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IMPROVE THE UTILIZATION OF BROILER LOW PROTEIN DIETS USING THREONINE, CITRIC ACID AND SULPHATE

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ABSTRACT: This study aims to examine the ability of threonine (TH), citric acid (CA), sodium sulphate (SS) or their mixture to improve the utilization of broiler low protein diets. A total number of 240 Cobb broilers 10 day old were randomly distributed into eight groups received control diet containing Cobb nutritional requirements, diet containing 2 percentage lower crude protein than control diet without the adequate requirement of threonine compare to threonine cobb requirement(LTH), diet contain 2 percentage lower crude protein than control diet with synthetic threonine equal to control group and cobb requirement(LP), LP +0.3 % citric acid (CA), LP +0.3% Anhydrous sodium sulphate (SS) , LP+0.3% CA + 0.3 % SS, LP+ 0.05% threonine (TH) and LP +0.05% TH + 0.3% CA + 0.3 % SS. The result obtained showed that, at 21 day, using LP diet significantly decreased broiler body weight compared to control diet while all feed additives improved weight gain and feed conversion compared to LP. The birds fed mixture of TH+CA+SS recorded the highest value of body weight and the best feed conversion. At 35 day, the birds fed mixture of TH+CA+SS recorded significantly higher body weight value and lower feed conversion by 5.62, 7.83 %, respectively, compared to those fed control diet while the carcass values recorded by different treatments did not differ significantly. Compared to other treatments, birds fed mixture of TH+CA+SS recorded the highest values of total protein, albumin and total cholesterol in blood analysis. We can conclude that addition of TH, CA or SS to LP diet improved the broiler performance as well as those fed control diet while addition of mixture of TH+CA+SS surpassed the control diet performance and recorded the highest value of economic efficiency .

Keywords: broiler- low protein- threonine- citric acid -sulphate

INTRODUCTION

There is considerable interest in the successful development of low protein diets for broiler chickens, which contain high inclusions of synthetic amino acids. Limiting CP consumption and adding synthetic amino acids can improve the efficiency of dietary protein utilization of broiler chickens (Attia and Hassan, 2017). Feeding reduced-protein diets to poultry is an environmentally friendly practice to prevent environmental pollution with nitrogen (Khajali *et al.*, 2008).

All cells of the vertebrate animals depend on a functional antioxidant capacity to provide protection against the harmful effects of free radicals and reactive oxygen species that are the inevitable consequences of aerobic life (Halliwell, 1999). Major tissue antioxidants, especially thiols, vitamins C and E have been identified as natural antioxidants that act in biological systems. But some clinical trials have identified that, application of vitamins as antioxidants may cause adverse effects where they act as pro-oxidants in some cases (Seo *et al*., 2002). On the other hand, the maximum level of synthetic antioxidants that can be used in animal feeds is legislatively restricted due to their potential toxic effects. For example, the US Food and Drug Administration established a maximum inclusion level of 150 ppm for ethoxyquin, 200 ppm for both butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) in animal feeds. Similar regulatory standards have also been adopted by many other countries (Salami *et al.*, 2015). Abd El-Hakim *et al.* (2009) have been used *Curcuma longa* plus thyme as natural antioxidants in broiler diet to decrease the damage of protein by free radical and decrease the loss of protein in feces. They obtained significantly increasing in nitrogen retention by 13.25% compared to control diet(18% crude protein). Grune *et al.* (1997) showed that the degradation of proteins is an essential part of the overall antioxidant defenses against free radical attack. Sharifi *et al.* (2016) reported that chicks fed low protein diet recorded higher serum malondialdehyde and creation of reactive oxygen species in comparison to others fed recommended protein diet, moreover adding antioxidants to the former diet recovered the antioxidative role of uric acid. Theoretically using antioxidants protect and save protein from degradation by free radical (Ali *et al*,. 2011). Threonine is the third most limiting amino acid, especially in a low crude protein diet (Rezaeipour *et al*., 2012). Threonine participates in protein synthesis and its catabolism generates many products important in metabolism. Threonine serves as a component of body protein and a precursor of glycine and serine, is involved in immune responses (Lemme, 2003). Threonine is a major component of intestinal mucin and plasma alfa-globulin in animals (Kim *et al.* 2007). Also, immune system is sensitive to dietary threonine intake (Li *et al.* 1999b). Azzam *et al*. 2012 found with laying hens that, L-threonine supplementation improved hen performance and indicated that threonine may have an antioxidant function under hot climate conditions. Threonine chelated with iron and copper ions in vitro biochemical assays (Grenouillet *et al*. 1973; Reddy and Mahoney 1995). Huang *et al.* (1999) reported that free transition metal ions (without protein chelation), such as iron, copper and manganese, could induce the formation of hydroxyl radicals via the Fenton-Haber Weiss reaction in biological systems. Ali *et al*. (2012) indicated that SS increased the activity of hydrophobic antioxidants and/ or protected it from free radical attach during circulation in the blood. CA is the most common organic acid used in poultry diets. It acts as a growth promoter through acidifying the gastrointestinal (GI) content. In addition, CA also improves the solubility of the feed ingredients, digestion and absorption of nutrients by modifying intestinal pH, (Centeno *et al*., 2007). Ali *et al*. (2011) found that addition of CA, SS and cumin (as nature antioxidant) to low protein low energy diet improved weight gain, feed conversion and nitrogen retention by 7.21, 6.16 and 16.69%, respectively. They indicated that those feed additives may save the protein by protecting it from free radical**.** This study examines the ability of TH (as a new antioxidant material), CA, SS or their mixture to improve broiler low protein diets**.**

