Egyptian Poultry Science Journal

http://www.epsaegypt.com

ISSN: 1110-5623 (Print) – 2090-0570 (On line)

EFFECT OF ADDING EXTRA THREONINE WITH VARIOUS METHIONINE SOURCES, AND THEIR INTERACTIONS ON BROILER PERFORMANCE

A.I. El-Faham; Nematallah G.M. Ali and M.A.M. Abdelaziz
Poult. Prod. Dept., Fac. of Agrc., Ain Shams Univ., Egypt

Received: 15/10/2015 Accepted: 01/11/2015

ABSTRACT: One hundred and eighty one-day-old Hubbard broilers chicks were randomly distributed into 6 treatments to examine the effect of adding extra threonine with various methionine sources and their interactions on broiler growth performance and some blood plasma constituents. Six experimental diets of iso-nutritive value and contained three different sources of added methionine [DL- methionine (DL-Met), acid liquid methionine (Ali-Met) and methionine hydroxy-analogue - Calcium salt (Met-HA-Ca)]. Each one of these sources, was combined with one of two levels of threonine (0 or 1 Kg/ ton) in 3 x 2 factorial design trial. Experimental diets were fed until 5 weeks of age.
Results obtained could be summarized as following:

1. Live body weight, daily weight gain, daily feed intake and feed conversion ratio had insignificantly affected by different sources of methionine.
2. Live body weight and daily weight gain were significantly improved when diets was supplemented with extra threonine (1 Kg/ ton).
3. Blood plasma concentrations of total protein, albumin, globulin or albumin/ globulin ratio, were not affected by different dietary treatments.
4. Carcass characteristics parameters (percentage of dressed weight, giblets, ready to cook and abdominal fat) showed insignificant figures when chicks fed different dietary treatments.
5. Best economic efficiency value was demonstrated when chicks fed broiler diets supplemented with Ali-Met + threonine 1 Kg/ ton and the value was 45.55% more when compared to that of chicks fed DL-Met without excess threonine.

Generally, the interaction between dietary methionine source and threonine supplementation for different studied criteria was insignificant. Consequently, it might be advisable to add extra threonine (1 Kg/ ton) in order to economically maintain productive performance of broilers.

Key words: Threonine, Methionine Sources, Broiler, Performance.

Corresponding author: mrwanabdelaziz@agr.asu.edu.eg

INTRODUCTION

In recent years, broiler industry has been focused to obtain faster broiler growth in minimal time (Longo et al., 2007). In order to achieve this improvement, broilers should be fed diets that meet all their nutrient requirements. One of the most important nutritional prerequisites for broiler growth performance is to insure adequate dietary protein levels and an optimum ratio of amino acids that ensures the ideal amino acid profile for the development stages of the chicks (Bregendahl et al., 2002). In general, most protein ingredients supplied to broilers are obtained from vegetable proteins, with oil crops and legumes being their major sources. Plant proteins are inadequate for broiler, not only in terms of quantity but also in terms of quality, i.e.; amino acid composition (Thorpe and Beal, 2001). Broiler diets based on corn soybean meal are generally deficient in amino acid methionine (Meth.) which is the first limiting amino acid followed by amino acid lysine (Schutte and De Jong, 1999). In addition, Saki et al. (2012) reported that hens fed diets supplemented with methionine became more efficient in utilization of available methionine. Moreover, methionine is essential for various vital functions in body such as: protein synthesis, regulation of cell division, cellular and humoral immunity, methyl donation, reduction of reactive oxygen species etc. An important aspect of protein and methionine interrelationship is the ability of both to act as lipotropic agents. In addition, methyl groups are important for numerous cellular functions such as DNA methylation, phosphatidyl-choline synthesis and protein synthesis (Kalbande et al., 2009; Obeid, 2013). In Egypt, the common sources of supplemental methionine used in broiler diets are DL-methionine (DL-Met), methionine hydroxy analogue-free acid, Alimet (Ali-Met) and methionine hydroxy analogue calcium salt (Met-HA-Ca). Several studies had been conducted with broiler chicks to determine the biological efficacy of methionine hydroxy analogues (Ali-Met and Met-HA-Ca) compared to DL-Met (Balnave and Oliva, 1990; Huyghebaert, 1993; Harms and Russel, 1994; Leeson and Summers, 1997, Mohamed et al., 1998; El-Daly and Mohamed, 1999; Daenner and Bessei, 2003). However, there are numerous inconsistent and conflicting findings surrounding the effect of using methionine and its hydroxy analogues on broilers productive performance.

Leeson and Summers (1997) and Mohamed et al. (1998), concluded that the major variable in response to methionine sources is specifications of the type of diet, intact protein or crystalline amino acids. Fayek et al. (1991) showed that the addition of DL-Met or Met-HA-Ca at 0.05 and 0.10% in broiler chick diets gave a progressive increase in chicks body weight gain (BWG) and feed efficiency (FE) and insignificant difference was noticed between the two sources of methionine in BWG and FE. In addition, El-Daly and Mohamed (1999) and Daenner and Bessei (2003) reported that when methionine was the limiting factor in the broiler diets, Ali-Met could be successfully used as methionine supplement as comparable to DL-Met in equimolar equivalent.

