

EFFECT OF DIETARY VITAMIN E SUPPLEMENTATION ON MEAT PRODUCTION RELATED TRAITS OF BARKI LAMBS

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SUMMARY

The purpose of the present study was to evaluate the effects of dietary vitamin E supplementation (DVES) on the meat production traits. Ten Barki lambs, 8 months old, were randomly assigned into two equal groups with similar ($P>0.05$) initial body weights (29 ± 2.63 kg). The first group (G0) received no supplement, while, the second group (G500) was orally administered 500 IU vitamin E/lamb/day. Both groups were fed concentrate mixture and wheat straw for 120 days before slaughter at 12 months of age.

Meat production related traits involved those concerning lambs fatteners (average daily gain and final body weight), retailers (carcass weight, dressing percentage, total non-carcass fat partitioning between depots and meat pH) and consumers (physical and chemical characteristics). Color parameters (redness, yellowness and brightness) were assessed under two main factors; DVES level (0, 500 IU) and storage periods (2, 7, 14 days).

DVES had no significant ($P>0.05$) effect on live performance traits, carcass weight and dressing percentage. Use of DVES enhanced the proportion of total non-carcass fat deposited in the tail and decreased that deposited around the kidneys and in the abdomen. The treatment boosted intramuscular fat percentage assessed chemically. Significant ($P<0.05$) interaction effect was found between DVES level and storage period on meat brightness, highlighting DVES to decrease the reduction in brightness during the first week of chill storage. While DVES significantly reduced meat yellowness, it did not change its redness regardless of storage period.

Keywords: Barki lambs, vitamin E, display, meat quality, color

INTRODUCTION

According to the National Research Council (NRC, 1985) the recommended dose of vitamin E in the normal feeding of lambs is 20 IU/lamb/day. Therefore, limited doses (15, 30 and 60 IU/d, Njeru *et al.*, 1994 and 45 mg/h/d, Macit *et al.*, 2003a, b), high doses (200 and 400 mg/kg/d, Vignola *et al.*, 2002 and 500 IU/d, McDowell *et al.*, 1996) and mega doses (1000 IU/d, Wulf *et al.*, 1995 and Guidera *et al.*, 1997; 1020 IU/d, Lopez-Bote *et al.*, 2001 and 1000 IU/d, Lauzurica *et al.*, 2005) were tried to improve sheep meat production related traits. High and mega dose levels are likely to improve performance, carcass and meat quality traits (McDowell *et al.*, 1996).

Egyptian sheep breeds have been subjected to limited numbers of trials (Abbas and Kobeisy, 2001) involving the impact of vitamin E supplementation on improvement of traits related to meat production. The present paper used the important Egyptian sheep breed, the Barki, to investigate the effect of a vitamin E dose as high as 500 IU/lamb/day on traits of interest to sheep fatteners (average daily gain; final body weight), retailers (carcass weight; dressing percentage; non-carcass fat partitioning between depots; pH value) and meat consumers (color; cooking loss; tenderness; chemical composition).

MATERIALS AND METHODS

Animals, treatments, feeding and traits

Animals and treatments: The trial was carried out at the Desert Research Center Farm, Egypt. Ten Barki lambs, 8 months old, were randomly assigned into two equal groups with similar ($P>0.05$) initial body weights (29 ± 2.63 kg). The first group (G0,) received no supplement, while the second (G500) was orally administered 500 IU vitamin E/lamb/day.

Feeding plan: Both G0 and G500 groups were fed concentrates mixture according to Kearn (1982). Wheat straw was fed *ad libitum* during the feeding period. Biweekly adjustment of the offered concentrates mixture was calculated according to the body weight changes during the 120 days feeding period. The concentrate mixture was consisted of soybean meal (15%), yellow corn (25%), barley grain (30%), wheat bran (24%), molasses (3%), limestone (1%), vitamins and trace minerals (0.05%) and common salt (0.95%). The average concentrate consumption per lamb per day was calculated to be 600 g/day for both groups.

Traits concerning fatteners: Individual body weight was taken biweekly for the period from 8 months to 12 months of age. The average daily gain was calculated over such period. Final body weight was recorded at the end of the trial.