MATERIALS AND METHODS

The animal experiment of the present study was carried out at Gezeret El-Sheir Station, El-Kanater El-Khyria, Qaliobia Governorate, Egypt. While, the laboratory work was done at Poultry Nutrition Department, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. A total number of 240 of 10 day old Cobb broiler chicks in average weight about 212.83 g were randomly distributed into eight groups, each group contain 3 replicates (10 chicks in each replicate). Diets and water were fed *ad-libitum* and chicks were kept under the same management hygienic and environmental conditions during the experimental period up to 35 days. Artificial lighting was provided 24 h daily during the whole experimental period. The control diets were supplied with required nutrients to satisfy the recommended requirement of Cobb broilers (Table 1). Chicks were allocated on the following dietary treatments:

1. The control diet containing Cobb nutritional requirements (Control).
2. The Low protein diets contain 2 percentage lower crude protein than control diet without the requirement of threonine which was a lower content of threonine than cobb requirement (LTH).
3. The Low protein diet contain 2 percentage lower crude protein than control diet with synthetic threonine like control group (LP) equal to threonine cobb requirement (Table 1).
4. The LP + 0.3 % citric acid (CA).
5. The LP + 0.3 % $NaSO_4$ (SS).
6. The LP + 0.3 % CA + 0.3% SS.
7. The LP + 0.05% threonine as a new antioxidant material(TH).
8. The LP + 0.05% TH + 0.3 % CA + 0.3 % SS.

The citric acid (CA) was supplied from Egyptian Company for Laboratory Services, Cairo, Egypt and Sodium Sulphate (SS) from the Egyptian Salt and Mineral Company. Body weight (BW) and feed intake (FI) were recorded weekly, while weight gain (WG) and feed conversion ratio (FCR) were calculated for the same periods. At the end of the experimental period three birds were chosen randomly from each treatment and slaughtered. Individual blood samples were collected into heparinized tubes and centrifuged on 3000 rpm for 20 minutes to obtain plasma samples. The clear plasma samples stored at -20^{o}C. The suitable commercial kits were used to determine total protein, albumin, total cholesterol, phosphorus and creatinine, while globulin and A/G ratio values were calculated. The slaughtered birds were used to record weights of the edible organs including heart, empty gizzard and liver. Values of Carcass and organs weights were calculated as percentage from live body weight. The economical and the relative economical efficiency (REE) were calculated in relation to local market prices at time of the experiment. Data were analyzed using the GLM procedure of SAS software (SAS, 2001) as a completely randomized design. Differences among treatments were assessed using Duncan (1955) multiple range tests (P<0.05). The statistical model performed was as follow:

$Y_{ik} = \mu + T_i + e_{ik}$

Where, Y_{ik} = An observation,

μ = Overall mean,

T_i = Effect of treatments (i = 1, 2….8),

e_{ik} = random error.