On the other hand, there is little available published literature dealing with feeding methionine hydroxy analogue by practical high energy broiler chick diets. In addition threonine may often become limiting amino acid in poultry diets (Fernandez et al., 1994; Kidd and Kerr, 1996; Schutte and De Jong, 1999). Therefore, in case of formulating broiler diets to be adequate in threonine (the third most limiting amino acids), its deficiency may decrease the efficiency of lysine (the second most limiting amino acid) utilization (Kidd, 2000). Threonine is also involved in important metabolic processes, protein synthesis and uric acid formation, besides, its catabolism generates many important products such as glycine, acetyl CO-A and pyruvate (Bender, 1985; Ballevre et al., 1991). Additionally, Dozier et al. (2003) observed that, threonine is not only necessary for essential amino acid balance but also plays a central role in recovery of metabolizable energy. Kidd and Kerr (1997) estimated total threonine requirements for body weight gain, feed conversion ratio and breast meat was found to be about 0.70%, 0.70% and 0.78% of the broiler chick diets, respectively.

The objective of the present work was to measure the biopotency of two different sources of methionine hydroxy analogue [free acid, Alimet (Ali-Met) and calcium salt (Met-HA-Ca)] as compared to DL-methionine (DL-Met) with or without threonine (1 g / kg diet) addition on growth performance, carcass characteristics, some of blood plasma parameters and economic efficiency.

MATERIALS AND METHODS

The current study was conducted at Poultry Experimental Unit, Agricultural Research Station, Faculty of Agriculture, Ain Shams University, in order to investigate growth performance, some blood components, carcass characteristics and economic efficiency of broiler chicken fed all-plant protein diets supplemented with three different sources of methionine (DL-Met, Ali-Met and Met-HA-Ca) with or without threonine (1 g/ Kg diet) addition. Table (1) shows that DL-Met was used at 0.25% level while Ali-Met and Met-HA-Ca were added at 0.29 and 0.30%, respectively. A total number of 180 Hubbard broiler chicks, one-day-old were randomly divided into 6 equal groups, each was subdivided into 3 replicates with 10 chicks each. Chicks were housed in wire-floored battery brooders and reared from 0 to 5 weeks of age, under similar conditions of management. As shown in Table (1), the experimental diets were based on corn-soy and formulated to meet the nutrient requirements of broiler chicks according to NRC (1994). Starter diets were offered from 0 to 3 weeks of age while, grower diets were fed from 4 to 5 weeks of age. The performance parameters included live body weight (LBW) and daily feed intake (DFI) which were determined at the end of both starter (3 weeks of age) and grower (5 weeks of age) periods and then daily weight gain (DWG), feed conversion ratio (FCR)were calculated. Moreover, performance index (PI) was calculated according to North (1981) and production efficiency factor (PEF) according to Emmert (2000). At 5 weeks of age (end of the experiment), three birds from each treatment representing the average body weight of each treatment were slaughtered. After slaughtering and complete bleeding, the birds were scalded and feathers were removed. Carcass were eviscerated then feet, head, neck and shanks were removed and the whole carcass were weighed. Giblets including liver, heart and gizzard as well as abdominal fat percentages were calculated in relation to respective live body weight.

Individual blood samples were collected in dry clean centrifuge tubes from the slaughtered birds and blood plasma was then separated by centrifugation at 3000 (rpm) for about 15 minutes and assigned for subsequent determination. Plasma samples were, stored at (-20° C) in a deep freezer until the time of chemical determination. Values of total protein (Gornall et al., 1949) and albumin (Doumas et al., 1971) were estimated by using commercial diagnosing kits (produced by Bio-diagnostic company, Egypt). Plasma globulin values were obtained by subtracting the values of albumin from the corresponding values of total proteins. Then albumin/ globulin ratio (A/ G ratio) was mathematically calculated. Economic parameters of production including feeding costs (starter and grower diets), selling income and returns per bird were calculated. Economic efficiency was calculated as net return/ total cost according to method described by Bayoumi (1980). Additionally, relative economic efficiency was calculated by assuming that the corresponding value of control group was 100%.

Data were analyzed using two-way analysis of variance with methionine source (M), threonine supplementation (T) and their interaction (T*M) using the General Linear Model Procedure of SAS (2002) as following model:

Yijk = μ + Ti + Mj + (TM) ij + eijk.

Where:

Yijk = Trait measured
μ = Overall mean
Ti = Methionine source
Mj = Threonine supplementation
(TM) ij = Interaction between methionine source and threonine
eijk = Experimental error

When significant differences among means were found, means were separated using Duncan's multiple range tests (Duncan, 1955).

RESULTS AND DISCUSSION

Live body weight and daily weight gain:

The live body weight (LBW) and daily weight gain (DWG) of broiler as affected by dietary treatments are illustrated in Table (2). The obtained data showed that there were no significant differences within LBW or DWG values among methionine sources during the studied period (0-5 wks). Moreover, chicks fed (Met-HA-Ca) supplemented diets reflected the highest LBW and DWG, followed by (Ali-Met), while (DL-Met) group recorded the lowest figures. However, LBW increased by 7.7% (1443.73 vs. 1340.67) compared with that fed (DL-Met) supplemented diets and DWG showed significantly similar trend (39.90 g vs. 36.96 g). Besides, the differences between the two treatments were not significant. Similar observations were reported by other investigators (Fayek et al., 1991; El-Daly and Mohamed, 1999; Daenner and Bessei, 2003). They concluded that LBW and BWG of birds fed (Met-HA-Ca) or (Ali-Met) diets were equal to those fed control (DL-Met) diets.

