EFFECT OF USING CINCHONA BARK AS A FEED ADDITIVE ON THE PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF BAHEIJ STRAIN DURING EARLY AND LATE PRODUCTION PERIODS

By

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Abstract: *The present study was carried out at EL-Sabahia Poultry Research Station, Animal Production Research Institute, Agricultural Research Center, Egypt to study the effect of adding cinchona bark at levels (0, 0.5, 1, 1.5 and 2 g/kg diet) on performance of Baheij laying hens as a local strain during the early (32-44 weeks of age) and late (45-57 weeks of age) production periods. A total number of 75 laying hens and 30 cockerels were nearly similar in body weight and were randomly divided into five equal treatment groups (15 hens, 6 cockerels each) and were individual housed in cages in an open system house. Eggs were collected and recorded daily; average feed intake (g) and feed conversion ratio were calculated monthly. Egg quality measurements were performed (as mean) at the 57th weeks of age on eggs produced in one day. Total protein, albumen, globulin, cholesterol, aspartate aminotransferase (AST), alanine aminotransferase (ALT), and leptin hormone were determined. Semen characteristics (sperm concentration, sperm motility percent, live and dead percent were measured. Economical efficiency was calculated for the experimental diets.*

The results obtained can be summarized as follows: Incorporating of cinchona bark at level of 0.05% into the basal diet gave a significant egg number and egg mass over those of the control group, during the whole experimental periods, while, the opposite was true with feed consumption which was decreased compared with those of the other treatments. Feed conversion during period of (32-44 weeks of age) and (45-57 weeks of age) were significantly improved for hens fed diets contain cinchona at level 0.5 gm/kg of diet. Addition of cinchona bark at level of 0.5 gm/kg of diet significantly increased total protein and leptin hormone compared to *control group and other treatments. Sperm concentration and viability were significantly increased as supplemented diet with cinchona bark levels compared to control group. Chick's weight at hatch did not significant affected by cinchona levels supplementation. The best economical efficiency (EE) was obtained when hens fed diet containing 0.5 gm/kg cinchona bark, followed by hens fed diet contains 0.1 gm/kg cinchona bark, respectively.*

INTRODUCTION

Natural feed additives of plant origin are generally believed to be safe, healthier, less subject to hazards and not accompanied by problems than that of the synthetic ones. Recently, using growth promoters obtained from herbal sources (medicinal plants) are very limiting, because of little information about them and their mode of action. In regard, reports have showed that, supplementing poultry diets with various herbs had favorable effects on the performance and health of broilers (El-Gendi, 1996).

Cinchona (*Quinine bark, quinan, quinine, kinakina, China bark, cinchona bark*) is a genus of about 25 species from the family Rubiaceae. It is cultivated in their native South America, and also in other tropical regions, notably in India and Java (http://en.wikipedia.org/wiki/Cinchona). They are large shrubs or small trees growing to 5-15 metres tall with evergreen foliage. The cinchona bark has 30 chemically related alkaloids, of which quinine ($C_{20}H_{24}O_2N_2$) is the most important. The alkaloids are formed during the descent of the sap and, therefore, its percentage is lowest in the twigs and it rises in the stem and is maximum in the root bark; the collar portion of about 30-45 cm in length is the richest portion. The percentage of total alkaloids increases till the age of 8 to 12 years and then begins to decline. (Payne, 1997). Cinchona bark is using as a tonic, stomachic and used in India to treat chronic malaria (Kotb, 1979). Many authors have undertaken studies on the antibacterial, antifungal, antiviral and antihumour effects of peganum harmala seeds (source of alkaloids) (Lamchouri *et al.* (1999).

The medicinally active bark, which is stripped from the tree, dried and powdered, includes other alkaloids that are closely related to quinine but react differently in treating malaria (Kitoh, *et al.*, 2005). Cinchona bark as a medicinal herb is also known as Jesuit's bark or Peruvian bark. In most domestic animals, reproductive function is considerably affected by nutrition (Armstrong and Benoit, 1996 and Williams, 1998). Various hormones, including growth hormone, insulin-like growth factors (IGFs) and insulin, have been proposed as potential mediators affecting reproductive function (Diskin, *et al.,* 2003). However, the interactions effect between the reproductive endocrine axis and the metabolic axis has not been clearly determined. Leptin represents also a good candidate for such reproductive-metabolic interactions. Leptin, the protein hormone synthesized and secreted mainly by adipose tissue, has primarily been shown to regulate food intake and energy expenditure (Friedman and Halaas, 1998; Houseknecht and Portocarrero, 1998 and Caprio, *et al.*, 2001).

