HIGH LEVELS OF ASCORBIC ACID IN LAYER DIETS UNDER HOT CLIMATE

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Abstract

An experiment using Gimmizah sp. hens was conducted to study the effect of high levels of Ascorbic Acid (AA) on layer productive performance and egg traits under hot climate. Four experimental diets were involved in the experiment : Basal layer diet (B), B + 500, 1000 or 2000 ppm AA. The experiment used forty-eight hens (60 weeks of age) for three 4-week interval (June, July and August). Hens were fed on the experimental treatments in triplicate, four hens each. At the end of each interval, the productive performance and egg traits parameters were measured. The multi-layer structure of the egg shell was studied using electron-micrography.

Results of the overall period (the average of the three intervals) showed significant effect of AA supplementation on the productive performance. The level of 500 ppm increased egg number (EN), egg mass (EM) and feed efficiency (FE) 7.02, 10.87 and 10.10% relative to the basal (without supplementation), respectively. Further increase was obtained at higher levels. The level of 1000 ppm gave 14.04, 13.94 and 30.60% further increase as compared to the level of 500 ppm, whereas, 2000 ppm of AA showed 12.70, 2.07, 15.70 and 15.89% additional increase in EN, EW, EM and FE, respectively as compared to 1000 ppm level.

As regard to egg traits, 500 and 1000 ppm AA increased significantly yolk weight (YW) %, whereas, no significant effect could be found at 2000 ppm in all egg traits parameters. However, the results of the first interval (June) revealed significant increase in shell thickness at 2000 ppm. Electronmicrography confirmed also greater strength of the egg shell due to such treatment.

The economic evaluation of AA supplementation demonstrated 3.11, 14.3 and 17.5% decrease in feed cost/kg eggs at 500, 1000 and 2000 ppm AA, respectively.

INTRODUCTION

Early reports supported the hypothesis that poultry do not require dietary ascorbic acid (AA) (Emmett and Peacock 1922, Mitchell *et al.* 1923 and Sugiura and Benedict 1923). The birds actively synthesize AA primarily in the kidneys in sufficient quantities to cover their physiological needs. Chaudhuri and Chatterjee (1969) reported that the fowl can synthesize 120 ug vitamin c/mg protein/hour in vitro. The mean concentration of the acid in the blood averages overall poultry breeds, ages and sexes approaches 14.0 ug/ml in the absence of adverse stimuli (Pardue and Thaxton 1986) .

Several stress factors are known to alter AA utilization and / or synthesis. These include environmental, pathological and nutritional stress factors. High ambient temperature is the major environmental stress factor which causes complicated metabolic reactions such as panting, respiratory alkalosis and reduced thyroid activity (Dale and Fuller 1980) These changes often result in substantially reduced growth and reproductive performance. Attia (1976) reported that blood AA declined by 23% in hens that were maintained at 15°C and then transferred to 32°C environment. Therefor, it was reported by many investigators that under high temperature birds need supplement of AA in the diet (Ahmed *et al.* 1967 and Attia 1976).

Hot climate of Upper Egypt in the summer season may be one of the causal factors of low productivity of chickens. Therefore, the present study aimed at evaluating the effectiveness of AA dietary supplementation on the productive performance of local strain layers exposed to environmental heat stress.

MATERIALS AND METHODS

The present study involved one layer experiment using Gimmezah hens (Egyptian Local Strain). The experiment was conducted in Seds Poultry Research Station, Beny Sweef, Animal Production Research Institute, during June, July and August, 1995.

Forty-eight Gimmezah layers (60 weeks of age) were selected from the farm flock to be similar in weight and productivity. They were assigned according to their weights in 12 layer groups having nearly the same average weight, and placed in standard layer wire cages.

Four experimental treatments were fed to the experimental groups in triplicate, 4 hens each. They were based on a basal layer diet (Table 1) to be supplementated with AA at three levels: 500 ppm, 1000 ppm and 2000 ppm. The supplemental levels of AA was incorporated in the basal diet using Rovimix 20% AA [Hoffmann-La Roche, Inc., Basel, Switzerland]. The product was assessed for AA concentration following the procedure of AOAC (1984) using HPLC. Results confirmed the manufacturer's label. The product was mixed in the feed at biweekly interval at a rate equivalent to the required AA levels in ppm .