On the other hand, chicks fed different dietary treatments supplemented with threonine (1 g/ kg) gave significantly higher overall LBW (1448.83 g) compared to those fed diets without threonine, being (1338.72 g), the differences were statistically significant (P≤0.05). In addition, DWG showed similar trend (40.06 vs. 36.89 g), and differences between the two treatments were significant. Similar observations were also reported by other investigators in broilers (Barkley and Wallis, 2001) and in layer hens (Khalifah and Abdalla, 2005). They reported that increasing threonine concentration of the diet improved broiler and layer hens performance.

Feed consumption and feed conversion ratio:

Data in Table (3) indicate that daily feed intake (DFI) per bird (g /day) was insignificantly increased by feeding (Met-HA-Ca) supplemented diets compared with those fed (DL-Met) or (Ali-Met) diets throughout the experimental periods (0-3, 4-5 and 0-5 weeks), and it ranged (23.24 to 24.45 g), (90.40 to 95.40 g) and (63.54 to 67.03), respectively. Differences within DFI values among treatments were not significant. In the same order, birds fed diets supplemented with (Ali-Met) showed the lowest DFI while, birds fed (Met-HA-Ca) had the highest figure. Moreover, dietary supplemented threonine had no significant effect on DFI throughout different experimental periods (0-3, 4-5 and 0-5 weeks of age). The corresponding figures were (25.53 vs. 22.20), (90.44 vs. 93.84) and (64.47 vs. 65.19) g/ day, respectively, without any significant differences.

Feed conversion ratio (FCR) had been insignificantly affected by either source of methionine or by added threonine. In the same order, birds fed (Ali-Met) supplemented diets were more efficient in converting their food into body weight gain compared with those fed (Met-HA-Ca) or (DL-Met) supplemented diets. The corresponding figures during the whole experimental period were 1.65, 1.67 and 1.75, respectively, without significant differences between treatments.

On the other hand, adding extra threonine in broiler diets (1 g / kg) improved the feed conversion ratio throughout the experimental period and the corresponding figures were (1.63 vs. 1.77) during the whole period (0-5 weeks of age), without any significant differences. These results are in harmony with those reported by Balnave and Oliva (1990); Mohamed et al. (1998); Daenner and Bessei (2003), who reported no significant differences between the methionine sources for feed intake, body weight gain and feed conversion ratio in broilers. Barkley and Wallis (2001) also showed that increasing threonine concentration in broiler diets improved growth and feed conversion ratio.

<u>Performance index (PI) and production efficiency factor (PEF):</u>

Insignificant differences were observed in (PI) and (PEF) within experimental treatments during the whole experimental period (Table 4). PI figures ranged between 86.32 and 80.92, while those of PEF, ranged between 246.63 and 231.20. Diets supplemented with Ali-Met or Met-HA-Ca gave higher PI figures, while, chicks fed diet supplemented with DL-Met had lower figure and differences among treatments were insignificant. In the same order, PEF showed the same trend, in which DL-Met supplemented diet reflected lower figure compared with other treatments (Ali-Met or Met-HA-Ca) and the corresponding figures being 231.20, 246.36 and 246.63, respectively and in most cases differences between treatments were insignificant. On the other hand, feeding diets containing (1 g threonine/ kg), broiler chicks gave insignificant higher PI and PEF values as compared to those fed un-supplemented diets. The corresponding values of PI and PEF were (90.57 vs. 78.40) and (258.79 vs. 224.01), respectively without significant differences. Similar observation were reported by other investigators, in broiler chicks (Gadelrab, 2014) and in local Sinai laying hens (El-Moustafa et al., 2015). They concluded that synthetic methionine supplementation of birds diets was more profitable than feeding un-supplemented diets and subsequently improved performance index.

<u>Blood constituents:</u>

Effects of different dietary treatments on blood total protein, albumin, globulin and albumin/ globulin (A/ G) ratio, are shown in Table (5). Results showed that experimental treatments had no significant ($P > 0.05$) effect on blood parameters at 35 days of age. Numerically, group fed (Ali-Met) with extra threonine (1 g/ kg) had the highest total protein value compared to other treatments, which reflects improved growth performance. Concerning albumin values, birds fed (Ali-Met) without or with threonine (1 g/ kg), recorded higher values when compared with other groups. Birds fed (Ali-Met) without threonine or (Met-HA-Ca) without or with threonine (1 g/ kg), recorded lower globulin values when compared with other groups, which might imply that these dietary treatments reduced birds' immunity which was noticed on performance of birds. These results were in partial agreement with those of Lu et al. (2003).

On the other hand, lower value of (A/ G) ratio was recorded with birds fed (DL-Met) without threonine, while higher value was recorded with those fed (Met-HA-Ca) with threonine (1 g/ kg). Results of (A/ G) ratio revealed that feeding birds with (DL-Met) without threonine, had improved immunity of birds compared to other groups.

Carcass characteristics:

Data in Table (6) shows the effect of different sources of methionine with or without threonine supplementation to broiler diets on carcass characteristics at the end of 5th weeks of age. No significant differences were observed by feeding different dietary treatments in all carcass characteristics (expressed as percentage of live body weight). The corresponding values for dressing percentages ranged between 63.68 and 65.94%, while ready to cook (Hot carcass weight + giblets) percentages ranged between 69.49 and 71.59% and abdominal fat ranged between 1.07 and 1.30%. These findings are in agreement with those reported by other investigators (Mukhtar et al., 2010; Goulart et al., 2011; Gadelrab, 2014). They concluded that, adding methionine and lysine in broiler diets were insignificantly effective on carcass and total edible parts percentages among all treatments. Additionally, El-Daly and Mohamed (1999) showed that source of supplemental methionine did not affect liver or bursa weights recorded as absolute or percentage of live body weight.

