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IMPROVING THE UTILIZATION OF BROILER LOW PROTEIN DIETS USING TYROSINE, TRYPTOPHAN, CITRIC ACID AND SULPHATE

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ABSTRACT: The aimed of this study evaluate the ability of tyrosine, tryptophan, citric acid (CA) , sodium sulphate (SS) or their mixture to improve the utilization of broiler low protein diets (LP diet). A total number of 270 Cobb broiler 10 day old were randomly distributed into nine groups received basal diet (control), diet containing 2 percentage points lower protein (LP diet), LP +0.3 % citric acid (CA), LP +0.3% Anhydrous sodium sulphate (SS) , LP+0.3 % CA + 0.3 % SS, LP+ 0.05% tyrosine , LP +0.05% tyrosine + 0.3 % CA +0.3 % SS, LP+0.05% tryptophan and LP+0.05% tryptophan +0.3 % CA + 0.3 % SS. 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 diet. The birds fed mixture of tyrosine +CA+SS recorded the highest value of body weight and the best feed conversion. At 35 day, The birds fed mixture of tyrosine +CA+SS recorded significantly higher body weight value and better feed conversion by 8.63 and 8.53 %, respectively, compared to those fed control diet . Compared to other treatments, birds fed mixture of tyrosine +CA+SS recorded the highest values of total protein, albumin and total cholesterol in plasma. It can be concluded that addition of tyrosine, tryptophan, CA or SS to LP diet improved the broiler performance to be like those fed control diet while the mixture of tyrosine +CA+SS surpassed the control.

Keyword: broiler, low protein, citric acid, tyrosine, tryptophane and sulphate**.**

INTRODUCTION

It is well known that the demand of poultry meat and it will lead to an increase in the demand for animal feed and its ingredients like vegetable proteins, e.g., soybean meal (Alexandratos and Bruinsma, 2012). Due to the high import of soybeans to cover the protein content in poultry diets, as well as the environmental pollution resulting from the excretion of nitrogen in the broiler feces and ammonia emissions. Therefore, reducing the proportion of protein in the diet helps to overcome the lack of soy in the market and its high prices, in addition to reducing environmental pollution from broiler chicken houses (Kidd *et al*., 1996). In this connection, feeding a low-protein diet to broiler chickens also exposes them to high oxidative stress (Behrooj *et al.*, 2012). Also, Sharifi *et al.* (2016) observed in broiler chickens high incidence of pulmonary hypertension when reduced-protein diet and they improved pulmonary hypertensive response by using antioxidant supplementation. They suggested that when reducing protein in broilers diets, the antioxidants can play a crucial role. But, in practice, we can't increase the level of synthetic antioxidants in feed due to their potential toxic effects, because legislatively we have to restrict the maximum level of it, due to the US Food and Drug Administration which established a maximum inclusion. For example, the level of 150 ppm for ethoxyquin, 200 ppm for both butylated hydroxyl toluene (BHT) and butylatedhydroxyanisole (BHA) in animal feeds. Many other countries have also been adopted similar regulatory standard (Salami *et al*., 2015). However, study reported that exogenous antioxidants are also a double-edged sword, highlighting that antioxidants at physiological levels are generally safe, while higher levels are detrimental in cellularredox state (Bouayed and Bohn, 2010). The birds or animal need a higher amount of different antioxidants for free radical scavenging. For example, under normal physiological conditions about 3-5% of the oxygen taken up by the cell undergoes univalent reduction leading to the formation of free radicals (Singal *et al*., 1998).

L-tyrosine is found to be effective antioxidant in different *in vitro* assay including anti lipid peroxidation, reductive ability, 2,2’-azino-bis (3-ethylbenzthiazoline6-sulfonic acid) (ABTS), 2,2-diphenyl-1-picrylhydrazyl (DPPH) and superoxide anion radical scavenging, hydrogen peroxide scavenging and metal chelating activities when they are compared to standard antioxidant compounds, such as BHA, BHT, alfa-tocopherol, a natural antioxidant, and trolox as a water-soluble analogue of tocopherol (Gulcin, 2007).

