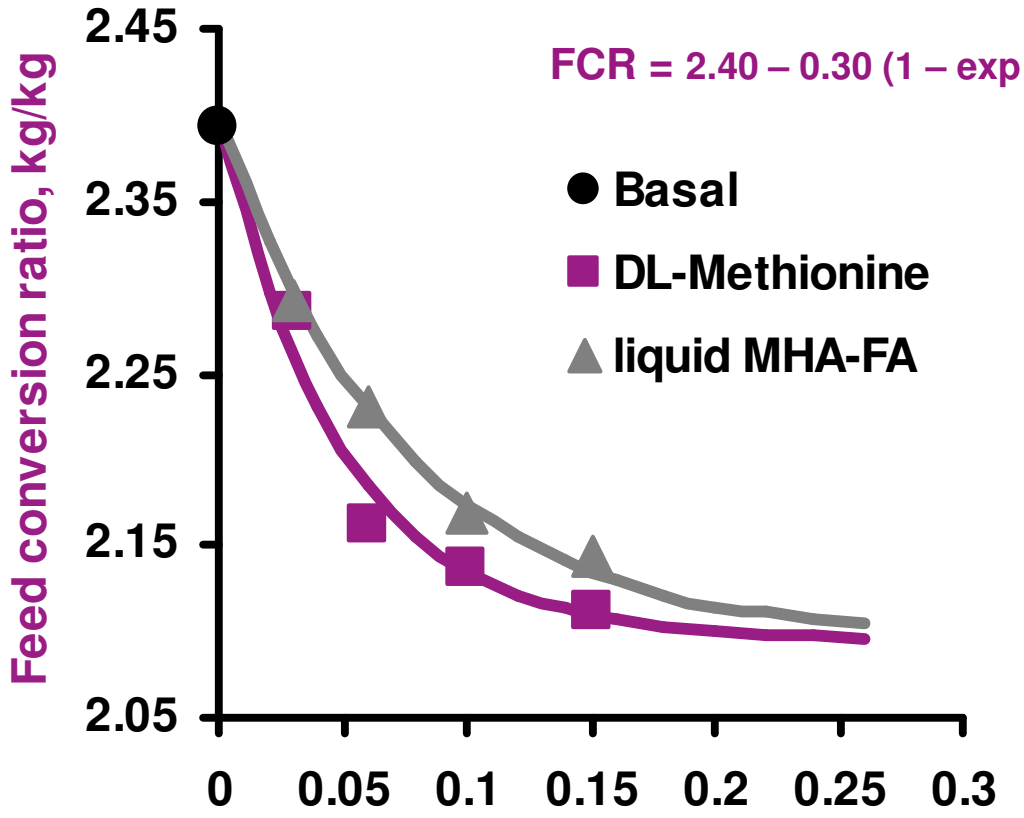
Weight gain = 1659 + 277 (1 – exp (–14.3 DL-Met – 9.7 MHA-Ca)