The basal diet covered all the essential nutrients according to the Ministerial decree No 554 (1984). Layers were fed the experimental treatments for 12 weeks for 3 subsequent 4-weeks interval. Feed and water were provided *ad lib* for 16 hours photo period per day .

At the end of each interval, the productive performance parameters : egg number (EN), egg weight, g (EW), egg mass, kg (EM), feed intake, kg (FI) and feed efficiency, kg egg/kg feed, (FE) were measured. Egg traits parameters: shell weight % (SW), shell thickness, mm (ST), albumin weight % (AW), yolk weight, % (YW), albumin height, mm (AH) and yolk high, mm (YH) were also measured for each experimental interval.

The photomicrographs demonstrating the ultra-structure of the shell membrane were taken by the electron microscope belonging to the National Research Center, NRC, Dokki.

Ambient temperatures during the experiment were recorded daily. Body temperature was also measured from the layer cloaca.

Data obtained from this experiment were tested for significance of AA supplementation effect and interval effect by two-way ANOVA using SAS (1982) procedures. Duncan's multiple range test was performed for means separation when the effect was significant.

RESULTS AND DISCUSSION

The effect on body temperature :

Records of ambient temperatures during the subsequent intervals are illus-

Table 1. Composition and analysis of the basal layer diet .

Ingredients	%
Yellow maize	67.0
Protein concentrate (50 %)*	10.0
Lime stone	7.0
Maize gluten (60%)	5.0
Soya bean meal (44%)	5.0
Sun flower meal	3.0
Wheat bran	2.8
L-Lysine	0.2
Total	100
Chemical Analysis**	
Crude protein, N X 6.25%	17.0
Metabolizable energy, kcal/kg	2850
Calcium %	3.54
Available phosphorus, %	0.40
Lysine	0.80
Methionine	0.44

* Protein concentrate, LMP International company, Belgium.

** Calculated according to NRC, 1994 feed composition tables.

Table 2. Effect of AA dietary supplementation on the productive performance.

Item	Basal	Ingredients			Mean
		1	2	3	
1st interval					
average EN	12.67 c	13.17 c	13.34 c	16.67 a	14.46 a
average EW	51.30 b	51.94 b	52.29 b	54.56 a	52.52 a
average EM	0.655 c	0.684 c	0.802 b	0.909 a	0.763 b
average FI	3.20 a	3.13 ab	3.05 b	3.06 b	3.11 a
average FE	0.205 c	0.219 c	0.246 b	0.298 a	0.247 a
2nd interval					
average EN	11.34 c	12.00 bc	13.34 b	15.50 a	13.05 a
average EW	51.82 b	52.23 ab	53.13 a	53.22 a	52.60 a
average EM	0.588 c	0.627 c	0.708 b	0.825 a	0.687 b
average FI	2.74 a	2.72 a	2.62 ab	2.58 b	2.66 b
average FE	0.215 c	0.231 c	0.271 b	0.321 a	0.259 a
3rd interval					
average EN	7.34 c	8.17 bc	9.34 b	10.67 a	8.88 b
average EW	48.68 c	44.84 bc	50.91 ab	51.80 a	50.30 b
average EM	0.357 c	0.434 bc	0.475 ab	0.552 a	0.429 c
average FI	02.74 a	2.69 ab	02.60 b	02.60 b	02.66 b
average FE	0.131 d	0.152 c	0.183 b	0.212 a	0.169 b
overall average					
average EN	10.45 d	11.11 c	12.67 b	14.28 a	--
average EW	50.60 c	51.33 bc	52.11 b	53.19 a	--
average EM	0.533 d	0.581 c	0.662 b	0.762 a	--
average FI	2.89 a	2.84 b	2.75 c	2.74 c	--
average FE	0.183 d	0.200 c	0.239 b	0.277 a	--

Averages in the same row having the same small letter are statistically insignificant (P>0.05).
Means of the same parameters having the same capital letter are statistically insignificant (P>0.05).

Table 3. Percent changes in productive performance parameters of AA treatments relative to the basal* .