The antioxidant activities in egg yolk are tyrosine and tryptophan which considered the main contributors (Nimalaratne *et al*., 2011). Moreover, a during conditions of oxidative stress many studies have found the medical useful in animal or human trials of tyrosine (Deijen and Orlebeke, 1994). However, many studies have observed that some amino acids may be more active than their parent peptides (Erdmann *et al.* 2008). Ali *et al* (2012) indicated that SS increased the activity of hydrophobic antioxidants and/ or protect it from free radical attach during circulation in the blood. Ali *et al.* (2018) found that L-tyrosine at 0.5 g/kg diet either alone or with sodium sulphate increased egg production in local laying hen from 39 to 58 weeks old and indicated that L- tyrosine may help birds for elimination of free radical and sulphate increase its activity. Ali *et al.* (2019) found with broiler that addition of tyrosine alone or with sulphate significantly increased body weight by increased body weight by 21.13 , 26.10%,respectively compared to control diet. Antongiovanni *et al.*, 2007 and Jahanian, 2011 showed that increasing growth rate and improving feed conversion ratio (FCR) in broiler chickens when using different organic acid in diet. Also, adding citric acid at the level of 5 g/kg in broiler chickens diet improved growth, feed intake, feed efficiency, carcass yield, bone ash, and immune status (Chowdhury *et al.,* 2009). Tonsy *et al.* (2010) 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. Ali *et al.* (2011) found that addition of citric acid, sodium sulphate 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, indicating that these feed additives may save the protein by protecting it from free radical. Therefore, this study examine the ability of tyrosine and tryptophan (as antioxidants) with CA, SS or their mixture to improve the utilization of broiler low protein diets.

MATERIALS AND METHODS

The present study was carried out at Gezeret El-Sheir Station, El-Kanater El-Khyria, Kalyobia Governorate, Egypt. The laboratory work was done at Poultry Nutrition Department, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. A total of 270 of Cobb broiler at 10 day old, approximately similar in average weight were randomly distributed into nine groups, each group contain 3 replicates (10 chicks in each replicate). Diets and water were offered 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 allotted on the following dietary treatments:

1.The control diet containing COBB requirement (Control).
2.The Low protein diet contain 2 percentage points lower protein than control diet (LP)
3.The LP + 0.3 % citric acid (CA).
4.The LP + 0.3 % $NaSO_4$ (SS).
5.The LP + 0.3 % CA + 0.3% SS.
6.The LP + 0.05% tyrosine
7.The LP + 0.05% tyrosine + 0.3 % CA + 0.3 % SS.
8.The LP+ 0.05% tryptophan
9.The LP+ 0.05% tryptophan + 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. Tyrosine and tryptophan were supplied by EVONIC Germany. Body weight (BW) and feed intake (FI) were recorded weekly, while weight gain (WG) and feed conversion (FC) were calculated. Three birds were taken randomly from each treatment and slaughtered and the edible organs included heart, empty gizzard and liver were weighed to calculate total edible parts. Carcass and total edible parts percentage weights percentage were calculated on the basis of live body weight. Individual blood samples were taken from 3 birds within each treatment, and collected into dry clean centrifuge tubes containing drops of heparin and centrifuged for 20 minutes on (3000 rpm) for obtaining plasma . The clear plasma was separated and stored at -20º C. The suitable commercial kits were used to determine total protein, albumin, total cholesterol, phosphorus and creatinine. The globulin and A/G Ratio values were calculated. Data were analyzed using the GLM procedure of SAS software (SAS, 2001) as a completely randomized design. Differences among treatments were assessed using Duncan's multiple range tests (1955) ($P<0.05$). The statistical model performed was as follow:

Yik = μ+ Ti + eik

Where, Yik = An observation,

μ = Overall mean, Ti = Effect of treatments (i = 1,2….9),

eik = Experimental random error

RESULTS AND DISCUSSION

Performance:

The effect of dietary treatments on performance of Cobb broiler chickens is presented in Table (2). At 21 days of age, there were significant differences between body weight values recorded by different dietary treatments .The control diet recorded the highest value while birds fed LP recorded the lowest value. The LP diet was lower significantly by 9.71% compared to control diet. These results disagree with those obtained by Harn *et al.* (2019) who demonstrated that the CP content of grower and finisher diets can be reduced by 2.2–2.3% units without adverse effects on growth performance of broilers when fed low CP protein feeding programs. However, Pesti (2009) stated that to optimize animal performance, it is not only necessary to supplement low protein diets with essential amino acids (EAAs), but also to ensure the balance between EAA and CP or the sum of EAA and nonessential amino acids (NEAA). In general, the response of broiler chickens to radically low protein concentrations varies, even when augmented with an array of synthetic amino acids (Corzo *et al.,* 2005 and 2010). All feed additives used in this study improved body weight compared to LP diet. The addition of tyrosine, tryptophan either alone or with CA+SS significantly increased body weight compared to birds fed LP diet. The effect of citric acid with broiler diet have been reported by Chowdhury *et al.* (2009) who obtained that improved growth, feed intake, feed efficiency, carcass yield, bone ash, and immune status of broiler chickens by adding citric acid at the level of 5 g/kg diet. The beneficial effects of citric acid on low protein diet were observed by Dehghani-Taftiand Jahanian (2016) who indicated that organic acid (citric + butyric) could reduce dietary CP demands to some extent. The beneficial effect of tyrosine on LP diet can explained by its role as antioxidants. For example, a number of studies have observed that the medical useful of tyrosine in animal or human trials during conditions of oxidative stress (Deijen and Orlebeke 1994). In this connection, number of authors demonstrated that low protein diet need an increases of antioxidants. Behrooj *et al*. (2012) reported that broilers exposed to high oxidative stress when fed on reduced-protein diets. Also, Sharifi *et al*. (2016) found that using low protein diet for broilers is associated with higher incidence of pulmonary hypertension and antioxidant supplementation of low protein diets effectively improves pulmonary hypertensive response. They suggested that antioxidants can play a crucial role when low protein diets are fed to broilers. Putting in mind that the effect of tyrosine as antioxidants with broiler has been observed by Ali *et al.* (2019). The inclusion rate of tyrosine may increase in the future studies due to its lower toxicity than any other antioxidants. The same explanation was also stated with tryptophan as antioxidants. The fact that tryptophan can play a role as antioxidant has been shown by Nimalaratne *et al*. (2011) who showed that the antioxidant activities in egg yolk are tyrosine and tryptophan which considered the main contributors. The synergist effect of SS with antioxidants have been demonstrated before. Ali *et al.* (2019) found with broiler that addition of tyrosine alone or with sulphate significantly increased body weight by 21.13, 26.10%, respectively compared to control diet. Under low protein diet condition, the synergist effect of SS+CA with antioxidants has been reported before 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 fingerlings fed low protein diets. Ali *et al.* (2011) found that addition of citric acid, sodium sulphate 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, indicating that these feed additives may save the protein by protecting it from free radical. The same trend was found also in weight gain values (Table 2).