R^2 = 0.99

Relative bioavailability:
DL-Met: 100 %
MHA-Ca: 68 %



MHA-Ca was 67 % as effective as DL-Met on product basis for FCR in broilers

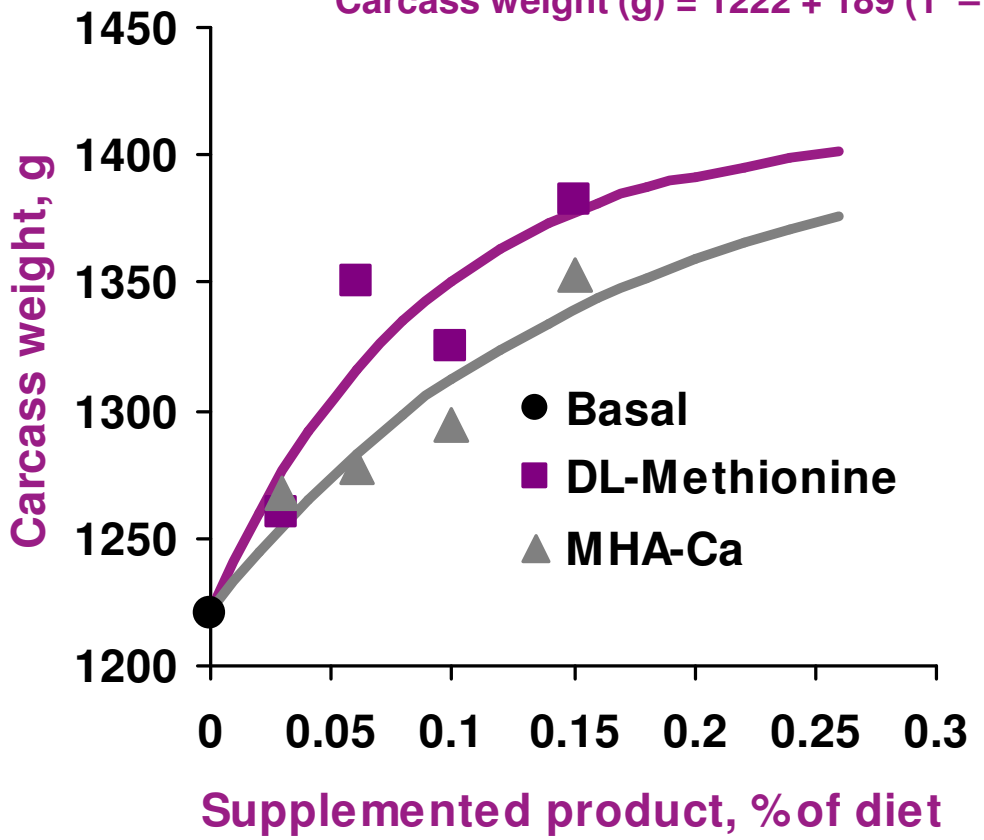


$FCR = 2.40 – 0.30 (1 – \exp (–20.2 \text{ DL-Met } –13.5 \text{ MHA-Ca}))$

$R^2 = 0.98$

Relative bioavailability:
DL-Met: 100 %
MHA-Ca: 67 %

MHA-Ca was 56 % as effective as DL-Met on product basis for carcass weight in broilers



Carcass weight (g) = 1222 + 189 (1 – exp (–11.5 DL-Met – 6.5 MHA-Ca))

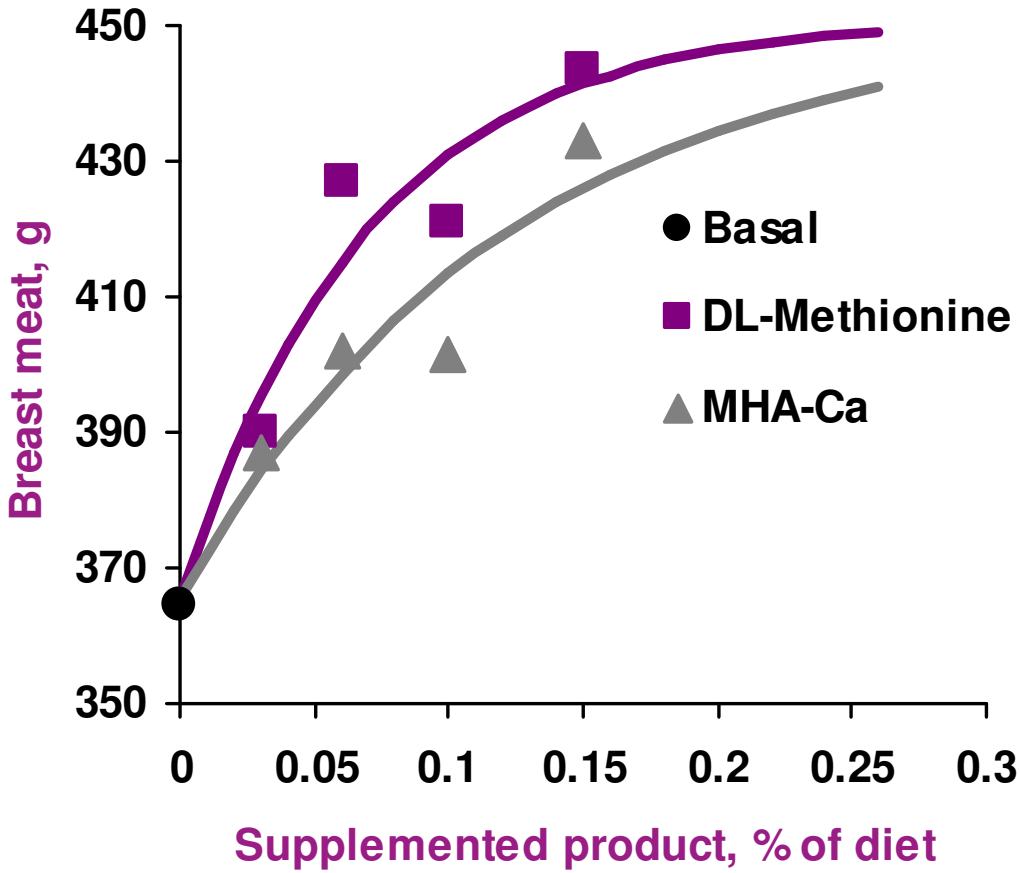
$R^2 = 0.87$

Relative bioavailability:
DL-Met: 100 %
MHA-Ca: 56 %

MHA-Ca was 57 % as effective as DL-Met on product basis for breast meat in broilers

Breast meat (g) = 365 + 86 (1 – exp (–14.4 DL-Met – 8.4 MHA-Ca))

$R^2 = 0.91$



Relative bioavailability:
DL-Met: 100 %
MHA-Ca: 57 %

Summary and conclusions

- Slope-ratio analysis revealed that bioefficacy of MHA-Ca relative to the DL-Met was 68 and 67 % for weight gain and FCR, on a product basis, respectively.
- Similarly, MHA-Ca was 56 and 57 % as efficient as DL-Met for carcass weight and breast meat yield, respectively, on weight to weight basis.
- These estimates are significantly lower than the active portion of 84% in MHA-Ca.

- **Overall, bioefficacy values for MHA-Ca relative to DL-Met obtained from this trial did not differ from those (~65%) obtained in the previous studies, suggesting that there is no additional benefit of feeding MHA during heat stress event.**

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