Relative effectiveness of herbal methionine compared to DL-methionine on growth, performance and carcass responses basis in broiler chickens

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Abstract:

BACKGROUND: The degree to which the amount of an ingested nutrient is absorbed and available to the body is called bioavailability. **OBJECTIVES:** Relative effectiveness of herbal methionine (H-Met®) compared to DL-methionine (DL-Met) was investigated in this experiment. **METHODS:** Exponential regression analysis was used to determine bioefficacy of H-Met® based on body weight gain, feed intake and feed conversion. DL-Met and H-Met® were added to a basal diet in 3 and 4 levels, respectively, in starter, grower and finisher periods. Therefore, that met the nutrient and energy requirements of broiler chickens, with the exception of Met+Cys. **RESULTS:** In the 42-d trial, broilers growth increased significantly ($p<0.05$), relative to those broilers fed basal diet, regardless of Met sources. Carcass characteristics did not respond significantly to the supplemental Met. **CONCLUSIONS:** Regression analysis revealed that H-Met® was 52% (body weight gain), 72% (feed intake) and 77% (feed conversion ratio) as efficacious as DL-Met. H-Met® can be administered as a new and a natural source of Met in poultry industry.

Introduction

Methionine (Met) is universally recognized as the first limited amino acid in broiler chickens diets based on corn and soybean meal (Saki et al., 2011). Sufficient intake of dietary Met and cysteine is important for the synthesis of proteins (Grimble, 2006). It may therefore influence growth and development of carcass and visceral organs. Wallis (1999) described several benefits of amino acid supplementation: 1) reducing cost of production, 2) producing the optimal balance of essential amino acids that enhances growth, and 3) balancing an animal's nutrient intake to conserve resources and minimize wastes.

The most common source of Met in poultry diets is DL-Met. This source of Met is produced by chemical synthesis from acrolein, methyl mercaptan, and hydrogen cyanide. Increasing prices for petrol-derived precursors of acrolein and methyl mercaptan coupled to increasing demand for a source of organic Met have led to the production of an organic source of Met called Herbal-Methionine (H-Met®). Prior to use in poultry nutrition, it is necessary to understand the efficacy of this new source of Met, particularly in comparison to DL-Met. Halder and Roy (2007) examined the effect of Herbomethionine (HerboMet) as a source of Met on performance of broilers and demonstrated that HerboMet can be used more efficiently than DL-Met. But there is little information on the bioavailability of H-Met® relative to DL-Met. Therefore, this article discusses the bioavailability of H-Met® relative to DL-Met and the effects of H-Met® on growth performance and carcass characteristics of broilers.

Materials and Methods

One-hundred and sixty males, 4-year-old Ross

308 broilers were assigned to 8 dietary treatments. Each treatment was replicated 4 times with 5 birds per replicate. Treatments were composed of basal corn-soybean meal diets (Table 1) with 3 and 4 series of graded levels of DL-Met (98%) and H-Met® (Met: 12.6 and Met+Cyc: 16.9%); (Table 2). H-Met® was supplied by India. Constituent herbs of H-Met® included *Andrographis paniculata*, *Ocimum sanctum*, *Asparagus racemosus* and *Zea mays*. The amount of Met of H-Met was analyzed according to the AOAC (2003) method 982.30. For each treatment starter, grower and finisher diets were fed from day 4 to 10, 11 to 24 and 25 to 42, respectively. Feed and water were offered ad-libitum. Temperature and lighting were according to practice in local commercial operations. Basal diets were formulated to be adequate for energy and all nutrients, except for Met+Cys.

Measurements (Growth Performance): Body weights and feed consumption were recorded for the periods of day 4 to 10, 11 to 24 and 25 to 42. Subsequently, body weight gain and mortality corrected feed conversion ratio were calculated.

Carcass Dissection: At 42 days of age, two birds from each replicate with a body weight as close as possible to the average weight of the pen were subjected to feed withdrawal for 6 hours prior to processing to determine carcass yield, breast, thigh, liver and abdominal fat including the fat surrounding the gizzard. The yield of carcass traits was expressed in terms of percentage of live weight.