Item	AA levels		
	level 1	level 2	level 3
1st interval			
average EN	3.95	21.07	31.57
average EW	1.25	1.93	6.35
average EM	4.43	22.44	38.78
average FI	-2.19	-4.69	-4.58
average FE	6.83	28.78	45.37
2nd interval			
average EN	5.82	17.64	36.68
average EW	0.79	2.53	2.70
average EM	6.63	20.41	40.31
average FI	-0.73	-4.38	-5.84
average FE	7.44	20.05	49.30
3rd interval			
average EN	11.31	27.25	45.37
average EW	2.38	4.58	6.41
average EM	21.57	33.05	54.62
average FI	-1.62	-5.11	-5.11
average FE	16.03	39.69	61.83
overall average			
average EN	7.02	21.98	37.87
average EW	1.47	3.01	5.15
average EM	10.87	25.30	44.57
average FI	-4.54	-4.72	-5.11
average FE	10.10	29.50	52.16

* Basal = 0.0

trated in Figure 1. It was found that the mean value ± SD in the 1st interval (June), 2nd interval (July) and 3rd interval (August) was 29.89 ± 2.65, 34.59 ± 3.2 and 34.59 ± 1.54°C, respectively. Irrespective of AA supplementation treatments, the mean value of cloacal temperature (CT) was 41.07 ± 0.30 during July and 41.20 ± 0.31 during August. Cloacal temperatures during June were not recorded. Difference between July and August cloacal average temperature was slight, however, difference in ambient average temperature was 4.16°C.

CT of layers fed the basal diet in July averaged 40.71 ±0.247°C in CT. Supplementation with the three levels of AA did not show significant effect on body temperature. However, when ambient temperature increased obviously during August (Ca. 41°C), the CT increased slightly. Results of AA supplementation could not show a pronounced decrease in CT. This is not in agreement with results reported by Ahmed *et al.* (1967). They found significant decrease in body temperature of 18-month old laying hens exposed to environmental temperature 29.4 and 35°C with AA supplementation. Also, Attia (1976) demonstrated that AA reduced body temperature in 7 and 13-months old hens transferred from 15 to 32°C. He also showed that the 0.39°C increase in body temperature decreased to be 0.33°C with 100 ppm AA.

Productive performance :

Results showing the effect of supplementing layer diet with 500,1000 and 2000 ppm AA on the productive performance parameters throughout the experimentla intervals are shown in Table 2 .

During the 1st interval the basal diet (without AA supplementation) gave 12.67, 51.30, 0.650, 3.2 and 0.203 in EN, EW, EM, FI and FE, respectively. Level 1 of AA could not affect all these parameters significantly, whereas, level 2 increased EN, EM and FE significantly. The relative increase was found to be 21.07%, 22.4% and 28.78%, respectively as compared to the basal. Insignificant effect was obtained in EW, whereas, FI value of levle 2 decreased significantly by 4.69. Concerning level 3, significant increase in all parameters except FI occurred. Values in EN, EW, EM and FE relative to those of the basal were 31.57%, 6.35%, 38.78% and 45.37%, respectively. A significant decrease in FI (4.37%) was found with this level. Comparing the effect of level 2 with level 3 resulted in significant differences in all parameters except FI. Level 3 showed an increase of 8.67%, 4.34%, 13.3% and 12.8% in EN, EW, EM and FE, respectively as compared to level 2.

The basal diet in the 2nd interval gave values of 11.34, 51.82, 0.588, 2.74

Table 4. Effect of AA dietary supplementation on egg traits .

Item	Basal	AA levels			Mean
		1	2	3	
1st interval					
average EW	52.54 a	53.13 a	56.22 a	53.97 a	53.97 a
average SW	11.17 a	12.78 a	11.35 a	13.24 a	12.13 a
average ST	0.33 b	0.35 b	0.34 b	0.41 a	0.357 a
average AW	53.82 a	49.09 b	50.44 b	51.50 ab	51.21 a
average YW	35.04 a	38.11 a	38.20 a	35.27 a	36.65 a
average AH	0.45 a	0.45 a	0.50 a	0.55 a	0.487 a
average YH	2.00 a	1.90 a	1.95 a	2.00 a	1.962 a
2nd interval					
average EW	51.80 a	51.39 a	54.68 a	54.29 a	53.05 a
average SW	9.98 a	8.98 a	9.26 a	9.74 a	09.49 b
average ST	0.28 a	0.26 a	0.23 a	0.25 a	0.255 b
average AW	50.58 a	52.37 a	49.39 a	52.77 a	51.28 a
average YW	39.44 a	38.65 a	41.36 a	37.91 a	39.34 a
average AH	0.55 a	0.55 a	0.60 a	0.65 a	0.587 a
average YH	1.80 a	1.65 b	1.85 a	1.85 a	1.787 a
3rd interval					
average EW	49.61 a	42.37 a	52.91 a	51.80 a	49.17 a
average SW	11.67 a	12.66 a	11.16 a	11.21 a	11.675 a
average ST	0.33 a	0.32 a	0.37 a	0.35 a	0.345 a
average AW	54.50 a	48.51 a	52.51 a	51.31 a	51.70 a
average YW	33.84 b	38.84 a	36.34 ab	33.53 b	35.63 a
average AH	0.70 a	0.70 a	0.60 ab	0.55 b	0.637 a
average YH	1.825 a	1.80 a	1.80 a	1.85 a	1.85 a
overall average					
average EW	51.34 ab	48.46 b	54.60 a	53.35 a	---
average SW	10.94 a	11.47 a	10.59 a	11.39 a	---
average ST	0.31 a	0.31 a	0.31 a	0.33 a	---
average AW	52.97 a	49.99 a	50.78 a	51.86 a	---
average YW	36.10 b	38.53 a	38.62 a	35.57 b	---
average AH	0.57 a	0.57 a	0.57 a	0.58 a	---
average YH	1.87 ab	1.78 b	1.88 a	1.90a	---