RESULTS AND DISCUSSION

Performance:

The effect of dietary treatments on growth performance of broiler chicks up to 35 days of age is shown in Table (2). At 21 day, all feed additives used in this study improved numerically body weigh compared to those fed LP diets alone except the last those fed TH+CA+SS improved significantly BW compared with LP . The birds fed mixture of TH+CA+SS recorded the highest value of body weight while those fed LTH recorded the lowest value. The addition of synthetic threonine to LTH diet improved live body weight which proves the important of adequate requirement of TH under low protein diet condition. In this respect, Kidd (2000) reported that threonine deficiency resulted in decreasing the utilization of total sulphur amino acid and Lysine. Tugay *et al.* (2009) showed that the highest body weight gain was at 0.75%, and better feed efficiency was in 0.85% threonine for Ross broilers fed diet containing 20% crude protein from 22-42 days.

However, it is worthy to add L-threonine in low-protein diet which in turn reduced uric acid in broilers excreta and decrease nitrogen release in environment (Kidd *et al.,* 2005). Using LP diet significantly decreased broiler body weight compared to control diet. In this respect, Dean *et al*. (2006) and Payne (2007) concluded that broilers fed protein-reduced diet (-3%) recorded lower growth rate and worse feed conversion ratio compared to control group fed optimum protein diet. In current this study, LP containing content of protein lowering by only 2 percentage points compared to Cobb requirement but significant decrease in body weight was observed .However, Pesti (2009) documented that covering the requirement of essential amino acids (EAA) in low protein diet is not sufficient to achieve the optimal broilers performance but it must consider the balance between EAA and crude protein. On the other hand, low protein diet may increase free radical production and lost the protein especially birds. In this respect, Behrooj *et al.* (2012) concluded that oxidative stress was greater in broilers fed low protein diet than others fed control diet. It is known that creation of reactive oxygen species (ROS) and loss of mitochondrial electron is greater in birds than in mammals which have the same size (Stinefelt *et al*., 2005). The beneficial effect of CA on performance of broiler fed low protein diet agree with the results obtained by (Ali *et al*., 2011) who indicated that adding of CA may increase the retention of trace minerals which decrease as a result of using low protein diets. The beneficial effect of SS on LP diet can be explain on the base that SS may increase the activity of natural antioxidants (Ali *et al*., 2007) and/or increase the mineral retention. Ali *et al.,* (2010) found that sulphate addition increased ash retention by 61.63% compared to control diet in growing chicks under heat stress condition.The beneficial effect of addition of TH to LP diet under condition of this study may be due to its role in chelating mineral. In this respect, TH chelated with iron and copper ions in vitro biochemical assays (Grenouillet *et al.,* 1973; Reddy and Mahoney 1995). On the other hand, TH may play a role in antioxidant defense .For example, Azzam *et al*. (2012) found with laying hens, L-threonine supplementation improved hen performance and indicated that TH may have an antioxidant function under hot climate. The beneficial effect of TH in this study may be related to its role as antioxidants under low protein condition. Our results confirms the previous findings of Sharifi *et al.* (2016) who suggested that supplementing broilers diet with antioxidant plays vital role in enhancing pulmonary hypertensive reaction especially when they fed protein reduced diet. Also, the growth and function of the digestive organs are usually correlated with its antioxidant status (Shoveller *et al*., 2005). Moreover, proteins used in immune response and mucus syntheses requires threonine (Stoll *et al*., 1998) or a human (Fuller *et al*., 1994) is retained at the intestinal level to fulfil these gut-maintenance functions and is primarily used in the synthesis of mucins (Corzo *et al*., 2007) Also, immune system is sensitive to dietary threonine intake (Li *et al.* 1999b). Addition of TH+CA+SS significantly increased body weight by 12.56% compared to LP diet meaning synergist effect between these additives. All feed additives used in this study improved feed conversion compared to LP diet and birds fed mixture of additives recorded the best feed conversion. LP plus the mixture of TH+CA+SS recorded performance values at 21 day as well as control diet. These results agree with those obtained by Tonsy *et al.* (2010) who showed that mixture of thyme (as natural antioxidants), citric acid and sulphate is the most successful additives for improving performance of Nile tilapia fingers fed low protein diets.