During growing period there were significant differences between values of feed intake recorded by birds fed different dietary treatments. The birds fed control diet recorded the highest value (1138g) while birds fed tyrosine+CA+SS recorded the lowest value (1004g). Also, significant differences were detected between feed conversion values. The birds fed tyrosine+CA+SS recorded the best value while birds LP recorded the worst value. All feed additives improved feed conversion compared to LP treatment. It was surprised that birds fed either tyrosine or tryptophan plus CA+SS recorded significantly better feed conversion values than control diet. The deteriorated FCR for broiler fed control diets compared broiler fed tyrosine or tryptophan plus CA+SS could due to a poorer intestinal health. Qaisrani *et al.*, (2015); Apajalahti and Vienola, (2016) proposed that the negative effects on gut health and performance may be due to high protein diets. Another reason for better feed conversion in low protein diet with additives than control diet may be due to the protein fermentation. The putrefactive bacteria in the caecum can potentially fermented the protein that was not digested in the end of the small intestine. Many harmful and toxic compounds are produce during the putrefaction like amines, indoles, phenols, cresol and ammonia, which in high concentrations may have adverse effects on chicken growth and performance (Apajalahti and Vienola, 2016). The production of toxic protein fermentation metabolites in the caeca might reduce by the reduction of the protein bypassing the small intestine during reducing the dietary CP content.

At 35 day, all feed additives used in this study improved significantly body weight compared to LP diet. Addition of tyrosine alone significantly increased body weight gain by 12.29 and 6.06% compared to LP and control diets, respectively. The beneficial effect of tyrosine alone due to its antioxidants role have been demonstrated before by Salamance *et al.* (2021) who found with fish fed diet supplemented with tyrosine reduction on several stress markers. Also, in this study birds fed tyrosine plus CA+SS increased body weight by 15.04 and 8.65 % compared to LP and control diets, respectively. Addition of tryptophan plus CA+SS increased body weight by 13.36 and 7.07% compared to LP and control diets , respectively .On the other hand, the synergist between CA and other feed additives may be due to its effect on digestion of nutrients under low protein digestion or its effect of phosphorus utilization . Fikry *et al.*

(2021) found that adding citric acid to broilers fed significantly improved ($P < 0.05$) digestion coefficients of crude protein, ether extract, crude fiber, and nitrogen free extract as well as metabolizable energy compared to the control. Rafacz-Livingston *et al*. (2005) obtained that supplementation citric acid to crossbred and commercial broiler chickens fed improved phytate phosphorus utilization in both breeds. The improvement of phosphorus by addition of citric acid may be the reason of synergist effect of citric acid with other additives under low protein diet condition. In this respect, Cowieson *et al.* (2020) found that a low protein diet was associated with performance loss and adding available phosphorous to this diet promoted growth rate and FCR and this strategy was effective in restoring some but not all losses. The same trend of feed additives found also in weight gain. There were significant differences detected between finisher feed intake values recorded by birds fed different treatments. The highest value recorded with birds fed tyrosine (1935 g) while the lowest value recorded with those fed control diet (1765 g). Total feed intake values in all over period recorded by different treatments are shown in (Table 2) with significant differences between them. The birds fed tyrosine recorded the highest value (2978 g) while birds fed LP+SS recorded the lowest value (2875 g). In all over period, the differences between feed conversion values recorded by birds fed different treatments were significant. The birds fed tyrosine plus CA+SS recorded the best value (1.5) while birds fed LP diet recorded the worst value (1.78). The addition tyrosine plus CA+SS improved feed conversion by 15.73 and 8.53% compared to LP and control diets, respectively. The results of this study show clearly that tyrosine or tryptophan in combination with CA+SS is the best mixture of feed additives under low protein diet condition .Further studies are needed with different levels of either tyrosine or tryptophan.

Carcass characteristics

The effect of dietary treatments on carcass characteristics is shown in Table (3).There were significant differences between carcass percentage values recorded by different treatments while the differences between total edible parts were insignificant. In this respect, Aletor *et al.* (2000) obtained that reduced CP content in the broiler diet from 225 to 153 g/kg had no effects on slaughter yields. These results agree with work have been done by Harn *et al.* (2019) who found that the broilers fed CP-1% or CP-2% feeding program had slaughter yields did not differ from the control feeding program. The birds fed tryptophan plus CA+SS recorded the highest value while birds fed CA recorded the lowest value. These results did not agree with Chowdhury *et al.* (2009) who showed that using 5 g/kg citric acid dietary supplementation had positive effects on carcass yield of broiler chickens. Also, significant differences were detected between abdominal fat percentages recorded by different treatment. The highest value recorded with the birds fed control diet while those fed LP diet recorded the lowest value. These results disagree with those obtained by Moran *et al.* (1992) who found that decreasing crude protein concentration in the feed increased in relative fat pad weight.