Traits concerning retailers: Animals were slaughtered after 18 hours fasting period. Hot carcass with and without tail and individual non-carcass fat depots (abdominal, kidney and channel and tail) were weighed. Dressing percentage was calculated. Meat pH value was measured on freshly cut surfaces of muscle *longissimus dorsi* (m. LD) by direct pH meter (portable digital waterproof HANNA Model HI 9025). The 11th, 12th and 13th rib cuts were removed from individual carcasses and transferred under cooling (4°C) to the Department of Animal Production, Faculty of Agriculture, Cairo University for subsequent color and meat quality analyses.

Traits concerning consumers: Meat color. For measuring meat color, steaks (2 cm thick) from chilled (4°C) m. LD of 12th ribs were divided into 3 slices which were placed individually in polystyrene trays covered by oxygen permeable polyethylene film and stored at 4°C under fluorescent light for 2, 7 and 14 days after slaughter. Colorimeter device (color difference meter model D25 optical sensor, Hunter associates laboratory, Serial No. 4750, Reston, Virginia, USA) was used to

objectively measure the brightness (L), redness (a*) and yellowness (b*) values of the m. LD.

Cooking loss and tenderness: Samples from chilled (4°C) m. LD of 13th rib were cooked, in a plastic bag, in a water bath at 90°C until the internal temperature reached 70°C according to Esenbuga *et al.* (2001). Cooked samples were left to cool at room temperature. Cooking loss percentage was calculated by dividing the difference between uncooked and cooked weight on the uncooked weight. Cooked samples were sheared, as a mechanical assessment of tenderness, using shear force device (Testing machine model AIM 339-3, Larg, Florida, 33543, USA).

Chemical composition: The chilled (4°C) m. LD of 11th rib cuts were dissected to estimate the content of moisture, protein, ether extract and ash (A.O.A.C. 2000).

Statistical analysis

The collected data were statistically analyzed according to the GLM procedure of SAS (1996). Data concerning all traits studied except color were analyzed according to the following model:

$$Y_{ij} = \mu + G_i + E_{ij}, \text{ (Model I)}$$

where:

Y_{ij} = the observation of the j^{th} lamb subjected to the i^{th} vitamin E supplementation level;

μ = the overall mean;

G_i = the effect of the i^{th} vitamin E supplementation level, ($i= 0, 500$ IU); and

E_{ij} = the random error

Data related to meat color, storage period and their interaction were analyzed according to the following model:

$$Y_{ijk} = \mu + G_i + S_j + GS_{ij} + E_{ijk}, \text{ (Model II)}$$

where:

Y_{ijk} = the observation on the meat subjected to the j^{th} storage period obtained from the k^{th} lamb supplemented with the i^{th} vitamin E level;

μ = the overall mean;

G_i = the effect of the i^{th} vitamin E supplementation level, ($i= 0, 500$ IU);

S_j = the effect of the j^{th} storage period, ($j = 2, 7, 14$ days);

GS_{ij} = the interaction between vitamin E supplementation level and the storage period; and

E_{ijk} = the random error

The following model was used when the interaction between vitamin E level and storage period was significant:

$$Y_{ij} = \mu + C_i + E_{ij}, \text{ (Model III)}$$

where:

Y_{ij} = the observation on the meat subjected to the i^{th} vitamin E-storage period combination obtained from the j^{th} lamb;

μ = the overall mean;

C_i = the effect of the i^{th} vitamin E - storage period combination ($i= 1, 2, \dots, 6$); and

E_{ij} = the random error

For vitamin E level - storage period combinations in Model III, statistical differences between means were tested using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Traits concerning fatteners and retailers

Vitamin E supplementation (IU/lamb/day) of lambs seem to have no effect on average daily gain, final body weight, hot carcass weight, dressing percentage (500 and 1000 IU: Wulf *et al.*, 1995; 200 and 400 IU: Vignola *et al.*, 2002; 45 IU: Macit *et al.*, 2003 a,b; 500 IU: Table 1 and 2, present study). Table 2 showed that inspite of the fact that the two groups were similar ($P > 0.05$) in total non carcass fat weight, its partitioning between depots was different. Vitamin E supplemented lambs had significantly ($P < 0.05$) more fat in the tail and less fat in the abdomen and around kidney than the non-supplemented lambs. This trend is in agreement with corresponding calculations made from results presented by Abbas and Kobeisy (2001) using 20 IU vitamin E/lamb/day. Dietary supplementation with vitamin E appears to have no effect on meat pH (45 IU: Macit *et al.*, 2003 a, b; 500 IU: Table 2, present study).