Interaction between methionine sources and threonine supplementation:

In most cases, the interaction between dietary methionine sources (M) and threonine (1 g /kg) supplementation (M x T) for studied criteria, were insignificant (Tables 2, 3, 4, 5 and 6).

Economic evaluation:

Data for economic evaluation are summarized in Table (7). Results of economic efficiency (EE) and relative economic efficiency (REE) estimated for experimental diets are based on recent local market prices for feed ingredients and selling price of live broilers. Chicks fed diets supplemented with (Ali-Met + threonine) had the best economic and relative efficiency values being 78.54 and 145.55%, respectively, this may be due to the highest body weight. Whereas, chicks fed diet supplemented with (DL-Met without threonine) had the lowest corresponding values, being 53.96 and 100%, respectively. On the other hand, using (Ali-Met) (T2) or (Met-HA-Ca) (T3) or different source of methionine + threonine (T4: T6) increased net return, EE and REE of broiler chicks compared with those fed diets supplemented with (DL-Met) (T1) and the corresponding increment values in REE were 2.67, 30.80, 44.28, 45.55 and 29.99, respectively. Similar observations were reported by Onu et al. (2010), Shahzad et al., (2011) and Gadelrab (2014). They reported higher economic efficiency when extra methionine and lysine were used in broiler diets.

CONCLUSION

Finally, after reviewing all these results, it might be advisory to add extra threonine (1 Kg/ ton) in order to economically maintain productive performance of broilers.

Table (1): Feed ingredients and chemical analyses of experimental diets:

Ingredients	Dietary Treatments - Starter (0-14 days)					
	Without Threonine			With Threonine 1 g/ Kg		
	1	2	3	4	5	6
Yellow Corn	56.04	56.00	56.00	55.94	55.90	55.90
Soybean Meal 44%	28.82	28.82	28.81	28.82	28.82	28.81
Corn Gluten Meal 60%	8.97	8.97	8.97	8.97	8.97	8.97
Vegetable Oil	1.50	1.50	1.50	1.50	1.50	1.50
Ca Carbonate	1.59	1.59	1.59	1.59	1.59	1.59
Mono-Calcium Phosphate	1.84	1.84	1.84	1.84	1.84	1.84
L- Lysine HCl	0.39	0.39	0.39	0.39	0.39	0.39
DL-Met	0.25	-	-	0.25	-	-
Ali-Met	-	0.29	-	-	0.29	-
Met-HA-Ca	-	-	0.30	-	-	0.30
L-Threonine	-	-	-	0.10	0.10	0.10
Salt (NaCl) + Premix#	0.60	0.60	0.60	0.60	0.60	0.60
Total	100	100	100	100	100	100
Chemical Analysis (Calculated)						
Crude Protein %	23.01	23.00	23.00	23.01	23.00	23.00
ME Kcal/ Kg diet	3002	3000	3000	3002	3000	3000
Calcium %	1.00	1.00	1.00	1.00	1.00	1.00
Available Phosphorus %	0.50	0.50	0.50	0.50	0.50	0.50
Lysine %	1.40	1.40	1.40	1.40	1.40	1.40
Methionine & Cysteine %	1.05	1.06	1.06	1.05	1.06	1.06
Threonine %	0.84	0.84	0.84	0.94	0.94	0.94
	Dietary Treatments - Grower (15 - 35 days)					
Yellow Corn	59.93	59.90	59.90	59.83	59.80	59.80
Soybean Meal 44%	26.38	26.37	26.36	26.38	26.37	26.36
Corn Gluten Meal 60%	6.94	6.94	6.94	6.94	6.94	6.94
Vegetable Oil	2.50	2.50	2.50	2.50	2.50	2.50
Ca Carbonate	1.45	1.45	1.45	1.45	1.45	1.45
Mono-Calcium Phosphate	1.63	1.63	1.63	1.63	1.63	1.63
Lysine HCl	0.32	0.32	0.32	0.32	0.32	0.32
DL-Met	0.25	-	-	0.25	-	-
Ali-Met	-	0.29	-	-	0.29	-
Met-HA-Ca	-	-	0.30	-	-	0.30
L-Threonine	-	-	-	0.10	0.10	0.10
Salt (NaCl) + Premix#	0.60	0.60	0.60	0.60	0.60	0.60
Total	100	100	100	100	100	100
Chemical Analysis (Calculated)						
Crude Protein %	21.00	21.00	20.99	21.00	21.00	20.99
ME Kcal/ Kg diet	3101	3100	3099	3101	3100	3045
Calcium %	0.90	0.90	0.90	0.90	0.90	0.90
Available Phosphorus %	0.45	0.45	0.45	0.45	0.45	0.45
Lysine %	1.26	1.26	1.26	1.26	1.26	1.26
Methionine & Cysteine %	0.98	0.99	0.99	0.98	0.99	0.99
Threonine %	0.77	0.77	0.77	0.87	0.87	0.87

DL-Met: DL methionine, Ali-Met: Acid liquid methionine, Met-HA-Ca: methionine hydroxy-analogue calcium salt.