Statistical Analysis: The data were evaluated as completely randomized designs. Significant differences were compared by Duncan's multiple range test ($p<0.05$). The pen mean was considered the experimental unit for all statistical analyses. A nonlinear exponential model was used to estimate the bioefficacy of H-Met® relative to DL-Met as suggested by Littell et al. (1997). The body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were analyzed by simultaneous multi-exponential regression. Simultaneous exponential regression analysis is a valid statistical means to determine the relative bioefficacy of Met sources (Hoehler et al., 2005a). The general linear model procedure (PROC GLM) in SAS software was applied fitting the following nonlinear (multi-exponential) equation:

$$y= a+ b \times (1- e^{(c_1 \times x_1 + c_2 \times x_2)})$$

Where y is performance criterion, a is intercept (birds performance with basal diet), b is asymptotic response, a+b is common asymptote (maximum performance level), c_1 is steepness coefficient for DL-Met, c_2 is steepness coefficient for H-Met® and x_1, x_2 are dietary level of DL-Met and H-Met®, respectively. According to Littell et al., (1997), bioefficacy values for H-Met® relative to DL-Met are given by the ratios of regression coefficient, c_2/c_1.

Results

Performance: Total mortalities over the 42-day periods were 0.5%. Mortality did not significantly ($p>0.05$) affect either of the Met source treatments. As indicated by the performance data and regression curves, the broiler chickens responded significantly to both supplements ($p<0.05$) (Tables 3 to 5). In the starter, grower and finisher periods, BWG increased

Table 1. The Composition of the starter, grower and finisher basal diets. a Vitamin premix provided the following per kilogram of diet: Vitamin A: 5,600 IU from all trans-retinyl acetate; Cholecalciferol: 2000 IU; Vitamin E: 20 IU from all-rac-α-tocopherol acetate; Nboflavin: 3.2 mg; Capantothenate: 8 mg; Nicotonic acid: 28mg; Choline Cl: 720 mg; Vitamin B12: 6.4 µg; Vitamin B6: 1.6 mg; Menadione: 1.6 mg (as menadione sodium bisulfate); Folic acid: 0.08 mg; D-biotin: 0.06 mg; Thiamine: 1.2 mg (as thiamine mononitrate); Ethoxyquin: 125 mg. b Trace mineral premix provided the following in milligrams per kilogram of diet: Mn, 40; Zn, 32; Fe, 32; Cu, 3.2; I, 1.2; Se, 0.06.

Ingredients (%)	Starter	Grower	Finisher
Corn	49.86	62.30	68.50
Soybean meal (44% cp)	31.51	22.08	16.53
Canola meal	10.00	10.00	10.00
Soybean oil	3.71	1.37	0.99
Dicalcium phosphate	1.94	1.62	1.49
Oyster shell	1.52	1.23	1.20
Salt	0.43	0.42	0.37
Vitamin premix a	0.30	0.30	0.30
Mineral premix b	0.30	0.30	0.30
L-Lysine Hcl	0.29	0.27	0.24
Thr %	0.14	0.11	0.08
Calculated Composition:			
ME,kcal/kg	2950	2950	3000
CP %	20.94	17.95	16.08
Calcium %	1.02	0.84	0.80
Available Phosphorus %	0.49	0.42	0.39
Na %	0.19	0.18	0.16
Met %	0.31	0.28	0.26
Met+ Cys %	0.77	0.68	0.61
Lys %	1.24	1.03	0.88
Thr %	0.81	0.68	0.61

Table 2. Treatments and the levels of supplemented DL-Met and H-Met® of the experimental diets (4-42 d). *Required Met according to Ross's (308) catalog is 0.46, 0.39 and 0.36 % for starter, grower and finisher periods respectively.