Averages in the same row having the same small letter are statistically insignificant (P>0.05).
Means of the same parameters having the same capital letter are statistically insignificant (P>0.05).

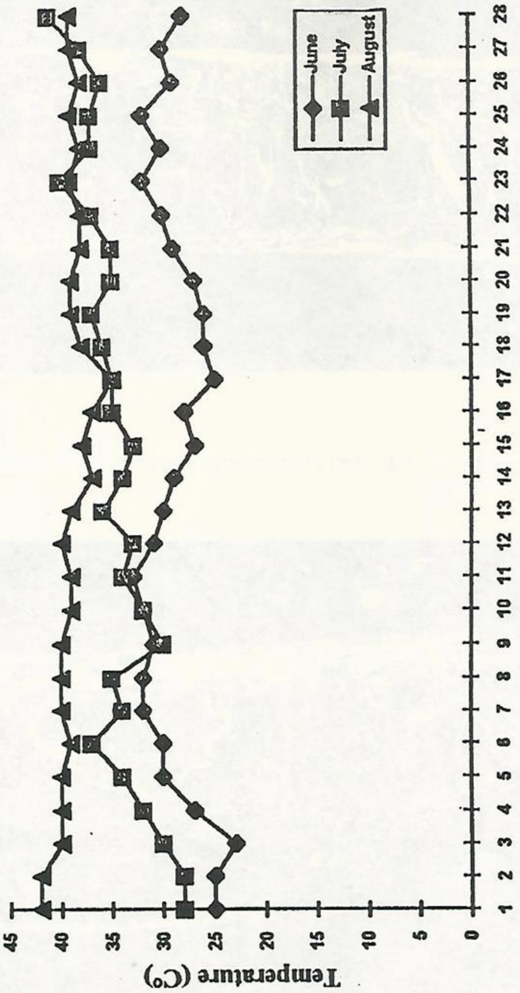

Fig. 1. Environmental temperature through June, July and August.

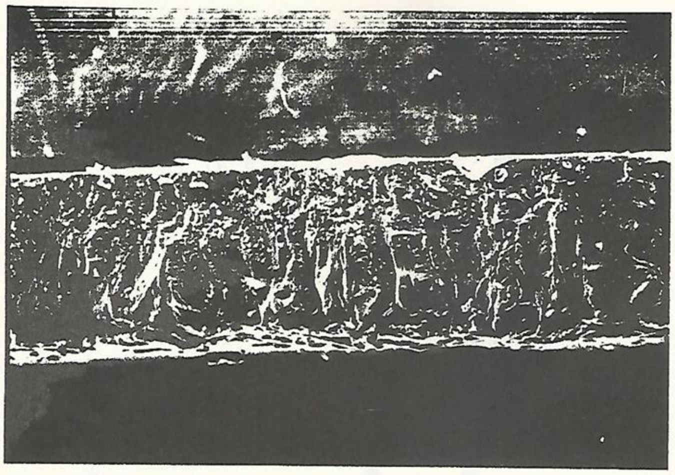

Figure 2. Egg shell photomicrograph of the basal diet.