Table 1. Effect of vitamin E supplementation level (IU/lamb/day) on traits concerning fatteners (Model I)

Item	Group			
	G0	G500	SE	P
Final body weight, kg	47.5	47.6	1.63	NS
Average daily gain, g/day	153	156	0.01	NS

Number of animals = 5 for each group.

NS, $P > 0.05$.

Table 2. Effect of vitamin E supplementation level (IU/lamb/day) on traits concerning retailers (Model I)

Item	Group			
	G0	G500	SE	P
Carcass weight, kg	21.1	21.6	0.38	NS
Carcass weight without tail, kg	20.7	21.2	0.37	NS
Dressing, %	44.4	45.4	1.57	NS
Total non-carcass fat, g	698	664	39.17	NS
Total non-carcass fat partitioning between:				
Abdominal and kidney depots, %	45.0	37.2	1.69	*
Tail depot, %	55.2	62.8	1.80	*
pH value	5.47	5.50	0.01	NS

Number of animals = 5 for each group.

NS, $P > 0.05$. * $P < 0.05$.

Traits concerning meat consumers

Cooking loss. This trait has been shown to be irresponsive to dietary supplementation with vitamin E (45 IU: Macit *et al.*, 2003 a, b; 298 IU: Mitsumoto *et al.*, 1995; 500 IU: Table 3, present study).

Table 3. Effect of vitamin E supplementation level (IU/lamb/day) on traits concerning consumers (Model I)

Item	Group			
	G0	G500	SE	P
Cooking Loss, %	43.22	46.07	2.08	NS
Shear force, kg/cm ²	1.90	1.48	0.22	NS
Moisture, %	75.61	75.64	0.04	NS
Protein, %	20.70	20.47	0.26	NS
Ether extract, %	2.73	2.93	0.06	*
Ash, %	0.96	0.90	0.03	NS

Number of samples = 5 for each group

NS, P > 0.05.

* P < 0.05.

Tenderness

Dietary vitamin E supplementation would not affect shear force values under high dose (Table 2, present study) or even limited dose (Macit *et al.*, 2003a, b).

Chemical composition

Vitamin E supplementation in limited (Macit *et al.*, 2003a, b) or high doses (Vignola *et al.*, 2002; Table 3, present study) appeared incapable to change the chemical composition of sheep meat, with the only exception of ether extract percentage which was significantly (P < 0.05) high in the G500.

Color. Table 4 shows no significant effect of the interaction vitamin E level x storage period on the meat redness and yellowness; thus testing the significance of the main effects were legitimate. Storage period had no effect (P>0.05) on redness or yellowness regardless of vitamin E level. Vitamin E had significant (P<0.05) effect on yellowness but not on redness (P>0.05) regardless of storage period. Dietary vitamin E supposes to delay recovery of the yellow component (Liu *et al.*, 1996).

Table 4. Effect of vitamin E supplementation and storage period on color parameters (Model II)

Item	Vitamin E, IU/lamb/day (E)				Storage period, day (S)					(E x S)
	0	500	SE	P	2	7	14	SE	P	
Redness	13.9	14.7	0.26	NS	14.5	14.3	14.2	0.32	NS	NS
Yellowness	6.5	5.3	0.29	*	5.7	5.6	6.3	0.36	NS	NS
Brightness	55.4	56.3	0.18	(i)	58.0	55.7	53.7	0.22	(i)	*

NS, P > 0.05.

* P < 0.05.

(i) Test (s) of significance statistically illegitimate.