Treatment	Met source	Addition of Met source (% product)				Difference between amounts of provided Met and required amounts of Ross's (308) catalog*
		Starter	Grower	Finisher	Total	
1	BasalDiet	0.31	0.28	0.26	-	-0.15, -0.11, -0.10
2	DL-Met	0.07	0.06	0.05	0.06	-0.08, -0.05, -0.05
3	DL-Met	0.15	0.11	0.10	0.11	0.00, 0.00, 0.00
4	DL-Met	0.22	0.17	0.14	0.17	+0.07, +0.06, +0.04
5	H-Met	0.07	0.06	0.05	0.06	-0.08, -0.05, -0.05
6	H-Met	0.15	0.11	0.10	0.11	0.00, 0.00, 0.00
7	H-Met	0.22	0.17	0.14	0.17	+0.07, +0.06, +0.04
8	H-Met	0.29	0.23	0.19	0.22	+0.14, +0.12, +0.09

Table 3. Performance of broiler chickens fed graded levels of DL-Met and H-Met® in starter period. a, b, c, d - values in columns with different superscripts differ significantly (p≤0.05). *BWG= body weight gain, FI= Feed Intake and FCR= Feed Conversion Ratio, SEM = Standard error of the means.

Treatment	Met source	Addition of Met source (%product)	BWG* (g/d)	FI (g/d)	FCR
1	-	-	18.51^{c}	19.26^{d}	1.04^{c}
2	DL-Met	0.07	19.13^{b}	19.85^{c}	1.04^{c}
3	DL-Met	0.15	19.66^{a}	21.13^{b}	1.07^{b}
4	DL-Met	0.22	19.56^{a}	21.89^{a}	1.12^{a}
5	H-Met	0.07	18.52^{c}	19.36^{d}	1.05^{c}
9	H-Met	0.15	18.93^{b}	19.88^{c}	1.05^{c}
7	H-Met	0.22	19.62^{a}	21.83^{a}	1.11^{a}
8	H-Met	0.29	19.50^{a}	21.94^{a}	1.13^{a}
SEM	-	-	0.081	0.117	0.006

Table 4. Performance of broiler chickens fed graded levels of DL-Met and H-Met® in grower period. a, b, c, d - values in columns with different superscripts differ significantly (p≤0.05). *BWG= body weight gain, FI= Feed Intake and FCR= Feed Conversion Ratio, SEM = Standard error of the means.

Treatment	Met source	Addition of Met source (%product)	BWG* (g/d)	FI (g/d)	FCR
1	-	-	49.98^{c}	66.68^{d}	1.33^{c}
2	DL-Met	0.06	54.25^{b}	81.18^{c}	1.50^{b}
3	DL-Met	0.11	58.22^{a}	88.99^{b}	1.53^{b}
4	DL-Met	0.17	57.45^{a}	95.75^{a}	1.67^{a}
5	H-Met	0.06	50.74^{c}	67.44^{d}	1.33^{c}
6	H-Met	0.11	54.24^{b}	81.80^{c}	1.51^{b}
7	H-Met	0.17	58.15^{a}	89.49^{b}	1.54^{b}
8	H-Met	0.23	57.40^{a}	97.97^{a}	1.71^{a}
SEM	-	-	0.439	1.282	0.030

Table 5. Performance of broiler chickens fed graded levels of DL-Met and H-Met® in finisher period. a, b, c, d - values in columns with different superscripts differ significantly (p≤0.05). *BWG= body weight gain, FI= Feed Intake and FCR= Feed Conversion Ratio, SEM = Standard error of the means.

Treatment	Met source	Addition of Met source (% product)	BWG* (g/d)	FI (g/d)	FCR
1	-	-	77.96^{c}	147.32^{d}	1.89^{c}
2	DL-Met	0.05	81.31^{b}	156.70^{c}	1.93^{b}
3	DL-Met	0.10	85.45^{a}	166.73^{b}	1.95^{b}
4	DL-Met	0.14	84.69^{a}	174.99^{a}	2.07^{a}
5	H-Met	0.05	78.08^{c}	147.63^{d}	1.89^{c}
6	H-Met	0.10	81.15^{b}	159.01^{c}	1.96^{b}
7	H-Met	0.14	84.73^{a}	166.76^{b}	1.97^{b}
8	H-Met	0.19	84.66^{a}	175.62^{a}	2.07^{a}
SEM	-	-	0.506	0.709	0.014