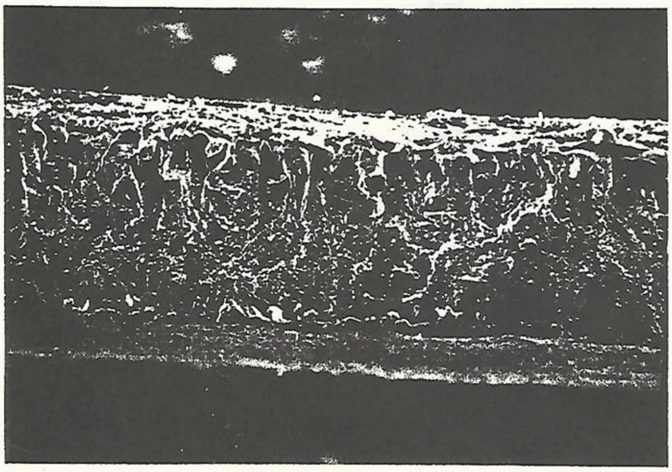

Figure 3. Egg shell photomicrograph of the basal diet plus 2000 ppm AA .

and 0.215 in EN, EW, EM, FI and FE, respectively. Level 1 of AA did not affect the productive performance parameters significantly. However, level 2 increased EN, 17.64%, EW 2.53%, EM 20.41% and FE 20.05%, whereas, FI was not affected significantly. relative to the values of the basal. At level 3, EN, EW, EM and FE increased 36.68%, 2.70%, 40.31% and 49.30%, respectively, and decreased significantly FI by 5.84%. Difference between level 2 and 3 was significant in all parameters except EW and FI. Level 3 was 16.19% higher in EN, 16.5% in EM and 18.45% in FE than level 2.

Values obtained in the 3 rd interval were 7.34, 48.68, 0.357, 2.74 and 0.131 in EN, EW, EM, FI and FE, respectively. Level 1 of AA increased significantly FE 16.03% relative to that of the basal, wherase, other parameters were not affected significantly. The second level of AA (1000 ppm) affected significantly these parameters. Values of EN, EW, EM, and FE, were found to be 27.25%, 4.58%, 33.05% and 39.69% higher than those of the basal, respectively. FI value was significantly lowered 5.11%. On the other hand, level 3 was found to be significantly higher than level 2 only in FE (15.8%).

Results of the overall experimental period revealed that, supplementing the basal diet with the three graded levels of AA had a progressive significant effect on EN, EM, and FE. Level 1 increased these parameters by 7.02%, 10.87% and 10.10%, respectively, as compared to those of the basal. Level 2 gave values 14.04%, 13.94% and 30.6% more than those of level 1, whereas, level 3 gave 12.7%, 2.07%, 15.7% and 15.89% further increase in EN, EW, EM and FE as compared to the previous level. Differences between level 2 and 3 in FI and level 1 and 2 in EW were insignificant.

It could be concluded from these results that supplementing Gimmizah layers diet with 500 ppm AA (level 1) improves the productive parameters under ambient temperature range of 29-41^{o}C dominated in Seds. This finding is, in part, in agreement with that obtained by Perek and Kendler (1962), Pardue adn Thaxton (1986). As regard to the further improvement obtained with 1000 and 2000 ppm AA in the present study, Herrick and Nockels (1969) did not obtain significant increase in egg production or egg weight at 2000 ppm. However, Chen and Nockels (1973) obtained positive effect at 1322 and 3000 ppm which could be in agreement, in part, with the results of the present study.These results were found to be in contrast with those of kechik and Sykes (1974), Herrick and Nockels (1969), Rowland *et al.* (1973) and Bell and Marion (1990) when they used from 400 to 2600 ppm AA in layer diets.

No research papers on AA supplementation of layer demonstrated the increase of the beneficial effect of AA with the increase of the acid supplementary level.

Irrespective to AA supplementation levels, statistical analysis of results representing the interval effect showed significant difference between the three intervals in the mean value of each parameter of egg production. The 3rd interval (August : 38.75 ± 1.54°C) gave the lower mean value of EN: 8.88, EW : 50.3, EM: 0.429, FI : 2.66 and EF : 0.169, as compared to the 1st and the 2nd interval where difference was insifgnificant in all parameters except FI. In the 2nd interval FI was significantly 14.46% less than that in the 1st interval.