Plasma parameters

The effect of dietary treatments on plasma parameters is shown in Table 4.

The statistical analysis indicated that there were significant differences between plasma total protein values recorded by different dietary treatments. The birds fed LP diet recorded the lowest value while birds fed tyrosine plus CA+SS recorded the highest value. The data of plasma total protein (Table 4) was in harmony with data of body weight (Table 2) meaning that feed additives succeeded in saving the protein by different mechanisms and consequently increased body weight and plasma total protein. These results agree with those obtained by Mosaad and Iben (2009) who found that increased dietary nitrogen intake leads to an increase in total plasma protein.

The same trend was also found in plasma albumin but without significant differences, while there were significant differences amonge globulin values of different treatments. Moreover, significant differences were detected between total cholesterol values recorded by dietary treatments. The LP diet recorded the lowest value while the birds fed tyrosine +CA+SS recorded the highest value. There were insignificant differences between plasma phosphorus values recorded by different treatments .It was observed that LP diet recorded the lowest value while CA recorded the highest value. These results may explain the reason of improvement of performance of LP diet with CA (phosphorus enhancer). However, Cowieson *et al.* (2020) found that loosed performance associated with a low protein diet and adding available phosphorous to this diet promoted growth rate and FCR and this strategy was effective in restoring some but not all losses. The additives used in this study numerically increased plasma phosphorus compared to LP diet. These results disagree with those obtained by Ali *et al.* (2019) who found that the addition of SS to control diet increased level of plasma phosphorus by 38.51% while other antioxidants alone or with SS increased it in range from18.70 to38.51%. They showed that the reason of increasing level of plasma phosphorus with using SS may be due that sulphate increase the circulation of vitamin D3.The differences between this study and findings by Ali *et al*. (2019) may be due to lower protein content in this study. There were significant differences between creatinine values, the birds fed CA diet recorded the lowest value while birds fed tyrosine plus CA+SS recorded the highest value. However, increased creatinine concentration is an indicative of muscle protein turn over (Hochleithner, 1994).

CONCLUSION

The addition of tyrosine, tryptophan, CA or SS to LP diet improved the broiler performance to be like as well as those fed control diet while the mixture of tyrosine +CA+SS surpassed the control diet.

Table (1): Ingredients and chemical composition for experimental diets.

Ingredients	**Starter**	**Grower**	**Grower LP**	**finisher**	**Finisher LP**
Yellow corn	54.91	59.97	64.30	62.16	66.40
Soybean meal 44%	34.83	29.83	28.12	27.09	25.60
Gluten meal	3.42	3.22	0.30	3.57	0.57
Soy oil	2.92	3.32	3.32	3.97	3.97
limestone	1.01	1.01	1.01	0.91	0.93
Di cal pho	1.75	1.55	1.55	1.37	1.37
Salt	0.38	0.38	0.38	0.38	0.38
Premix	0.30	0.30	0.30	0.30	0.30
Dl-methionine	0.24	0.20	0.29	0.16	0.24
L-lysine	0.20	0.18	0.27	0.09	0.17
L-threonine	0.04	0.04	0.11	-	0.07
Total	100	100	100	100	100
Calculated analysis**					
CP	22.00	20.05	18.00	19.09	17.07
ME	3004	3086	3094	3159	3165
CF	3.87	3.62	3.59	3.47	3.40
C.Fat	5.60	6.11	6.19	6.81	6.88
Ca	0.90	0.84	0.85	0.76	0.761
Avi.ph	0.46	0.42	0.42	0.38	0.38
lysine	1.34	1.19	1.19	1.05	1.05
Meth	0.62	0.56	0.59	0.52	0.54
Meth&Cys	0.99	0.89	0.89	0.84	0.82
Sodium	0.16	0.16	0.16	0.160	0.16
Threonine	0.87	0.79	0.78	0.72	0.71
Tyrosine	0.94	0.85	0.74	0.82	0.71
Tryptophan	0.30	0.27	0.25	0.25	0.23

* 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.