At 35 day, all feed additives used in this study improved body weight compared to LP diet. Birds fed LP plus TH+CA+SS significantly recorded body weight value was heavier by 5.62% compared to control diet and 13.83% compared to LP diet meaning synergist effect between these additives. TH may have a role as antioxidants and/ or chelating mineral and TH also need other factor like CA or SS to achieve performance. Ali *et al.* (2011) showed that under low protein condition, the trace elements retention decrease and CA+ SS may play role in increasing the elements retention. Also, Tonsy *et al.* *(*2010) who found with fish fed low protein diet that the mixture of thyme (as a natural antioxidants), citric acid and sulphate significantly increased ash percentage in fish meat by 12.21% compared to basal diet. TH may be effective as chelating mineral and easy transport to circulation system in the body. In this respect, many researches (Li *et al*., 1999a; Boza *et al*., 2000; Yen *et al*., 2004; Rubio and Clemente, 2009; Wu, 2009) concluded that peptide-bound AA is slower to up-take by systemic circulation than free AA in some animal species like pigs, rats, mice and chicks. On the other hand, threonine represents 7 – 11% of immunoglobulin proteins which reflect the importance to add this vital amino acid in poultry diets (Sandberg *et al*., 2007). In all over period, all feed additives improve weight gain and feed conversion as well as control diet meaning that these additives have a role in improving performance under low protein condition. Birds fed LP plus TH+CA+SS recorded the highest value of weight gain and the best value of feed conversion ratio. The question rise now, the level of addition of threonine (0.05%) is an optimum level under condition of low protein diet? The answer is very important because the degradation pass way of threonine is safe compare with other synthetic antioxidants. In this respect, Synthetic antioxidants, such as butylated hydroxytoluene (BHT), ethoxyquin and hydroxyl anisole (BHA), are in general used to safeguard feed quality. However, as the toxicological safety of synthetic antioxidants has been questioned, it may be desirable to replace these conventional antioxidants with natural antioxidative substances (Formanek *et al.*, 2001). Further studies are needed to determine the optimum level of TH (as a new antioxidant material) under condition of low protein diets in presence of CA and SS.

Carcass characteristics

The effect of dietary treatments on carcass characteristics at 35 days of age is shown in Table (3). There were insignificant differences between carcass characteristics percentage and giblets percentage. These results disagree with those obtained by Dehghani-Tafti and Jahanian (2016) who found that carcass yield was increased as the result of dietary inclusion of both citric and butyric acids and reducing dietary CP level decreased carcass yield**.**

There were significant differences between values of abdominal fate percentage recorded by different treatments. The birds fed control diet recorded the highest value compared for those birds fed LP diet which recorded the lowest value.

Plasma parameters:

The effect of dietary treatments on some plasma parameters at 35 days of age is shown in Table (4). There were significant differences between plasma total protein values recorded by different treatments. The birds fed LP diet recorded the lowest value while birds fed LP+TH+CA+SS recorded the highest value with significantly different compared with LTH, LP, LP+CA and LP+TH, while numerically increase was observed compare with the rest of other fed additives. These results agree with the results of body weight (Table 2) meaning these additives by different mechanisms save protein. The last group LP + TH+ CA+ SS recorded the highest plasma albumin value with significantly different compared with LP group and insignificant different compared with the other groups. While there were insignificant differences between values of plasma globulin and albumin/ globulin ratio. The addition of TH to LP diet numerically increased plasma globulin compared to those fed LP diet alone. However, antibody titer against NDV at 42 day of age was increased in broilers fed high levels of dietary L-Threonine compared to other groups fed low level of TH (Rezaeipour *et al*., 2012). There were significant differences between plasma cholesterol recorded by different treatments. The birds fed LP diet plus TH+CA+SS and control diet recorded the highest value with significantly different compared to LTH, LP, LP+ CA and LP+SS groups and with insignificantly with other groups while those fed LTH recorded the lowest value. There were insignificant differences between plasma phosphorus values while there were significant differences between creatinine values recorded by different treatments meaning that these additives did not affect protein turnover since increase creatinine concentration is indicative of muscle protein turnover (Hochleithner, 1994). These results indicated that the additive used in this study increased plasma total protein without affect plasma creatinine.