in response to DL-Met and H-Met® supplementation. Maximum BWGs were achieved by broilers consumed 0.15, 0.11 and 0.10% DL-Met (treatment 3) for the starter, grower and finisher periods, respectively and 0.22, 0.17 and 0.14% H-Met® for the starter, grower and finisher periods respectively (treatment 7). Also, FI increased with the increased Met supplementation. Maximum FI was observed in the dietary treatments containing 0.22, 0.17 and 0.14% DL-Met (treatment 4) for the starter, grower and finisher periods, respectively and 0.29, 0.23 and 0.19% H-Met® (treatment 8) for the starter, grower and finisher periods, respectively. FCR increased with the increasing Met supplementation ($p<0.05$).

Carcass Characteristics: There were no influences of the level or the source of supplemented Met on the carcass characteristics at 42 days of age (Table 6; $p>0.05$).

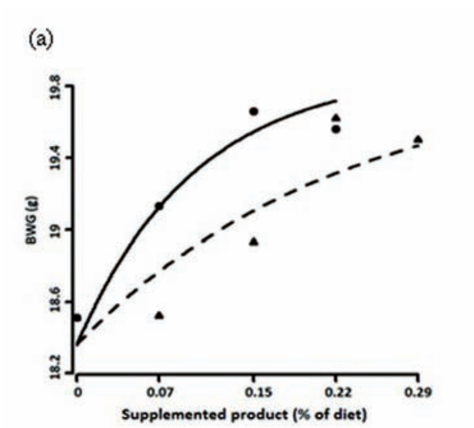
Bioefficacy of H-Met® relative to DL-Met: Broilers fed DL-Met and H-Met® performed well, but the results of the multi-exponential regression

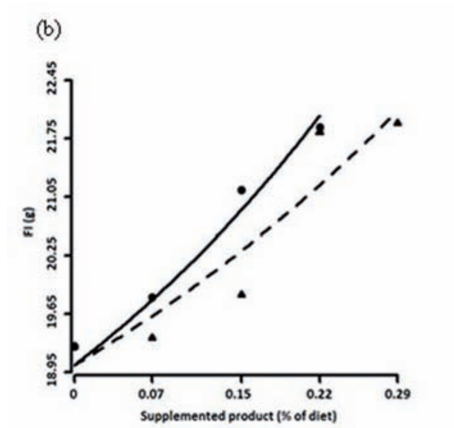
Table 6. Carcass yield (%), thighs (%), breast (%), liver (%) and abdominal fat (%) at 42 days of age in broilers submitted to different treatments and sources of Met. SEM = Standard error of the means.

Treatment	**Met source**	**Addition of Met source (% product)**			**Carcass**	**Thigh**	**Breast**	**Liver**	**Abdominal Fat**
		Starter	Grower	Finisher	% of live body				
1	-	-	-	-	77.31	24.45	27.17	1.84	1.83
2	DLMet	0.07	0.06	0.05	76.67	24.26	26.94	1.80	1.76
3	DLMet	0.15	0.11	0.10	76.59	24.19	26.91	1.58	1.27
4	DLMet	0.22	0.17	0.14	76.66	24.36	26.98	1.68	1.59
5	H-Met	0.07	0.06	0.05	76.57	24.26	27.06	1.77	1.68
6	H-Met	0.15	0.11	0.10	76.57	24.20	27.06	1.76	1.46
7	H-Met	0.22	0.17	0.14	76.64	24.39	26.93	1.75	1.28
8	H-Met	0.29	0.23	0.19	76.60	24.29	26.96	1.65	1.36
SEM	-	-	-	-	0.34	0.14	0.15	0.200	0.200

Table 7. Bioefficacy of H-Met® based on body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR).