**According the Egyptian Regional Center for Food and Feed (RCFF, 2001)

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Soy oil	2.92	3.32	3.32	3.97	3.97
limestone	1.01	1.01	1.01	0.91	0.93
Di cal pho	1.75	1.55	1.55	1.37	1.37
Salt	0.38	0.38	0.38	0.38	0.38
Premix	0.30	0.30	0.30	0.30	0.30
Dl-methionine	0.24	0.20	0.29	0.16	0.24
L-lysine	0.20	0.18	0.27	0.09	0.17
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**According the Egyptian Regional Center for Food and Feed (RCFF, 2001)

Table (2): Effect of dietary treatments on experimental chicks performance.

Treatments	Initial LBW 10 day (g)	Grower (11-21 d of age)				Finisher (22-35 d of age)				Total		
		Body Wt. (g)	Gain (g)	Feed Intake (g)	Feed Conv.	Body Wt. (g)	Gain (g)	Feed Intake (g)	Feed Conv.	Gain (g)	Feed Intake (g)	Feed Conv.
Control	213.33	909.33^{a}	696.00^{a}	1138.33^{a}	1.64^{b}	1980.00^{bc}	1070.67^{cd}	1765.00^{d}	1.65^{b}	1766.67^{bc}	2903.33^{cd}	1.64^{c}
Low Protin (LP)	213.00	821.00^{c}	608.00^{c}	1093.33^{ab}	1.80^{a}	1870.00^{d}	1049.00^{d}	1860.0^{bc}	1.77^{a}	1657.00^{d}	2953.33^{abc}	1.78^{a}
LP+ CA	213.33	836.67^{bc}	623.33^{bc}	1058.33^{bc}	1.70^{ab}	1945.67^{c}	1109.00^{c}	1885.67^{ab}	1.70^{ab}	1732.33^{c}	2944.00^{abc}	1.70^{b}
LP+ SS	213.67	859.00^{abc}	645.33^{abc}	1052.00^{bcd}	1.63^{b}	1970.00^{bc}	1111.00^{c}	1823.33^{c}	1.64^{b}	1756.33^{bc}	2875.33^{d}	1.64^{c}
LP+CA+ SS	213.00	865.33^{abc}	652.33^{abc}	1055.00^{bcd}	1.62^{b}	1990.00^{bc}	1124.67^{bc}	1855.00^{bc}	1.65^{b}	1777.00^{bc}	2910.00^{bcd}	1.64^{c}
LP+ Tyrosine	212.67	843.33^{bc}	630.67^{bc}	1042.33^{bcd}	1.65^{b}	2100.00^{a}	1256.67^{a}	1935.87^{a}	1.54^{cd}	1887.33^{a}	2978.20^{a}	1.58^{de}
LP+Tyrosine +CA+SS	214.00	884.67^{ab}	670.67^{ab}	1004.33^{d}	1.50^{c}	2151.33^{a}	1266.67^{a}	1893.33^{ab}	1.50^{d}	1937.33^{a}	2897.67^{cd}	1.50^{f}
LP+ Tryptophan	213.00	844.00^{bc}	631.00^{bc}	1025.00^{cd}	1.62^{b}	2020.33^{b}	1176.33^{b}	1901.93^{ab}	1.62^{bc}	1807.33^{b}	2926.93^{abcd}	1.62^{cd}
LP+ Tryptophan + CA+SS	212.33	885.33^{ab}	673.00^{ab}	1062.33^{bc}	1.58^{bc}	2120.00^{a}	1234.67^{a}	1900.13^{ab}	1.55^{cd}	1907.67^{a}	2962.47^{ab}	1.55^{e}
SEM	±0.50	±15.90	±15.93	±16.14	±0.4	±16.86	±18.63	±17.30	±0.03	±16.85	±17.47	±0.015
Probability	NS	0.02	0.02	0.001	0.002	0.0001	0.0001	0.0001	0.0001	0.0001	0.009	0.0001