Economical efficiency

The effects of dietary treatments on economical efficiency are shown in Table (5). The results indicated that the chicks fed LP+TH+CA+SS recorded the highest economic efficiency compared with other treatments. While the relative economic efficiency (REE) to control group for chicks fed LP+SS, LP+CA+SS and LP+TH+CA+SS recorded the highest value compared to other treatments. Further economical studies are needed to determine the optimum level of TH (as a new antioxidant material) under condition of low protein diets in presence of CA and SS.

CONCLUSION

At 21 day (grower period), using LP diet significantly decreased broiler body weight compared to control diet. All feed additives used in this study improved weight gain and feed conversion ratio compared to LP diet. The birds fed mixture of TH+CA+SS recorded the highest value of body weight and the best feed conversion ratio at 35 days of age which improved by 5.65 and 7.83%, respectively, compared to control diet. While the carcass values recorded by different treatments did not differ significantly. Addition of TH, CA or SS to LP diet improved the broiler performance as well as control diet while addition of mixture of TH+CA+SS surpassed the control diet performance and recorded the highest value of the economic efficiency .

Table (1): Composition and chemical analysis for experimental diets.

Ingredients	Control diets			Experimental diets			
	Starter (1-10 d of age)	**Grower (11-21 d of age)**	**Finisher (22-35 d of age)**	**Grower LTH**	**Grower LP**	**Finisher LTH**	**Finisher LP**
Yellow corn	54.91	59.97	62.16	64.41	64.30	66.47	66.40
Soya bean meal 44%	34.83	29.83	27.09	28.12	28.12	25.60	25.60
Gluten 60 %	3.42	3.22	3.57	0.30	0.30	0.57	0.57
Soya oil	2.92	3.32	3.97	3.32	3.32	3.97	3.97
Limestone	1.01	1.01	0.91	1.01	1.01	0.93	0.93
Di cal pho	1.75	1.55	1.37	1.60	1.60	1.37	1.37
Salt	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Premix	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL – Methionine (99%)	0.24	0.20	0.16	0.29	0.29	0.24	0.24
L –lysine (78.5%)	0.20	0.18	0.09	0.27	0.27	0.17	0.17
Therionine (98.5 %)	0.04	0.04	-	-	0.11	--	0.07
Total	100	100	100	100	100	100	100
Calculated analysis							
Crude Protein	22.00	20.05	19.09	17.93	18.00	17.00	17.07
Metabolic energy	3004.0	3086.0	3159.5	3094.0	3094.2	3165.0	3165.0
Crude Fiber	3.87	3.62	3.47	3.61	3.59	3.40	3.40
Crude Fat	5.60	6.11	6.81	6.19	6.19	6.89	6.88
Calcium	0.90	0.84	0.76	0.84	0.85	0.75	0.76
Available phosphors	0.46	0.42	0.38	0.42	0.42	0.384	0.382
Lysine	1.34	1.19	1.05	1.19	1.19	1.05	1.05
Methionine	0.62	0.56	0.52	0.59	0.59	0.54	0.54
Methionine & Cystin	0.988	0.89	0.835	0.89	0.89	0.82	0.82
Sodium	0.162	0.161	0.160	0.16	0.16	0.16	0.16
Therionine	0.865	0.789	0.716	0.673	0.789	0.64	0.716

* Premix contain per 3kg vit A 12 000 000, vit D3 2500 000 IU, vit E 110 000mg, Vit K3 4500mg , vit B1 2500mg, vit B2 10000mg, vit B6 4500mg, vit B12 30mg, pantothenic acid 18000mg, Niacin 40000mg, Biotin 300 mg, Folic acid 3000mg, Choline 900gm, Selenium 300mg, Copper 15000mg, Iron 80000mg, Manganese 120000mg, Zinc 110 000mg, Iodine 2000mg, Cobalt 400mg and $CaCO_3$ to 3000g

Table (2): Effect of dietary treatments on growth performance of broiler chicks at 35 days of age.