The main target of this study was carried out to investigate the effect of using of cinchona bark as a natural feed additive on the productive and reproductive of Baheij as a local strain and avoid the bad side effects of the chemical additives.

MATERIALS AND METHODS

The present study was carried out at EL-Sabahia Poultry Research Station, Animal Production Research Institute, Agricultural Research Center, Egypt. This study was conducted to study the effect of adding cinchona bark at levels 0.0, 0.5, 1.0, 1.5 and 2.0 g/kg diet on productive performance, egg quality parameters, blood parameters, semen characteristics, fertility, hatchability percent and the economical efficiency of Baheij laying hens, (a local strain) during the two experimental periods (32-44) and (45-57) weeks of age.

A total number of 75 laying hens and 30 cockerels were nearly similar in their body weight; birds were randomly divided into five equal treatment groups containing 15 hens and 6 cockerels and housed in individual cages in an open system house. Birds were exposed to 17 hrs. light daily. Diets of 16% crude protein and 2703 kcal ME/kg were offered *ad libitum*, the experimental diets and their calculated analysis are presented in Table 1. Egg number and egg weight (g) were recorded daily and egg mass was calculated. Average feed intake (g) were measured monthly throughout the entire the experimental period and feed conversion ratio was calculated monthly.

Egg quality traits including external and internal components were determined and observations of egg quality traits were made on all collected eggs from each group in the same day (fresh laid egg during 57th weeks of age). Blood samples were withdrawn from hen's wing vein and centrifuged at 3500 rpm for 15 minutes. Serum was frozen at -20°C until analysis. Cholesterol, total protein, albumen, aspartate aminotransferase (AST), alanine aminotransferase (ALT) and leptin hormone were determined calorimetrically using available commercial kits.

Semen was collected twice weekly by the abdominal massage method to measure semen characteristics (sperm concentration, sperm motility percent and live & dead percent). Cockers in each treated group were artificially inseminated with the same hens group (15 hens/group). Eggs produced by hens were used to estimate fertility and hatchability. Chicks hatched were weighed to nearest gram on the day of hatch according to the treatment.

Economical efficiency (E.E) and relative economic efficiency (REE) during the first stage were performed and was defined as the net revenue per unit feed cost were calculated from input output analysis as described by Hassan *et al*. (1996). Analysis of variance was performed using SAS® software computer program (SAS, 1992) and Duncan's new multiple range test (1955) to test mean differences if a significant probability value was obtained.

RESULTS AND DISCUSSION

Productive performance

The effect of inclusion levels of cinchona bark containing laying hen's diets on egg number, egg mass, feed intake and feed conversion ratio during two successive production periods are presented in Tables (2 and 3). Generally, egg number of all dietary treatments along the whole experimental periods surpassed that of the un-supplemented diet, except the group of birds fed 2.0 g cinchona bark/kg of diet which was numerically less as equal to the control group during the periods 32-44 and 45-57 weeks of age, respectively. The inclusion level of 0.5 and 1.0 g cinchona bark/kg diet gave a significant average of egg number and egg mass over that of control by 15.6 and 17.9% for the group received 0.5 g cinchona bark, respectively, however the increasing were 13.5 and 15.0% for the group received 1.0 g cinchona bark during the period 32-44 weeks of age. The corresponding values were 51.6 and 56.0% for the group received 0.5 g cinchona bark at 32-44 weeks of age and were 19 and 19.2% at 45-57 weeks of age, respectively. During the first stage (32-44 week of old) results indicated that cinchona bark had no significant effects on feed intake, however it significantly decreased when addition of cinchona bark at level of 1.0 g/kg diet compared to control group during the second stage (45-57 weeks of age). The highest feed intake was recorded in hens fed the control diet, whereas the lowest average was recorded in hens fed diet containing 1 gm cinchona /kg diet.