On the other hand, Table 4 indicates that the effect of vitamin E level x storage period interaction on brightness was significant ($P < 0.05$), thus testing the significance of the main effects was illegitimate. Consequently, Model III was adopted using one main effect, which is the vitamin E level - storage period combination, using six treatment groups. Table 5 indicates that meat brightness was significantly highest (58.5) with 500 IU and 2 days storage period combination and significantly lowest (53.7) with 0 or 500 IU and 14 days storage period combinations. It is noticeable that the reduction in meat brightness between 2 days and 7 days storage periods was significantly lower when they were combined with 500 IU level than with 0 IU level of vitamin E. This highlights the importance of vitamin E supplementation in acting against degradation of brightness. This confirms the findings of Guidera *et al.* (1997) indicating that the maximum beneficial effect of dietary supplementation of vitamin E on red color stability was observed until day 7 of storage under fluorescent light. These results may find explanation in the hypothesis presented by Wulf *et al.* (1995) that vitamin E supplementation to the lamb diet would cause accumulation of α -tocopherol in muscle and that this antioxidant would delay oxidation of oxy-myoglobin to metmyoglobin.

Table 5. Effect of vitamin E supplementation level - storage period combinations on meat brightness (Model III)

Combinations (cause)	Vitamin E, IU/lamb/day	0	0	0	500	500	500
Item (effect)	Storage period, days	2	7	14	2	7	14
	Brightness	57.6 ^b	54.8 ^d	53.7 ^e	58.5 ^a	56.6 ^c	53.7 ^e

^{a,b,c,d,e} Means with different superscripts are significantly differ ($P < 0.05$), (Duncan's multiple range test, Duncan, 1955).

CONCLUSION

Although the present work indicates no direct effect of dietary vitamin E supplementation on live performance. It highlights significant increase in the proportion of total non-carcass fat deposited in the tail and significant decrease in that deposited around the kidney and in the abdomen. Significant increase in intramuscular fat assessed chemically and significant decrease in the reduction of meat brightness assessed at the 7th day of chill storage after slaughter.

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تأثير إضافة فيتامين هـ إلى علائق حملان البرقي على الصفات ذات الصلة بإنتاج اللحم

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الغرض من هذه الدراسة تقييم تأثيرات إضافة فيتامين هـ إلى علائق حملان البرقي على عدد من الصفات ذات الصلة بإنتاج اللحم. في هذا الصدد وزع عشوائياً عشرة حملان عمرها ثمانية أشهر إلى مجموعتين مشتركتين في الوزن الابتدائي (29 كجم). وتلقت المجموعة الأولى عليقة غير مضاف إليها الفيتامين بينما تلقت المجموعة الثانية خمسمائة وحدة دولية للرأس في اليوم عن طريق الفم. وقد غذيت المجموعتان على مخلوط مركّزات إضافة إلى تبن القمح لمدة 120 يوماً قبل الذبح على عمر اثني عشر شهراً. وقد تضمنت الصفات ذات الصلة بإنتاج اللحم تلك التي تهّم مسمن الحملان (متوسط الزيادة اليومية والوزن النهائي) وتاجر تجزئة اللحوم أو الجزار (وزن الذبيحة، نسبة التصافي، نسبة توزيع إجمالي دهن خارج الذبيحة على مخازن الدهن ودرجة الأيون الأيدروجيني للحم) ومستهلك اللحم (الخصائص الطبيعية والكيميائية للحم). وقد جرى تقييم محددات اللون (الإحمرار، الإصفرار، البريق) تحت تأثير عاملين رئيسيين هما مستوى فيتامين هـ المضاف للعليق (0، 500 وحدة دولية) ومدة الحفظ المبرد (2، 7، 14 يوم). وقد تبين أن إضافة الفيتامين إلى العليقة لم يؤثر معنوياً على الصفات التي تهّم المسمن، إلا أن هذه المعاملة قد زادت من نسبة إجمالي الدهن خارج الذبيحة المترسب بالذيل بينما أنقصت من تلك النسبة المخزنة حول الكليتين وفي البطن. كما أن المعاملة بالفيتامين زادت زيادة معنوية من نسبة دهن داخل العضلات المقدره كيميائياً. وقد أكدت الدراسة على وجود تأثير تداخل معنوي على بريق اللحم بين مستوى الفيتامين المضاف ومدة الحفظ المبرد على نحو يلفت النظر إلى أن الإضافة الفيتامينية تقلل من اختزال البريق خلال الأسبوع الأول من التخزين المبرد للحم. كما أكدت الدراسة على أن الإضافة الفيتامينية تخفض معنوياً من إصفرار لون اللحم دون أن يعثرى إحمرار اللون أي تغيير بغض النظر عن مدة الحفظ المبرد.