#Each 3 Kg of premix contains: Vitamins: A: 12000000 IU; Vit. D3 2000000 IU; E: 10000 mg; K3: 2000 mg; B1:1000 mg; B2: 5000 mg; B6:1500 mg; B12: 10 mg; Biotin: 50 mg; Coline chloride: 250000 mg; Pantothenic acid: 10000 mg; Nicotinic acid: 30000 mg; Folic acid: 1000 mg; Minerals: Mn: 60000 mg; Zn: 50000 mg; Fe: 30000 mg; Cu: 10000 mg; I: 1000 mg; Se: 100 mg and Co: 100 mg.

Table (2): Effect of dietary treatments on live body weight (LBW) and daily weight gain (DWG).

Items	Threonine 1 g/ Kg (T)	Dietary Methionine Source (M)			Overall
		DL-Met	Ali-Met	Met-HA Ca	
LBW (at 3 weeks)	Without	511.50±18.77	485.81±37.96	531.81±6.74	509.71
	With	482.68±19.98	516.50±33.61	480.38±15.07	493.19
	Overall	497.09	501.16	506.10	
LBW (at 5 weeks)	Without	1268.63±48.38	1262.25±35.06	1485.29±90.20	1338.72[b]
	With	1412.71±40.85	1531.63±73.24	1402.17±48.58	1448.83[a]
	Overall	1340.67	1396.94	1443.73	
DWG (0-3 weeks)	Without	15.98±1.42	14.71±0.98	16.38±0.39	15.69
	With	14.00±0.70	14.34±0.82	14.67±0.61	14.37
	Overall	14.99	14.52	15.52	
DWG (4-5 weeks)	Without	47.50±2.37	48.07±1.59	57.51±4.89	51.03[b]
	With	55.71±2.37	61.16±3.39	54.78±2.46	57.22[a]
	Overall	51.61	54.61	56.15	
DWG (0-5 weeks)	Without	34.89±1.37	34.72±0.99	41.06±3.07	36.89[b]
	With	39.02±1.18	42.43±2.09	38.74±1.39	40.06[a]
	Overall	36.96	38.58	39.90	

Probability

Trait	T	M	T*M
LBW (at 3 weeks)	NS	NS	NS
LBW (at 5 weeks)	0.05	NS	NS
BWG (0-3 weeks)	NS	NS	NS
BWG (4-5 weeks)	0.02	NS	NS
BWG (0-5 weeks)	0.05	NS	NS

Means within the same row or column with different superscripts are significantly different. NS = Non Significant

Table (3): Effect of dietary treatments on daily feed intake (DFI) and feed conversion ratio (FCR).

Items	Threonine 1 g/ Kg (T)	Dietary Methionine Source (M)			Overall
		DL-Met	ALi-Met	Met-HA Ca	
DFI (0-3 weeks)	Without	25.46±2.05	24.50±1.65	26.63±2.07	25.53
	With	22.33±1.59	21.98±0.44	22.28±1.52	22.20
	Overall	23.90	23.24	24.45	
DFI (4-5 weeks)	Without	92.20±7.95	80.82±7.69	98.29±6.45	90.44
	With	89.04±10.40	99.97±10.88	92.52±5.49	93.84
	Overall	90.62	90.40	95.40	
DFI (0-5 weeks)	Without	65.50±4.21	58.29±4.81	69.62±3.73	64.47
	With	62.36±6.16	68.78±6.54	64.43±2.79	65.19
	Overall	63.94	63.54	67.03	
FCR (0-3 weeks)	Without	1.60±0.07	1.66±0.05	1.62±0.11	1.62
	With	1.59±0.05	1.54±0.07	1.52±0.11	1.55
	Overall	1.59	1.61	1.58	
FCR (4-5 weeks)	Without	1.97±0.25	1.70±0.21	1.73±0.12	1.80
	With	1.61±0.19	1.62±0.08	1.68±0.07	1.64
	Overall	1.79	1.66	1.71	
FCR (0-5 weeks)	Without	1.90±0.18	1.69±0.17	1.71±0.08	1.77
	With	1.60±0.17	1.61±0.07	1.66±0.04	1.63
	Overall	1.75	1.65	1.67	

Probability

Trait	T	M	T*M
DFI (0-3 weeks)	NS	NS	NS
DFI (4-5 weeks)	NS	NS	NS
DFI (0-5 weeks)	NS	NS	NS
FCR (0-3 weeks)	NS	NS	NS
FCR (4-5 weeks)	NS	NS	NS
FCR (0-5 weeks)	NS	NS	NS

Means within the same row or column with different superscripts are significantly different.
NS = Non Significant

Table (4): Effect of treatments on PI and PEF.

Items	Threonine 1 g/ Kg (T)	Dietary Methionine Source (M)			Overall
		DL-Met	ALi-Met	Met-HA Ca	
Performance index[1]	Without	69.74±1.81	77.31±1.55	88.14±1.22	78.40
	With	92.09±1.43	95.13±1.43	84.49±1.79	90.57
	Overall	80.92	86.22	86.32	
Production efficiency factor[2]	Without	199.26±8.05	220.88±4.43	251.84±6.34	224.01
	With	263.12±8.37	271.83±4.09	241.41±6.85	258.79
	Overall	231.20	246.36	246.63	

Probability			
Trait	T	M	T*M
PI [1]	NS	NS	NS
PEF [2]	NS	NS	NS

Means within the same row or column with different superscripts are significantly different. NS = Non Significant. Sig. = Significance, * ($P \leq 0.05$), NS = Non Significant. 1: North (1981), 2: Emmert (2000)

Table (5): Effect of dietary treatments on blood plasma parameters.