Treatments	Initial LBW (10 day)	Grower (11-21 d of age)				Finisher (22-35 d of age)				Total (11-35 d of age)		
		BW (g)	BWG (g)	FI (g)	FCR	BW (g)	BWG (g)	FI (g)	FCR	BWG (g)	FI (g)	FCR
Control	213.33	900.67^{ab}	687.34^{ab}	1101.67^{a}	1.60^{cd}	1999.67^{b}	1099.00^{bcd}	1862.16^{ab}	1.69^{abc}	1786.67^{b}	2963.83^{a}	1.66^{b}
LTH	213.00	782.33^{d}	569.33^{d}	1026.67^{c}	1.80^{a}	1804.67^{c}	1022.34^{d}	1844.83^{bc}	1.80^{a}	1591.67^{c}	2871.50^{b}	1.80^{a}
LP	212.33	809.00^{cd}	596.67^{cd}	1050.00^{bc}	1.76^{ab}	1855.33^{c}	1046.33^{cd}	1843.73^{bc}	1.76^{ab}	1643.00^{c}	2893.73^{b}	1.76^{a}
LP+CA	212.66	831.00^{cd}	618.34^{cd}	1039.67^{bc}	1.68^{abc}	1935.00^{b}	1104.00^{bcd}	1870.93^{a}	1.69^{abc}	1722.33^{b}	2910.60^{b}	1.69^{b}
LP+SS	213.00	853.33^{bc}	640.33^{bc}	1060.67^{b}	1.66^{bcd}	1983.00^{b}	1129.67^{abc}	1837.80^{c}	1.63^{bcd}	1770.00^{b}	2898.47^{b}	1.64^{b}
LP+CA+SS	212.66	859.33^{bc}	646.67^{bc}	1055.00^{b}	1.63^{bcd}	1997.00^{b}	1137.67^{ab}	1830.63^{c}	1.61^{cd}	1784.33^{b}	2885.63^{b}	1.62^{b}
LP+ TH	212.66	843.67^{c}	631.01^{c}	1034.67^{bc}	1.64^{bcd}	1976.00^{b}	1132.33^{abc}	1845.76^{bc}	1.63^{bcd}	1763.34^{b}	2880.43^{b}	1.63^{b}
LP+TH+CA+SS	213.00	910.67^{a}	697.67^{a}	1057.33^{b}	1.51^{d}	2112.00^{a}	1201.33^{a}	1844.60^{bc}	1.53^{d}	1899.00^{a}	2901.93^{b}	1.53^{c}
MSE	±0.47	±16.19	±16.13	±8.53	±0.4	±21.21	±26.17	±6.74	±0.04	±21.27	±12.17	±0.02
Probability	NS	0.0006	0.0006	0.0006	0.01	0.0001	0.006	0.01	0.01	0.0001	0.003	0.0001

a, b,..etc.: Means in the same column with different letters, differ significantly ($p<0.05$). NS = non significant

LBW = life body weight BW = body weight BWG= body weight gain FCR = feed conversion ratio

LTH = Low Protein without synthetic thironine. LP=low Protein with synthetic therionine.

CA= Citric Acid (0.3%). SS= Anhydrous sodium Sulphate (0.3%). TH= Threonine (0.05%).

Table (3): Effect of dietary treatment on carcass characteristics of broiler chicks at 35 days of age.