On the other hand, it can be noticed that, values of the productive performance parameters of each suppleementary level of AA relative to those of the basal (Table 3) increase obviously from the 1st to the 3rd interval, and from level 1 to level 3 of AA. The 3rd interval and level 3 revealed the maximum relative improvement on productive performance. Improvement was found to be 45.37% in EN, 6.41 in EW, 54.62 in EM and 61.83% in FE. These findings may indicate that AA supplementation is more effective under high ambient temperature and at higher supplementary levels of AA. In addition, improvement could be obtained with higher AA supplementary levels to achieve the same productivity realized under low or moderate temperatures. Our results herein with those of Nockels (1973) confirm te hypothesis that AA apears to be of greatest benefits when hens are exposed to heat stress but when conditions are mild it will give little value.

Egg traits :

Results showing the effect of AA supplementation on egg traits parameters are presented in Table 4. It was found from the results of the 1st interval that, the basal diet gave values of 52.54, 11.17, 0.33, 53.82, 35.04, 0.45 and 2.00 in EW, SW, ST, AW, YW, AH and YH, respectively. Levels 1 and 2 of AA could significantly decrease AW giving relative decrease of 8.78% and 6.28%, respectively, as compared to the basal. Level 3 did not affect this parameter significantly. All other utilized parameters were found to be unaffected by AA supplementation except ST which significantly increased 12.7% by this level relative to the basal .

In the 2nd interval, insignificant effect could be found on egg traits parameters except a significant decrease in YH (8.33%) at level 1. A significant effect of level 1 and 3 of AA on YW and AH, respectively, was found in the 3rd interval. Level 1 increased YW 14.77% and level 3 increased AH 2.7% relative to the basal.

The overall results revealed insignificant effect of AA supplementation on EW, SW, ST, AW, AH and YH. The only effect was that of level 1 and 2 on YW. They increased the value 6.73 and 7.00% over the basal, respectively, without significant difference between them.

Statistical analysis showed insigificant effect of interval on egg traits parameters.

The ineffectiveness of AA supplementation on most egg traits and in particular on shell thickness as an overall results agreed to that found by Perek and Kendler (1962, 1963) at 400 ppm AA, (Kechik and Sykes 1974) at 500 ppm, Heywang and Kemmerer (1955), Heywang *et al.* (1964) at 1000 ppm or Herrick and Nockels (1969) at 2600 ppm. However, several researchers demonstrated positive effect on egg shell thickness at low levels (Thornton and Moreng 1958) at 22 ppm (El-Boshy *et al.* 1968). In contrast, Ahmed *et al.* (1967) showed a significant decrease in egg shell thickness at 50 ppm AA.

Multistructure of egg shell membrane :

Improvement of egg shell thickness was obviously found in the 1st interval, while the basal diet was supplemented with 2000 ppm AA. From the photomicrographs of egg shell for the basal (Figure 2), and that for this effective level (Figure 3), it can be clearly seen that the egg shell of the latter treatment was more thick than the former. Inspection of the fine layers of the shell membrane revealed relatively more dense and narrow mammillary knob with larger palisade layer. The crystalline layer was also found to be more thick. In this respect, Simons (1971) suggested that, the higher density of mammillae confirmed greater strength characteristics to the shell. Accordingly, our finding may refer to greater strength of the egg shell with AA supplementation. However, Van Toledo (1982) observed that, mammillary knob density was lower and diameter is greater in eggs from high breaking strength lines of layers.

Economical evaluation of AA supplementation :

The economical evaluation of supplementing layer diet with AA is presented in Table 5. According to market price of the commercial AA (20%), and the inclusion rate in the feed, 2.5 (500 ppm), 5.0 (1000 ppm), 10 (2000 ppm) kg/ton, total feed cost increased 6.1, 12.3 and 24.6%, respectively. Due to improved egg mass production, feed cost/kg eggs decreased 3.17% at 500 ppm, 14.3% at 1000 ppm, and 17.5% at 2000 ppm AA. It could be concluded from these results that the economical values of AA supplementation increase with the increase of AA inclusion rate. The manufacturer always recommends 100-200 ppm as optimum level of AA in layer diets which is far below that obtained in the present study (500 ppm) under ambient temperature range of 29.89 ± 2.65 - 38.75 ± 1.54°C. However, recent trial showed an effective high dose (600 ppm) at 23 - 39°C (Basil 1990).

It seems that, the optimum dose is for maintaining normal egg weight and egg production, wherease, high doses evaluated in the present study may surpass this effect of AA under heat stress.

Table 5. Economics of supplementing layer diet with AA .