Items	Threonine 1 g/ Kg (T)	Dietary Methionine Source (M)			Overall
		DL-Met	Ali-Met	Met-HA Ca	
Total protein mg/dl	Without	3.38±0.67	3.41±0.31	3.28±0.99	3.36
	With	3.62±0.91	4.46±0.88	3.05±0.86	3.71
	Overall	3.50	3.93	3.16	
Albumin mg/dl	Without	1.34±0.22	1.57±0.32	1.47±0.30	1.46
	With	1.52±0.07	1.55±0.11	1.35±0.21	1.49
	Overall	1.44	1.56	1.42	
Globulin mg/dl	Without	2.04±0.54	1.83±0.54	1.81±0.83	1.89
	With	2.09±0.97	2.91±0.94	1.70±1.04	2.23
	Overall	2.07	2.38	1.75	
Albumin / Globulin ratio	Without	0.86±0.35	1.19±0.41	1.89±1.01	1.32
	With	2.02±1.20	1.19±0.76	4.22±2.89	2.48
	Overall	1.45	1.19	3.06	

Probability			
Trait	T	M	T*M
Total protein	NS	NS	NS
Albumin	NS	NS	NS
Globulin	NS	NS	NS
A / G ratio	NS	NS	NS

Means within the same row or column with different superscripts are significantly different. NS = Non Significant

Table (6): Effect of dietary treatments on carcass traits.

Items	Threonine 1 g/ Kg (T)	Dietary Methionine Source (M)			Overall
		DL-Met	ALi-Met	Met-HA Ca	
Dressing %	Without	62.67±0.75	64.09±0.52	65.86±1.13	64.21
	With	64.70±1.40	66.67±0.35	66.02±1.65	65.79
	Overall	63.68	65.38	65.94	
Abdominal Fat %	Without	1.06±0.20	1.25±0.28	1.30±0.42	1.20
	With	1.09±0.16	0.89±0.17	1.30±0.36	1.09
	Overall	1.08	1.07	1.30	
Liver %	Without	3.01±0.39	3.08±0.19	2.54±0.23	2.88
	With	3.05±0.33	2.30±0.13	3.08±0.33	2.81
	Overall	3.03	2.69	2.81	
Gizzard %	Without	2.14±0.17	2.27±0.13	2.45±0.46	2.29
	With	2.29±0.16	2.01±0.17	2.13±0.13	2.14
	Overall	2.22	2.14	2.29	
Heart %	Without	0.59±0.04	0.73±0.08	0.49±0.09	0.60
	With	0.52±0.08	0.59±0.04	0.58±0.09	0.56
	Overall	0.55	0.66	0.54	
Giblets %*	Without	5.75±0.51	6.09±0.21	5.50±0.27	5.78
	With	5.86±0.39	4.89±0.30	5.80±0.41	5.52
	Overall	5.81	5.49	5.65	
Ready to Cook %#	Without	68.43±0.75	70.18±0.32	71.36±1.18	69.99
	With	70.56±1.37	71.57±0.51	71.82±1.24	71.32
	Overall	69.49	70.88	71.59	

Probability

Trait	T	M	T*M
Dressing %	NS	NS	NS
A Fat %	NS	NS	NS
Liver %	NS	NS	NS
Gizzard %	NS	NS	NS
Heart %	NS	NS	NS
Giblets %*	NS	NS	NS
RTC %#	NS	NS	NS

Means within the same row or column with different superscripts are significantly different. NS = Non Significant. * Giblets = Liver + Gizzard + Heart, # Ready to Cook = (Carcass weight + Giblets weight)

Table (7): Effect of dietary treatments on economic traits.

Items	Dietary Treatments					
	Without Threonine			With Threonine		
	1	2	3	4	5	6
Average feed consumption (Kg)	2.29 ±0.14	2.04 ±0.16	2.43 ±0.13	2.18 ±0.21	2.40 ±0.22	2.25 ±0.09
Total cost (LE)	12.06 ±0.50	11.20 ±0.59	12.59 ±0.45	11.69 ±0.75	12.48 ±0.80	11.95 ±0.33
Feed cost (LE)	8.06 ±0.50	7.20 ±0.59	8.59 ±0.45	7.69 ±0.75	8.48 ±0.80	7.95 ±0.34
Live body weight (Kg)	1.27 ±0.04	1.26 ±0.03	1.48 ±0.10	1.41 ±0.04	1.53 ±0.07	1.40 ±0.04
Total return# (LE)	18.39 ±0.70	18.30 ±0.50	21.53 ±1.55	20.48 ±0.59	22.20 ±1.06	20.33 ±0.70
Net return (LE)	6.32 ±1.17	7.10 ±1.01	8.94 ±1.21	8.79 ±1.10	9.72 ±0.28	8.38 ±0.48
Economic efficiency	53.96 ±2.25	65.11 ±1.14	70.58 ±1.39	77.85 ±1.86	78.54 ±3.29	70.14 ±3.53
Relative economic efficiency %	100.00	120.67	130.80	144.28	145.55	129.99
Mean economic efficiency %	117.15 (100 %)			139.94 (119 %)		

According to the local price of Kg LBW which was 13.00 L.E.

REFERENCES

Ballevre, O.; M.L. Houlier; J. Prugnaud; G. Bayle; D. Bercovici; B. Seve and M. Arnal (1991). Altered partition of threonine metabolism in pigs and protein-free feeding or starvation. Am. J. Physiol. Endocrinol. Metab., 261: 748-757.