Feed conversion at (32-44) and (45-57) weeks of age, was significantly improved for hens fed diets containing cinchona bark at levels 0.5 and 1.5 g/kg by 15.2 and 12.1% at 32-44 weeks of age, however, is significantly improved by 32 and 11.5% at 45-57 weeks of age respectively. These improvements may be due to the chemical constituents (alkaloids such as quinine) presented in cinchona bark. These chemical constituents had a tonic and stomachic effects (Kotb, 1979). The results of Abaza (2001) reported that addition of harmala seeds (contains alkaloids) decreased amount of feed intake than control group at any level of addition. Also, Abaza *et al*. (2003) noticed that addition of harmala seeds (contains alkaloids) at level of 0.25% to broiler diet improved feed conversion compared to control and antibiotics supplemented groups. Damron (2005) who found that, two species of *C.occidentalis* (source of alkaloids) reduced feed intake in the chicken. Hiroshi and Saori (2005) reported that, feed intake of quinine (0, 0.2, 0.4 and 0.8% for 3 or 4d as a single diet), depressed within the first 4h after the start of the experiment for 14-d-old chicks. There is no available data in the literature about the effect of cinchona bark on Productive performance in poultry.

Egg quality measurements

Data in Table (4) indicated that, various levels of cinchona bark containing diets did not significant affects egg quality parameters. However, addition of cinchona bark in the group fed 0.5 g/kg diet recorded the highest yolk weight %, shell thickness and yolk index as compared with other treatments and control group. Whereas, hens fed diets containing 2 g/kg cinchona bark recorded the highest shell weight % and egg shape index as compared with other treatment groups. The highest average of Haugh unit was recorded with hens fed diet contains 1.5 gm/kg cinchona bark, but the differenced among different treatments were not significant.

Blood parameters

Results of blood serum parameters are shown in Tables (5 and 6). Hens fed experimental diets showed a significant difference among treatments was recorded for cholesterol, total protein, albumen and leptin hormone. Addition of cinchona bark at level 0.5 g/kg, significantly increased total protein and leptin hormone compared to control group and other treatments. Hens fed diet containing cinchona bark at level 0.5 and 2 gm/kg diet recorded the lowest average plasma albumen. Increasing inclusion levels of cinchona bark containing diets resulted in the decrease average serum cholesterol. While, addition of cinchona bark showed insignificant effect on AST and ALT. (Table 5).

Data in Table (6) showed that, differences in leptin hormone were observed among experimental treatment groups through different experimental periods. It is worth to note that, serum leptin were significantly decreased with increasing cinchona bark supplementation to Baheij hen strain diet. Several studies conducted on theca and granulosa cells have shown that, leptin may have direct negative effects on ovarian steroidogenesis in various mammalian species. Leptin inhibits insulin-induced progesterone and 17β- estradiol production by isolated bovine granulosa cells [Spicer and Francisco, 1997] and impairs the hormonally-stimulated in vitro release of 17β-estradiol by rat granulosa cells [Zachow and Magoffin, 1997]. In granulosa cells from fertile women, leptin inhibits FSH and IGF-I stimulated estradiol production [Agarwal, *et al.,* (1999); Karlsson, *et al*., (1997)]

Semen characteristics evaluation

Data in Table (7) showed that supplementing diet with different levels of cinchona bark resulted in improve all semen characteristics when compared with those of the control group. Sperm concentration and viability were significantly increased by adding various levels of cinchona bark compared to those of the control group. Sperm motility is recognized as one of the most important criteria of semen quality and a determinant in the success of fertilization. In this respect, sperm motility of cockerels fed different levels of cinchona bark containing diets was significantly improved compared with those received the control group. There is no available literature about the effect of cinchona bark on semen characteristics.

Reproductive performance

Fertility and hatchability percentage of total eggs significantly increased by dietary supplementation of cinchona bark as shown in Table (8). Increasing inclusion levels of cinchona bark containing diet resulted in to increase fertility percentage. Eggs of hens fed diets containing cinchona bark at level 0.5 g/kg diet recorded the highest hatchability percentage compared to those of the control group and other treatments. Chick weight at hatch did not significantly affected by supplementing diets with cinchona levels. There is no available literature about the effect of cinchona bark on semen characteristics.