a,b,..etc.: Means in the same column with different letters, differ significantly ($p<0.05$). LP = Low Protein diet. CA= citric acid SS= sodium sulphate NS= nonsignificant
Feed conv. = Feed intake (g) / weight gain (g)

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Table (3): Effect of dietary treatments on carcass characteristics.

Treatments	Live Wight (g)	Carcass (%)	Total edible Parts (%)	Abdominal Fat (%)
Control	1958.33[bc]	74.09[b]	4.30	1.81[a]
Low Protein (LP)	1917.00[e]	71.34 [b]	4.52	1.09[e]
LP + CA	1921.00[de]	70.91 [b]	4.72	1.46[bc]
LP +SS	1955.00[bcd]	72.04 [b]	4.57	1.33[cde]
LP+ CA + SS4	1985.00[ab]	73.89 [b]	4.24	1.18[de]
LP +Tyrosine	1943.33[cde]	73.11 [b]	4.44	1.63[ab]
LP+Tyrosine+ CA+SS	2003.33[a]	73.58 [b]	4.19	1.66[ab]
LP +Tryptophan	1927.33[cde]	73.21 [b]	4.98	1.42[bcd]
LP+ Tryptophan+CA+SS	2004.00[a]	77.59[a]	4.22	1.76[a]
SEM	11.26	1.16	0.37	0.08
Probability	0.0001	0.03	NS	0.0001

a, b,..etc.: Means in the same column with different letters, differ significantly ($p<0.05$).
NS= non significant
LP = Low Protein diet. CA= citric acid SS= sodium sulphate .

Table (4): Effect of dietary treatments on plasma parameters.

Treatments	Total Protein g/dl	Albumin g/dl	Globulin g/dl	A/G Ratio	Cholesterol mg/dl	Phosphorus mg/dl	Creatinine g/dl
Control	5.40[b]	1.61	3.79[a]	0.43	155.00[ab]	5.30	0.4[bcd]
Low Portion (LP)	4.50[c]	1.44	3.09[b]	0.46	139.00[c]	4.70	0.48[ab]
LP+CA	5.23[b]	1.55	3.69[a]	0.42	152.00[b]	5.72	0.36[d]
LP+ SS	5.23[b]	1.48	3.76[a]	0.4	151.67[b]	5.13	0.42[abcd]
LP+CA+SS	5.33[b]	1.55	3.78[a]	0.42	157.67[ab]	5.10	0.38[cd]
LP+ Tyrosine	5.47[ab]	1.58	3.88[a]	0.41	152.33[b]	5.40	0.43[abcd]
LP+ Tyrosine + CA+SS	5.97[a]	1.71	4.26[a]	0.4	160.33[a]	5.37	0.51[a]
LP + Tryptophan	5.47[ab]	1.56	3.91[a]	0.4	158.67[ab]	5.31	0.39[bcd]
LP +Tryptophan+CA+SS	5.5[ab]	1.75	3.75[a]	0.47	158.7[ab]	5.63	0.47[abc]
SEM	0.08	0.01	0.11	0.003	16.00	0.15	0.002
Probability	0.001	0.06	0.04	NS	0.0002	NS	0.02

a,b,..etc.: Means in the same column with different letters, differ significantly ($p<0.05$).
NS= non significant
LP = Low Protein diet. CA= citric acid SS= sodium sulphate

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broiler, low protein, citric acid, tyrosine, tryptophane and sulphate.