Balnave, D. and A. Oliva (1990). Responses of finishing broilers at high temperatures to dietary methionine source and supplementation levels. Aust. J. Agric. Res., 415: 557-564.

Barkley, G.R. and I.R. Wallis (2001). Threonine requirement of broiler chickens: an experimental validation of a model using growth responses and carcass analysis. Br. Poult. Sci., 42: 616-624.

Bayoumi, S.B. (1980). Effect of different ration on egg production of breeding hens. M.Sc. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta University.

Bender, D.A. (1985). Amino Acid Metabolism 2nd Edition. John Wiley & Sons. Chickester, England.

Bregendahl, K.; J.L. Sell and D.R. Zimmerman (2002). Effect of low-protein diets on growth performance and body composition of broiler chicks. Poult. Sci., 81: 1156-1167.

Daenner, E. and W. Bessei (2003). Influence of supplementation with liquid DL-methionine hydroxy analogue - free acid (Alimet) or DL-Methionine on performance of broilers. J. Appl. Poult. Res., 12: 101-105.

Doumas, B.T.; W.A. Watson and H.G. Biggs (1971). Albumin standards and the measurement of serum albumin with bromocresol green. Clin. Chem. Acta., 31 (1): 87-96.

Dozier, W.A. III; E.T. Moran Jr and M.T. Kidd (2003). Broiler chick utilization of threonine from fermentation by-product broth. J. Appl. Poult. Res., 12: 299-305.

Duncan, D.B. (1955). Multiple ranges and multiple F test. Biometrics 11: 142.

El-Daly E.F. and M.A. Mohamed (1999). Effect of supplemental methionine source on performance and some physiological traits of broiler chicks. Egypt. Poult. Sci., 19: 591-606.

El-Moustafa K.E.M.; M.M. Beshara; M.A.A. Hussein; M.G. Hasim and A.A.A. Rehan (2015). Nutritional requirements of methionine and total sulfur amino acids local Sinai laying hens during period from 42 to 58 weeks of age. Egypt. Poult. Sci., 35: 423-438.

Emmert, J. (2000). Efficiency of phase feeding in broilers. Proceeding, California Animal Nutrition Conference. Fresno California, USA.

Fayek, H.M.; Y.A. Mady and T.M. Younis (1991). Biopotency of methionine hydroxy analogue - calcium salt estimated by slope - ratio chick assay. Egypt. Poult. Sci., 11: 129-143.

Fernandez, S.R.; S. Aoyagl; Y. Han; C.M. Parsons and D.H. Baker (1994). Limiting order of amino acids in corn and soybean meal for growth of the chick. Poult. Sci., 73: 1887-1896.

Gadelrab, S.S. (2014). Response of broiler chickens to varying amino acids feeding programs. Ph.D. Thesis, Faculty of Agric. Ain Shams Univ., Egypt.

Gornall, A.G.; C.J. Bardawill and M.M. David (1949). Determination of serum proteins by means of Biuret reaction. J. Biol. Chem., 177 (2): 751-766.

Goulart, C.C.; G.P.C. Fernando; J.V.S. Humberto; G.S. Janete; P.R. Valeria and C.F.S. Olivera (2011). Requirements of digestible methionine + cystein for broiler chickens at 1 to 42 days of age. R. Bras. Zootec., 40 (4): 797-803.

Harms, R.H. and G.B. Russell (1994). A comparison of the bioavailability of DL-methionine hydroxy analogue acid for the commercial laying hen. J. App. Poult. Res., 3: 1-6.

Huyghebaert, G. (1993). Comparison of DL-methionine and methionine hydroxy analogue-free acid in broilers by using multi-exponential regression models. Br. Poult. Sci., 34: 351-359.

Kalbande, V.H.; K. Ravikanth; S. Maini and D.S. Rekhe (2009). Methionine supplementation options in poultry. Intl. J. Poult. Sci., 8: 588-591.

Khalifa, M.M. and A.A. Abdalla (2005). Effect of graded levels of threonine on gimmizah layer hens performance. Egypt. Poult. Sci., 25: 187-194.

Kidd, M.T. (2000). Nutritional considerations concerning threonine in broilers. World's Poult. Sci. J., 56: 139-151.

Kidd, M.T. and B.J. Kerr (1996). L-threonine for Poultry: A review. J. Appl. Poult. Res., 5: 358-367.

Kidd, M.T. and B.J. Kerr (1997). Threonine responses in commercial broilers at 30 to 42 days. J. Appl. Poult. Res., 6: 362-367.

Leeson, S. and J.D. Summers (1997). In: "Commercial Poultry Nutrition" 2nd Ed. Published by University Books, Guelph, Ontario, Canada.

Longo, F.A.; J.F.M. Menten; A.A. Pedroso; A.N. Figueiredo; A.M.C. Racanicci and J.O.B. Sorfara (2007). Performance and carcass composition of broilers fed different carbohydrate and protein sources in the prestarter phase. J. Appl. Poult. Res., 16: 171-177.

Lu, J.J.; C.W. Huang and R.G.R. Chou (2003). The effects of DL-methionine and DL-methionine hydroxy analogue on growth performance, contents of serum amino acids and activities of digestive proteases in broilers. Asian-Aust. J. Anim. Sci., 16 (5): 714-718.