Treatments	Dressed Carcass (%)	Total giblets (%)	Abdominal Fat (%)
Control	72.66	4.32	1.82[a]
LTH	70.98	4.35	1.21 [bcd]
LP	71.21	4.31	1.01 [d]
LP+CA	72.41	4.74	1.46 [b]
LP+SS	74.59	4.59	1.34 [bc]
LP+CA+SS	74.41	4.27	1.19[cd]
LP+TH	72.93	4.63	1.29 [bc]
LP+TH+CA+SS	73.29	7.03	1.17 [cd]
MSE	± 10.61	±0.23	±0.08
Probabilty	NS	NS	0.0002

a,b,..etc.: Means in the same column with different letters, differ significantly ($p<0.05$). NS= non significant
LTH = Low Protein without synthetic thironine.
LP =low Protein with synthetic therionine
CA= Citric Acid (0.3%)
SS= Anhydrous sodium Sulphate (0.3%)
TH= Threonine (0.05%)

Table (4): Effect of dietary treatment on blood characteristics of broiler chicks at 35 days of age.

Treatments	Total Protein g/dl	Albumin g/dl	Globulin g/dl	A/G Ratio	Cholesterol mg/dl	Phosphorus mg/dl	Creatinine g/dl
Control	5.53[abc]	1.61[a]	3.92	0.41	157.00[a]	5.45	0.51[a]
LTH	5.17[bc]	1.55[ab]	3.62	0.43	143.00[d]	4.08	0.48[ab]
LP	4.90[c]	1.46[b]	3.44	0.42	151.33[bc]	5.15	0.43[b]
LP+ CA	5.36[bc]	1.66[ab]	3.70	0.45	146.33[cd]	5.43	0.47[ab]
LP + SS	5.47[abc]	1.67[ab]	3.80	0.44	150.67[bc]	5.35	0.44[b]
LP + CA +SS	5.37[abc]	1.67[ab]	3.70	0.45	154.33[ab]	5.43	0.43[b]
LP+ TH	5.37[bc]	1.58[ab]	3.79	0.42	153.67[ab]	5.49	0.50[a]
LP+TH + CA+SS	6.03[a]	1.74[a]	4.29	0.41	159.30[a]	5.34	0.51[a]
MSE	±0.11	±0.01	±0.17	±0.01	±9.29	±0.03	±0.001
Probability	0.04	NS	0.35	NS	0.0001	NS	0.01

a, b,..etc.: Means in the same column with different letters, differ significantly ($p<0.05$). NS= non significant
LTH = Low Protein without synthetic thironine.
LP =low Protein with synthetic therionine CA= Citric Acid (0.3%)
SS= Anhydrous sodium Sulphate (0.3%)
TH= Threonine (0.05%)

Table (5): Effect of dietary treatment on blood characteristics of broiler chicks at 35 days of age

Item	Control	LTH	LP	LP+CA	LP+SS	LP+CA+SS	LP+TH	LP+CA+SS+TH
Body weight gain (kg)	1.79	1.59	1.64	1.72	1.77	1.78	1.76	1.90
Price/kg sold for body weight	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Total revenue / chick (LE)	44.67	39.79	41.08	43.06	44.25	44.61	44.08	47.48
Fixed cost	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Total feed consumption / chick(kg)	2.96	2.87	2.89	2.91	2.90	2.89	2.88	2.90
Price/kg feed (LE)	10.08	9.64	9.73	9.84	9.74	9.85	9.98	10.10
Total feed cost /chick (LE)	17.08	16.64	16.73	16.84	16.74	16.85	16.98	17.10
Total revenue (LE)	44.67	39.79	41.08	43.06	44.25	44.61	44.08	47.48
Net revenue[1] (LE)	27.58	23.15	24.35	26.22	27.51	27.76	27.11	30.38
Economic efficiency[2]	161.45	139.09	145.56	155.74	164.39	164.79	159.67	177.68
Relative economic efficiency [3](%)	100.00	86.15	90.16	96.46	101.82	102.07	98.90	110.05