الملخص العربى

تحسين الإستفاده من علائق كتاكيت التسمين المنخفضة في البروتين باستخدام التيروزين والتريبتوفان وحمض الستريك والكبريتات

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تهدف هذه الدراسة إلى تقييم قدرة التيروزين والتربتوفان وحامض الستريك وكبريتات الصوديوم أومخلوطهم لتحسين الاستفادة من علائق كتاكيت التسمين المنخفضة في البروتين. تم توزيع إجمالي ٢٧٠ كتكوت كب بعمر ١٠ أيام بشكل عشوائي على تسع مجموعات. المعاملة الاولي مجموعة المقارنة تم تغذيتها علي العليقه القياسية والمعامله الثانيه منخفضه بنسبة البروتين ٢ % عن العليقه القياسيه والمعامله الثالثه عبارة عن العليقة منخفضة البروتين مع إضافة ٠.٣ % حامض السيتريك والمعامله الرابعه عباره عن العليقة منخفضة البروتين مع إضافة كبريتات الصوديوم بنسبة ٠.٣ % والمعامله الخامسه عباره عن العليقة منخفضة البروتين مع إضافة مخلوط كلا من حامض السيتريك بنسبة ٠.٣% وكبريتات الصوديوم بنسبة ٠.٣% والمعامله السادسه عباره عن عليقه منخفضة البروتين مع إضافة التيروزين بنسبة ٠.٠٥ % و المعاملة السابعة عبارة عن العليقة منخفضة البروتين مع إضافة مخلوط كلا من التيروزين ٠.٠٥% وحامض السيتريك بنسبة ٠.٣ % وكبريتات الصوديوم بنسبة ٠.٣ % والمعامله الثامنة عباره عن عليقه منخفضة البروتين مع إضافة التربتوفان بنسبة ٠.٠٥% والمعاملة التاسعة عبارة عن عليقه منخفضة البروتين مع إضافة مخلوط كلا من التربتوفان بنسبة ٠.٠٥ % وحامض السيتريك بنسبة ٠.٣ % وكبريتات الصوديوم بنسبة ٠.٣. في اليوم الحادي والعشرون من التجربة تم تسجيل إنخفاض معنوي في وزن جسم كتاكيت التسمين المغذي علي عليقة منخفضة البروتين مقارنة بمجموعة المقارنة بينما أدت جميع إضافات الأعلاف إلى تحسين زيادة الوزن وكفاءة التحويل الغذائي مقارنة بالمجموعة المغذاه علي عليقة منخفضة البروتين. سجلت الطيور التي تم تغذيتها على خليط التيروزين وحامض الستريك وكبريتات الصوديوم أعلى قيمة لوزن الجسم وأفضل كفاءة للتحويل الغذائي. في اليوم الخامس والثلاثين من التجربة سجلت الطيور التي تم تغذيتها بخليط التيروزين وحامض السيتريك وكبريتات الصوديوم قيمة أعلى معنويا لوزن الجسم و كفاءة التحويل الغذائي بنسبة ٨.٦٣ و ٨.٥٣٪ على التوالي مقارنة بتلك التي تم تغذيتها على العليقة المقارنة ، وسجلت الطيور التي غذيت على خليط من التيروزين وحامض السيتريك وكبريتات الصوديوم أعلى قيم للبروتين الكلي والألبومين والكوليسترول الكلي في بلازما الدم. يمكن الاستنتاج أن إضافة التيروزين والتربتوفان وحامض السيتريك وكبريتات الصوديوم الي العليقة المنخفضة في البروتين حسنت أداء دجاج التسمين ليكون مثل تلك التي تم تغذيتها على عليقة المقارنة بينما تجاوز خليط التيروزين وحامض السيتريك وكبريتات الصوديوم عليقة المقارنة