Mohamed, M.A.; A.S. Hamza and Y.A.F. Hammouda (1998). Biopotency of methionine hydroxy analogue calcium versus DL-methionine. Egypt. J. Poult. Sci., 18: 33-45.

Mukhtar, M.A.; A. Makkawi and M. Tigani (2010). Effect of amino acids supplementation to marginally deficient local broiler chick diets. J. Sci. Tech., 11 (2): 23-26.

NRC, National Research Council (1994). Composition of poultry feed stuffs. Nat Acad. Sci. Washington, D.C.

North, M.O. (1981). Commercial chicken. Production Annual, 2nd Edition, Av., Publishing Company I.N.C., West Post. Connecticut, USA.

Obeid, R. (2013). The metabolic burden of methyl donor deficiency with focus on the Betaine homocysteine Methyltransferase pathway. Nutrients, 5 (9): 3481-3495.

Onu, P.N.; M.C.A. Enwerm and E.O. Ahaotu (2010). Evaluation of carcass characteristics and cost effectiveness of broiler chicks fed synthetic lysine and methionine supplemented soybean-based diets. Intl. J. Sci. Nat. 1: 22-26.

Saki, A.A.; H.R. Naseri; M.M. Tabatabaei; P. Zamani and M. Haghight (2012). Estimates of methionine and sulfur amino acid requirements for laying hens using different models. Brazil. J. Poult. Sci., 14 (3): 209-216.

SAS (2002). SAS/ STAT User, S Guide: Statistics. Ver. 8.2, SAS Institute Inc., Cary. NC.

Schutte, J.B. and J. De Jong (1999). Ideal amino acid profile for poultry. 259-263 pp. In: Brufau J. and Tacon A. (eds). CIHEAM. Feed Manufacturing in the Mediterranean Region. Recent advances in Research and technology.

Shahzad, A.K.; U. Nisar; A. Gulzar; I.R. Muhammad; S.A. Fazlani; F. Shahid; S. Ahmed and A. Muhammad (2011). Effect of low protein diet supplemented with or without amino acids on the production of broiler. African J. Biotechnol., 49: 10058-10065.

Thorpe, J. and J.D. Beal (2001). Vegetable protein meals and the effects of enzymes, in Bedford, M.R & Partridge, G.G. (Ed.) Enzyme in Farm Animal Nutrition, P.P. 125-143 (CABI Publishing, Wallingford, Oxford, UK).

الملخص العربى

تأثير إضافة زيادة من الثيريونين مع المصادر المختلفة من الميثيونين والتداخل بينهما على الآداء الإنتاجى لبدارى التسمين

أحمد إبراهيم سليمان الفحام؛ نعمة الله جمال الدين على و مروان عبدالعزيز محمود عبدالعزيز
قسم إنتاج الدواجن - كلية الزراعة - جامعة عين شمس - شبرا الخيمة - القاهرة - مصر.

أجريت تجربة بإستخدام ١٨٠ كتكوت عمر يوم من صنف Hubbard وزعت عشوائيا على ٦ معاملات غذائية لدراسة تأثير إضافة الثيريونين مع مصادر مختلفة من الميثيونين والتداخل بينهما على الآداء الإنتاجى وبعض مكونات بلازما الدم لبدارى التسمين. إحتوت العلائق التجريبية على ٣ مصادر من الميثايونين المضاف [د - ل ميثيونين (DL-Met)، ميثيونين سائل حامضى (Ali-Met) و ميثيونين هيدروكسى أنالوج - كالسيومى (Met-HA Ca)]. أستخدم كل مصدر من هذ المصادر الثلاث فى وجود واحد من مستويين من الثيريونين (صفر أو ١ كجم/ طن) فى تجربة عاملية (٣ x ٢). غذيت العلائق التجريبية حتى ٥ أسابيع من العمر.

ويمكن تلخيص أهم النتائج المتحصل عليها كما يلى:

١. لم يتأثر وزن الجسم الحى ، وزن الجسم المكتسب اليومى، إستهلاك العلف أو معامل التحويل الغذائى بإستخدام المصادر المختلفة من الميثايونين.

٢. تحسن وزن الجسم الحى و وزن الجسم المكتسب اليومى معنويا بإضافة الثيريونين بمعدل ١ كجم/ طن.

٣. لم تتأثر تركيزات بلازما الدم من البروتين الكلى، الألبيومين، الجلوبيولين أو نسبة ألبيومين/ جلوبيولين معنويا بالمعاملات الغذائية المختلفة.

٤. لم تتأثر صفات الذبيحة (النسبة المئوية للذبيحة، الحوائج، الأجزاء الكلية المأكولة و دهن البطن) بالمعاملات الغذائية المختلفة.

٥. أوضح التقييم الإقتصادى للمعاملات الغذائية أن أفضل قيمة إقتصادية لوحظت عند إستخدام (Ali-Met) مع ١ كجم/ طن ثيريونين حيث تفوقت تلك المجموعة بمعدل ٤٥,٥٥ % بالمقارنة بتلك المغذاة على عليقة (DL-Met) بدون إضافة ثيريونين.

بصفة عامة، فإن التداخل بين مصدر الميثايونين وإضافة الثيريونين لم يتأثر معنويا فى معظم الصفات والقياسات المدروسة للمعاملات التجريبية المختلفة. وبالتالى فإنه ينصح بإستخدام زيادة من الثريونين المضاف (١ كجم/ طن) بهدف الحفاظ على الآداء الإنتاجى لطيور التسمين بطريقة إقتصادية.