Economical efficiency

Results of economical efficiency (EE) and relative economic efficiency (REE) estimated for the experimental diets used during the first period of the study are shown in Table (9). According to the input-output analysis, the best relative economic efficiency (REE) was recorded for hens fed diet containing 0.5 g/kg cinchona bark, followed by hens fed diet contains 1 g/kg cinchona bark. These results indicated that, diets containing 0.5 or 1 g/kg diet cinchona bark recorded the best economical treatment than that of the control one. Therefore, it is recommended that economic study was affected by different levels of cinchona bark where, 0.5 gm/kg level increased economic efficiency. This improvement could be due to improve the feed conversion ratio and the increase in egg number.

Table (1): The ingredients and calculated analysis of the control diet.

Ingredients	**Basal diet (%)**
Yellow corn	63.50
Soyabean meal (44%)	24.57
Wheat bran	2.00
Limestone	7.77
Premix*	0.30
NaCl	0.30
Dicalcium phosphate	1.50
Dl-methionine	0.06
Total	**100**
Calculated analysis**	
ME (Kcal/kg)	2703.34
Crude protein, %	16.00
Crude fiber, %	3.47
Crude fat, %	2.86
Calcium, %	3.32
Available phosphorus, %	0.406
Lysine, %	0.889
Methionine, %	0.350
Methionine+Cystine, %	0.620
Sodium, %	0.135
Price (L.E) per ton diet	**1013.07**

* Vitamins and minerals premix contain per 3kg Vit A 10 000 000 IU , Vit D3 2000 000 IU,Vit E 10000mg,Vit K3 1000mg, Vit B1 1000mg, Vit B2 5000mg, Vit B6 1500mg, Vit B12 10mg, pantothenic acid 10000mg, Niacin 30000mg, Biotin 50mg, Folic acid1000mg, Choline 250gm, Selenium 100mg, copper 4000mg, iron 30000mg,manganess 60000mg, zinc 50000mg,iodine 1000mg,cobalt 100mg and CaCO3 to 3000g.

** According to feed composition table for animal and poultry feedstuffs used in Egypt (2001).

Table (2): Effect of incorporating cinchona bark levels into basal diet on productive performance of laying hens during (32-44) weeks of age.

Traits / Treatments	Egg. No.	Egg mass (kg)	Feed intake (g/hen/day)	Feed conversion ratio
Control	39.35±4.77^{b}	1939.96±133.61^{b}	116.00±0.11	5.38±1.00^{a}
0.5 g/kg	45.50±2.51^{a}	2286.87±132.56^{a}	115.75±0.02	4.56±0.40^{b}
1.0 g/kg	44.67±1.8^{a}	2231.52±85.69^{a}	117.22±0.49	4.73±0.22^{b}
1.5 g/kg	41.33±5.8^{ab}	2069.18±149.79^{b}	116.24±0.05	5.06±0.73^{ab}
2.0 g/kg	38.00±4.01^{ab}	1869.62±188.97^{b}	116.13±0.02	5.59±0.69^{a}

a and b means with different letters in the same row are significantly different at $P \leq 0.05$.

Table (3): Effect of incorporating cinchona bark levels into basal diet on the productive performance of laying hens during (45-57) weeks of age.

Traits / Treatments	Egg. No.	Egg mass (Kg)	Feed intake (g/hen/day)	Feed conversion ratio
Control	21.00±0.53[c]	1030.00±16.75[c]	118.57±0.41[a]	9.67±0.010[a]
0.5 g/kg	30.83±0.31[a]	1605.93±22.45[a]	117.43±0.04[b]	6.58±0.003[c]
1.0 g/kg	25.00±0.58[b]	1227.5±18.92[b]	116.71±0.08[c]	8.56±0.001[b]
1.5 g/kg	22.00±0.23[c]	1054.3±14.48[c]	115.59±0.09[d]	9.97±0.001[a]
2.0 g/kg	21.0±0.31[c]	1047.90±14.58[c]	116.14±0.04[c]	9.97±0.001[a]

a,b and c means with different letters in the same row are significantly different at P≤0.05.

Table (4): Effect of incorporating cinchona bark levels into basal diet on external and internal egg quality parameters of laying hen during period of (45-57) weeks of age.