Item	Basal	A.A. * levels (ppm)		
		500	1000	2000
Feed Price (pt/kg)	65.0	69.0	75.0	81.0
Total feed intake / hen (kg)	8.68	8.54	8.27	8.24
Total feed cost / hen (pt)	564.2	589.2	603.7	667.44
Total egg weight / hen (kg)	1.586	1.711	1.981	2.275
Feed cost / kg eggs (pt)	355.7	344.4	304.7	293.4
Feed cost % basal	100	96.8	85.7	82.5

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إستخدام مستويات عالية من حمض الأسكوربيك في علائق الدجاج البياض تحت ظروف الجو الحار

مصطفي يوسف عطيه ، مختار أحمد أبو العلا ، حمدي محمد فائق ، محمد عبد العزيز عبد الجليل

معهد بحوث الأنتاج الحيواني - مركز البحوث الزراعية - جيزة - مصر .

يهدف هذا البحث إلي دراسة تأثير المستويات العالية من حمض الأسكوربيك علي الأداء الأنتاجي للدجاج البياض المحلي (جميزة) في الجو الحار.

تم في هذا البحث إجراء تجربة اشتملت علي أربع معاملات : عليقة دجاج بياض إنتاجي عليقة أساسية ، العليقة الأساسية مع إضافة حمض الأسكوربيك بثلاثة مستويات ٥٠٠ ، ١٠٠٠ ، ٢٠٠٠ جزء في المليون . وتم تغذية الدجاج علي هذه المعاملات علي إمتداد ثلاث فترات متتالية خلال شهور يونيو ويوليو وأغسطس . وقد تم توزيع كل معاملة علي ثلاث مكررات (بكل مكررة ٤ دجاجات) . وفى نهاية كل فترة تم أخذ القياسات الخاصة بإنتاج البيض ومواصفاته مع دراسة التركيب المتعدد لقشرة البيض بإستخدام الميكروسكوب الألكتروني . كما تم إجراء تقييم إقتصادي لتأثير إضافة حمض الأسكوربيك بالمستويات العالية.

أوضحت النتائج الكلية للتجربة مايلي:-

- زيادة في عدد وكتلة البيض والكفاءة الغذائية بمقدار ٧,٠٢ ، ١٠,٨٧ ، ١٠,١٠ ٪ بالنسبة للعليقة الأساسية علي التوالي وذلك عند إضافة ٥٠٠ جزء في المليون من حمض الأسكوربيك.
- وقد تم تحقيق أكثر عند إضافة ١٠٠٠ جزء في المليون من حمض الأسكوربيك حيث بلغت ١٤,٠٤ ، ١٣,٩٤ ، ٣٠,٦٠٪ بالنسبة لعدد وكتلة البيض والكفاءة الغذائية علي التوالي بالمقارنة مع المستوي السابق (٥٠٠ جزء في المليون).
- أدت إضافة ٢٠٠٠ جزء في المليون من حمض الأسكوربيك إلي مزيد من الزيادة في عدد ووزن وكتلة البيض والكفاءة الغذائية قدرها ١٢,٧٠ ، ٢,٠٧ ، ١٥,٧٠ ، ١٥,٨٩٪ علي التوالي بالمقارنة مع المستوي السابق (١٠٠٠ جزء في المليون).
- بالنسبة لمواصفات البيضة تبين أن إضافة حمض الأسكوربيك علي مستوي ٥٠٠ أو ١٠٠٠ جزء في المليون يؤدي فقط إلي زيادة معنوية في وزن البياض كنسبة مئوية من وزن البيضة. أما إضافتة بمستوي ٢٠٠٠ جزء في المليون لم يؤد إلي أية زيادة معنوية في مقاييس مواصفات البيضة.

- أظهرت النتائج في الفترة الأولي من التجربة التأثير المعنوي لمستوي ٢٠٠٠ جزء في المليون من حمض الأسكوربيك علي سمك القشرة. كما أظهر الفحص بالميكروسكوب الإلكتروني ما يشير إلي زيادة صلابة القشرة نتيجة لهذه المعاملة بالمقارنة بالمعاملات الأخري.
- إتضح من التقييم الإقتصادي لإضافة حمض الأسكوربيك أن تكلفة العلف لإنتاج الكيلو جرام تنخفض بمقدار ٣,١١ ، ١٤,٣ ، ١٧,٥٪ بإستخدام ٥٠٠، ١٠٠٠، ٢٠٠٠ جزء في المليون من حمض الأسكوربيك علي التوالي .