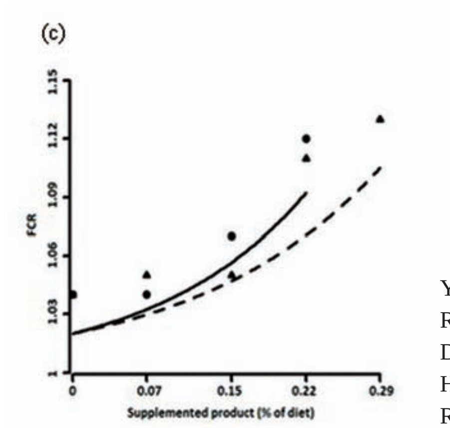
	Performance								
Periods	**Starter**			**Grower**			**Finisher**		
Variables	BWG	FI	FCR	BWG	FI	FCR	BWG	FI	FCR
Bioefficacy (%)	45	77	82	55	69	75	57	71	75
Mean (%)		64			65			66	
Total Mean (%)				65					





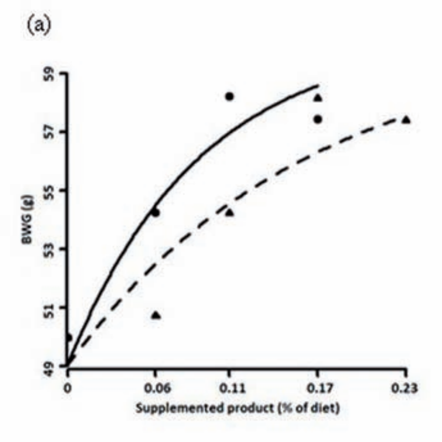
$Y = 18.36 + 1.53 \times (1 - e^{-(9.92x_1 + 4.44x_2)})$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 45% (26-64)*
R^2 = 79%

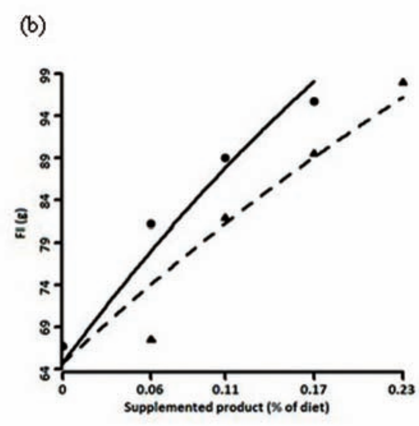
$Y = 19.03 - 4.30 \times (1 - e^{(2.40x_1 + 1.85x_2)})$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 77% (67-87)*
R^2 = 88%



$Y = 1.02 - 0.02 \times (1 - e^{(6.94x_1 + 5.72x_2)})$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 82% (73-91)*
R^2 = 85%

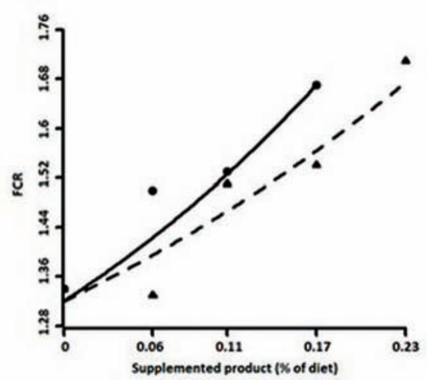
Figure 1. Bioefficacy of H-Met® relative to DL-Met using body weight gain (BWG) (a), feed intake (FI) (b) and feed conversion ratio (FCR) (c) in male Ross 308 broilers (starter period). Zero level indicates control. *Values in parentheses indicate the 95% confidence interval.
DL-Met ● H-Met ▲





$Y= 49.13+ 11.16\times (1- e -(11.11x_1 +6.14x_2))$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 55% (37-73)*
R^2= 82%

$Y= 64.6+100.6 \times (1- e -(2.38x_1 +1.64x_2))$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 69% (58-80)*
R^2= 89%



$Y= 1.32-0.52 \times (1- e (3.03x_1 +2.26x_2))$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 75% (61-88)*
R^2= 79%