Treatments / Traits	Control	0.5 g/kg	1.0 g/kg	1.5 g/kg	2.0 g/kg
Egg weight	40.90±0.51[b]	52.06±0.76[a]	49.09±0.34[a]	47.96±0.60[a]	49.83±0.74[a]
Albumen weight (%)	50.44±0.005	54.33±0.006	54.60±0.003	54.52±0.004	54.22±0.004
Yolk weight (%)	28.05±0.004	32.51±0.004	32.04±0.003	31.93±0.004	32.16±0.004
Shell weight (%)	12.58±0.002	13.16±0.002	13.40±0.001	13.55±0.002	13.72±0.002
Egg shape index	68.40±0.60	74.18±0.61	74.75±0.26	74.44±0.53	76.21±0.64
Yolk index	5.25±0.14	5.66±0.09	5.19±0.03	5.18±0.05	5.32±0.07
Haugh unit	78.39±2.32	77.99±2.45	80.83±0.85	81.86±1.47	77.98±1.75
Yolk color	7.00±0.37	6.95±0.35	7.06±0.12	7.68±0.22	6.60±0.23
Shell thickness (mm)	0.334±0.001	0.357±0.002	0.345±0.002	0.339±0.005	0.354±0.004

a and b means with different letters in the same row are significantly different at P≤0.05.

Table (5): Effect of incorporating cinchona levels into basal diet on blood parameters of laying hens during period of (45-57) weeks of age.

Treatments / Traits	Control	0.5 g/kg	1.0 g/kg	1.5 g/kg	2.0 g/kg
Cholesterol (mg/dl)	142.50±2.64[a]	141.00±9.05[a]	127.50±7.98[b]	115.00±6.84[c]	108.50±4.48[c]
T. protein (g/dl)	2.75±0.07[b]	4.05±0.06[a]	3.75±0.04[ab]	2.95±0.03[b]	3.75±0.04[ab]
Albumen (g/dl)	2.15±0.08[a]	1.60±0.06[b]	2.35±0.08[a]	2.15±0.09[a]	2.15±0.07[a]
Globulin (g/dl)	0.60±0.001	2.45±0.01	1.40±0.002	0.80±0.001	1.60±0.002
AST (U/L)	110.05±.00	111.30±2.30	110.95±0.98	112.00±1.00	111.80±1.50
ALT (U/L)	17.10±0.03	16.90±0.02	16.80±0.04	17.30±0.62	17.40±0.03

a,b and c means with different letters in the same row are significantly different at P≤0.05.

Table (6): Effect of incorporating cinchona levels into basal diet on serum leptin of laying hens.

Treatments / Traits	Control	0.5 g/kg	1.0 g/kg	1.5 g/kg	2.0g/kg
Leptin(mg/ml) (32-44 weeks of age)	1.76±0.19[b]	2.12±0.17[a]	2.00±0.21[a]	1.96±0.18[ab]	1.94±0.09[ab]
Leptin (mg/ml) (45-57 weeks of age)	0.93±0.01[c]	1.53±0.10[a]	1.39±0.11[b]	1.30±0.12[b]	0.92±0.05[c]

a, b and c means with different letters in the same row are significantly different at P≤0.05.

Table (7): Effect of incorporating cinchona levels into basal diet on semen characteristics during period of (45-57) weeks of age.

Traits \ Treatments	Control	0.5 gm/kg	1.0 gm/kg	1.5 gm/kg	2.0 g,m/kg
Sperm concentration (10^9/ml)	0.70±0.1[b]	0.84±0.08[a]	0.83±0.10[a]	0.87±0.09[a]	0.85±0.12[a]
Sperm motility (%)	86.90±1.9[b]	87.03±2.0[b]	87.93±2.1[b]	90.75±1.3[a]	90.80±1.9[a]
Viability (%)	76.2±2.50[b]	82.3±2.30[a]	83.3±2.53[a]	83.0±1.31[a]	82.34±2.40[a]

a and b means with different letters in the same row are significantly different at P≤0.05.

Table (8): Effect of incorporating cinchona levels into basal diet on fertility, hatchability percent and chicks hatching weight (g)

Traits \ Treatments	Control	0.5 g/kg	1.0 g/kg	1.5 g/kg	2.0 g/kg
Fertility (%)	78.40±2.55[b]	95.13±1.50[a]	97.37±2.49[a]	97.90±3.18[a]	98.11±3.00[a]
Hatchability (%)	80.37±2.93[b]	93.44±2.17[a]	92.94±1.99[a]	91.00±2.87[a]	92.45±3.91[a]
Chick hatching weight (g)	31.94±1.12	34.35±0.84	33.32±0.91	34.00±1.00	32.14±0.83

a and b means with different letters in the same row are significantly different at P≤0.05.