Total price for feeds was calculated according to the price of different ingredients available in ARE.
price of one Kg live weight was 25 LE.
1Net revenue= total revenue/ chick- total feed cost/chicks.
2Economic efficiency= net revenue/ total feed coast/chicks.
3Relative economic efficiency of the control, assuming that the relative E1 of the control =100
LTH = Low Protein without synthetic thironine. LP=low Protein with synthetic therionine.
CA= Citric Acid (0.3%) SS= Anhydrous sodium Sulphate (0.3%). TH= Threonine (0.05%)

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الملخص العربى

تحسين الإستفاده من علائق كتاكيت التسمين المنخفضه في البروتين بإستخدام الثريونين وحامض السيتريك والكبريتات

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تهدف هذه الدراسة إلي إختبار قدرة الثريونين والسيتريك والكبريتات او مخلوطهم علي تحسين الاستفاده من علائق دجاج التسمين المنخفضه في البروتين . تم توزيع 240 كتكوت كب عمر 10 أيام الي ثمان معاملات المعامله الاولي الكنترول حيث تم تغطية احتياجات سلالة الكب والمعامله الثانيه منخفضه في نسبة البروتين 2 % بروتين عن العلائق القياسيه بدون تغطية احتياجات الثيرونين لسلالة الكب والمعامله الثالثه منخفضه في نسبة البروتين 2 % بروتين عن العلائق القياسيه مع تغطية احتياجات السلاله من الثيرونين مثل الكنترول والمعامله الرابعه عباره عن عليقه منخفضة في البروتين مع إضافة حامض السيتريك بنسبة 0.3 % والمعامله الخامسه عباره عن عليقه منخفضة في البروتين مع إضافة كبريتات الصوديوم بنسبة 0.3 % والمعامله السادسه عباره عن عليقه منخفضة في البروتين مع إضافة كلا من حامض السيتريك بنسبة 0.3 % وكبريتات الصوديوم بنسبة 0.3 % والمعامله السابعه عباره عن عليقه منخفضة في البروتين مع إضافة الثريونين بنسبة 0.05 % والمعامله الثامنه عباره عن عليقه منخفضة في البروتين مع إضافة كلا من الثيرونين بنسبة 0.05 %و حامض السيتريك بنسبة 0.3 % وكبريتات الصوديوم بنسبة 0.3 %. سجلت النتائج عند عمر 21 يوم ان إستخدام العلائق المنخفضه في البروتين خفضت معنويا وزن الجسم للكتاكيت مقارنه بالكنترول بينما كل المعاملات التي تم استخدام الإضافات العلفيه بها حسنت وزن الجسم المكتسب والكفائه التحويله للغذاء. سجلت الطيور المغذاه علي العليقه المحتويه علي الثلاث إضافات وهي الثيرونين وحامض السيتريك وكبريتات الصوديوم علي أعلي قيم لوزن الجسم و أحسن كفاءة تحويل الغذاء. سجلت اوزان الطيور عند عمر 35 يوم المغذاه علي العليقه المحتويه علي الثلاث إضافات وهي الثيرونين وحامض السيتريك وكبريتات الصوديوم علي أعلي قيم لوزن الجسم و أقل قيمه لكفاءة تحويل الغذاء بنسبة 5.62 % و 7.83 علي التوالي بالمقارنه بتلك المغذاه علي عليقة الكنترول. بينما سجلت قيم الذبيحه زياده غير معنويه بالمقارنه بباقي المعاملات. المعامله الثامنه والمحتويه علي خليط الثيرونين وحامض السيتريك وكبريتات الصوديوم سجلت أعلي قيم للبروتين الكلي والالبيومين والكوليسترول الكلي في تحليلات الدم. يمكن تلخيص النتائج بأن إضافة كلا من الثيرونين أوحامض السيتريك أوكبريتات الصوديوم الي العليقه المنخضه في البروتين حسنت الأداء الإنتاجي لكتاكيت التسمين المغذاه عليها عن تلك الكتاكيت المغذاه علي عليقة الكنترول بينما إضافة الخليط للثلاث إضافات الثيرونين وحامض السيتريك وكبريتات الصوديوم تفوق عن عليقة الكنترول وسجلت اعلي كفاءة اقتصاديه.