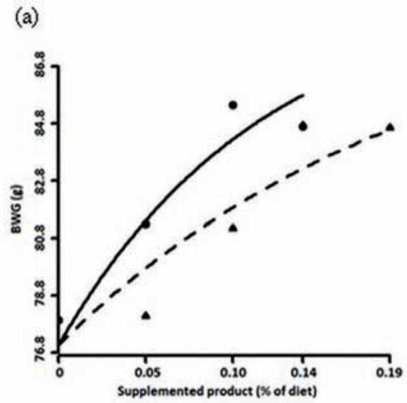
Figure 2. Bioefficacy of H-Met® relative to DL-Met using body weight gain (BWG) (a), feed intake (FI) (b) and feed conversion ratio (FCR) (c) in male Ross 308 broilers (grower period). Zero level indicates control. *Values in parentheses indicate the 95% confidence interval.
DL-Met ● H-Met ▲

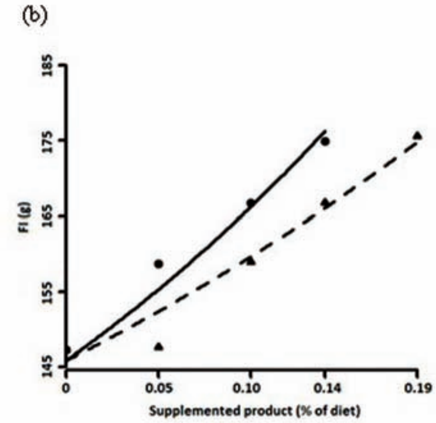
analysis showed that, the broilers fed by DL-Met were able to utilize it more effectively than those fed by H-Met® in growth performance variables (Figure 1 to 3). The bioefficacy of H-Met® relative to DL-Met was 45%, 77%, and 82% based on BWG, FI and FCR, respectively for the starter period (Figure 1); was 55%, 69% and 75% based on BWG, FI and FCR, respectively for the grower period (Figure 2); and was 57%, 71% and 75% based on BWG, FI and FCR, respectively for the finisher period (Figure 3). The overall average of these bioefficacy values is 64% for the starter period, 65% for the grower period, and 66% for the finisher period. Bioefficacy of H-Met® relative to DL-Met is 65% on a product based on the average across all the criteria tested (See Table 7).

Discussion

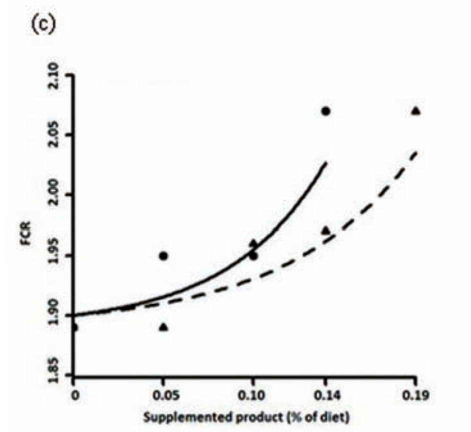
Performance: Met deficiencies depressed the FI of broiler chicks due to amino acid imbalances. It can be assumed that, under amino acid imbalances, chicks lose the potential to adjust FI to satisfy their amino acid requirements (Bunchasak and Keawarun, 2006). The main positive effect of Met supplementation may come from its improvement of FI via the amino acid balance (Bunchasak, 2009). The early growth of young birds is mainly due to the deposition of the body protein. Also, feed intake is an important factor that influences body protein synthesis (Kita et al., 1996 a,b). The body protein synthesis rate of the Tianfu duck decreased as dietary protein intake decreased (Zhou and Qi, 1995).

The outcome of the present study showed that by increasing the level of the Met sources, BWG and FI increased. The result of the growth performance, however, did not confirm the result obtained by Halder and Roy (2007). They reported that there were no significant differences between the utilization of





$Y= 77.08+12.55 \times (1- e^{-(8.48x_1 +4.81x_2)})$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 57% (39-74)*
R^2= 80%



$Y= 145.89-60.37 \times (1- e^{(2.91x_1 +2.06x_2)})$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 71% (65-77)*
R^2= 94%

$Y= 1.90- 0.01 \times (1- e^{(18.70x_1 +14.08x_2)})$
Relative effectiveness:
DL-Met (x_1) = 100%
H-Met (x_2) = 75% (69-82)*
R^2= 82%

Figure 3. Bioefficacy of H-Met® relative to DL-Met using body weight gain (BWG) (a), feed intake (FI) (b) and feed conversion ratio (FCR) (c) in male Ross 308 broilers (finisher period). Zero level indicates control. *Values in parentheses indicate the 95% confidence interval.
DL-Met ● H-Met ▲

H-Met® and using DL-Met at the same level. Contrary to their results, the results of our study showed that there were significant differences ($p<0.05$) between the same levels of either Met sources.