Table (9): Effect of different experimental diets on Economical Efficiency (E.EF) of layer hens during the early stage.

Level of cinchona (g/kg diet)	Average (E.N)[1]	T.revenu/hen (L.E)[2]	T.F.C[3]	F.Cost (Kg) L.E[4]	Net rev/hen (L.E.)[5]	E.E.[6]	R.EE[7] (%)
Basal diet + 0.0	39.35	19.68	10.44	10.59	9.10	0.860	100
Basal diet + 0.5	45.50	22.75	10.42	10.56	12.19	1.154	134.2
Basal diet + 1.0	44.67	22.34	10.55	10.69	11.65	1.090	126.7
Basal diet + 1.5	41.33	20.67	10.46	10.60	10.07	0.950	110.5
Basal diet + 2.0	38.00	19.00	10.45	10.59	8.41	0.794	92.3

- Price of individual (egg hatching) was 0.5 L.E at experimental time.
- Price of the basal diet and test material used in the experimental diets. L.E/kg diet 1.013 cinchona 20.0.

[1] Average egg number
[2] Total revenue/hen
[3] Total feed consumption (T.F.C.)
[4] Feed Cost
[5] Net revenue = (2-4)
[6] Economic efficiency (EE) = 5/4
[7] Relative economic efficiency (REE), assuming control treatment = 100%

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الملخص العربي

تأثير استخدام قلف الكينا كإضافة غذائية على الأداء الانتاجى و التناسلي لسلالة بهيج المحلية خلال المرحلة المبكرة و المتأخرة للإنتاج

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أجريت هذه الدراسة بمحطة بحوث الدواجن بالصبحية، لدراسة تأثير إضافة قلف نبات الكينا بمستويات (0، 0.5، 1، 1.5، 2 جرام/كجم علف) على الأداء الإنتاجي والتناسلي لسلاله بهيج المحلية و ذلك خلال فترتين (32–44) و (45–57) أسبوع من العمر. و قد أستخدم في هذه الدراسة 75 دجاجة بياضة و30 ديك تم تقسيمهم إلى 5معاملات وبكل معامله 3 مكررات و تحتوى كل مكررة على 5 دجاجات و2 ديك في أقفاص فردية. تم تجميع البيض و تسجيله يومياً وكذلك تم قياس استهلاك العلف والكفاءة التحويليه، كما تم قياس جودة البيض في المرحله الأخيرة، تم تقديرالبروتين الكلى– الالبيومين – الجلوبيولين – الكوليستيرول، كذلك تم تقدير ALT, AST في سيرم الدم كما تم تقدير هرمون الليبتين. تم عمل اختبارات جودة السائل المنوى و الخصوبة و التفريخ و تم وزن الكتاكيت عند الفقس من المعاملات المختلفة.

أوضحت النتائج ما يلى:

١. إضافة قلف الكينا إلى العلائق بنسبه 0.5 جم/كجم علف حسن معنويا عدد وكتله البيض عن الكنترول و كذلك عن بقيه المعاملات المختلفة خلال مراحل الإنتاج.

٢. تم تسجيل افضل كفاءة تحويليه للدجاج الذي تغذى على 0.5 جم قلف الكينا/كجم علف مقارنة بالمعاملات الاخرى

٣. إضافة قلف الكينا إلى العلائق بنسبه 0.5 جم قلف الكينا/كجم علف أدت إلى زيادة نسبة البروتين الكلى و الجلوبيولين و هرمون الليبتين في سيرم الدم عن بقيه المعاملات.

٤. تركيز الحيوانات المنوية و حيوتها كانت أعلى عند إضافة نبات الكينا بالمستويات المخلتفة عن الكنترول.

٥. العلائق التى احتوت على نبات الكينا بمستوى 0.5 جم/كجم و كذلك 1 جم/كجم اعطت افضل كفاءة اقتصادية نسبيه عن الأعلاف الأخرى.