Carcass Characteristic: These results are in accordance with those reported by Meirelles, et al., (2003) and Ribeiro et al., (2005) who claimed that the sources and/or the levels of Met did not affect carcass yield, thigh yield, leg yield, breast and abdominal fat. Also, Attia et al., (2007) and Mandal et al., (2004) reported that the Met sources did not influence the percentage of liver and this is in agreement with the finding in the present study.

Bioefficacy of H-Met® relative to DL-Met: The addition of the Met source can be performed on an equimolar basis or on a product to product (weight to weight) basis. Hoehler et al., (2005b) demonstrated that similar, if not exactly the same, results could be obtained by estimating bioefficacy with either of the comparisons. Accordingly, in this experiment the addition of each Met sources was made on a product to product (weight to weight) basis.

There are some possibilities for lower bioefficacy of H-Met® relative to DL-Met, as Hoehler et al., (2005a) and Payne et al., (2006) explained for comparing DL-Met and MHA-FA. One of the main reasons for lower bioefficacy of H-Met® relative to DL-Met is the poor utilization of the polymeric forms. Another possibility is that the H-Met® removed from the intestinal lumen was slower than DL-Met. This resulted in much exposure to bacterial fermentation. Yet another reason might be that H-Met® absorbs more slowely because of having transporters with lower affinity and less velocity than DL-Met. Additionally, producing considerable by-products during the passage of H-Met® through the small intestine may have affected the bioefficacy.

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سودمندی نسبی متیونین گیاهی در مقایسه با Dl-متیونین بر پایه عملکرد رشد و پاسخ‌های لاشه جوجه‌های گوشتی

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چکیده

زمینه مطالعه: درجه‌ای که مقدار ماده مغذی هضم شده جذب می‌شود و در دسترس بدن قرار می‌گیرد زیست فراهمی نامیده می‌شود. **هدف:** سودمندی نسبی متیونین گیاهی در مقایسه با DL- متیونین در این آزمایش بررسی شد. **روش کار:** آنالیز رگرسیون نمایی برای تخمین زیست فراهمی متیونین گیاهی بر پایه افزایش وزن، خوراک مصرفی و ضریب تبدیل غذایی به کار گرفته شد. DL- متیونین و متیونین گیاهی به ترتیب در ۳ و ۴ سطح به جیره پایه در دوره آغازین، رشد و پایانی اضافه شدند به طوری که نیازهای مواد مغذی و انرژی بجز نیاز متیونین+سیستئین را تامین کردند. **نتایج:** در ۴۲ روزگی آزمایش، رشد جوجه‌های گوشتی، بدون در نظر گرفتن نوع منبع متیونین، نسبت به جوجه‌های تغذیه شده با جیره پایه به طور معنی‌داری افزایش یافت ($p<0/05$). خصوصیات لاشه پاسخ معنی‌داری به سطوح افزودنی متیونین نشان ندادند. **نتیجه‌گیری نهایی:** آنالیز رگرسیون نشان داد که متیونین گیاهی ۵۲٪ (برای افزایش وزن)، ۷۲٪ (برای خوراک مصرفی) و ۷۷٪ (برای ضریب تبدیل غذایی) DL- متیونین سودمندی دارد. متیونین گیاهی می‌تواند به عنوان یک منبع طبیعی از متیونین در صنعت طیور به کار گرفته شود.

واژه‌های کلیدی: متیونین گیاهی، جوجه گوشتی، لاشه، کارایی زیستی

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