

EFFECTS OF DIETARY VITAMIN E ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS, LIPID OXIDATION AND VITAMIN E CONTENT IN MEAT AND LIVER OF MAHALI GOAT IN LIBYA

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ABSTRACT

Lipid oxidation caused deterioration changes in meat quality during processing and storage. Supplementation of vitamin E with the diet of livestock had an essential role in the inhibition of lipid oxidation. Twenty four male kids weighing 10-15 kg were randomly allotted to four groups to receive four various levels of vitamin E. Control group (C), (300 E) group received 300IU vitamin E (DL- α -tocopherol acetate)/animal/day, (500 E) group supplied with 500IU vitamin E/animal/day and (1000 E) group provided with 1000IU vitamin E/animal/day. The animals were fed concentrate with barley hay diet to meet all nutrient requirements according to (NRC, 2007). Body weight was weekly recorded, and the initial and final weights were taken. At the end of the trial, the animals were slaughtered, and warm carcass weight, cold carcass weight and dressing % were determined. Meat samples from *longissimus dorsi muscle* were analyzed for pH, meat malondialdehyde content (MDA), intramuscular (I/M) fat and vitamin E content in meat and liver. In conclusion, the result revealed that vitamin E had no significant influence on growth performance, warm carcass weight, cold carcass weight and dressing % . Whereas, supplementation of vitamin E in the diet reduced pH, I/M fat and lipid oxidation. By comparison, vitamin E in the diet increased α -tocopherol content in the *longissimus dorsi muscle* and liver.

Key Words: Vitamin E, Growth Performance, Carcass Characteristics, Lipid Peroxidation.

INTRODUCTION

Goats in Libya consists of 2.5 million head (Aoad, 2009). Libyan local goats (Mahali breed) represent more than 90% of the total goat population. They are kept primarily for meat production (FAO, 2010). The interest in goat breed and farming has

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been recently increased in many developed countries including Poland, as a result of fact that goat products have high nutritional value (Dankow *et al.*, 2006). Goats were prone to oxidative stress and lipid peroxidation as suggested by (Celi *et al.*, 2008). The quality of goat meat is influenced by age, gender and genetic characteristics (Casey and Webb, 2010). Many external factors influence meat quality such as exposure of meat to oxygen, light, high

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temperature, in addition, preservatives, freezing, additives, irradiation, and high pressure. Moreover, cooking and packaging played a significant role in lipid oxidation (Ahn *et al.*, 2009). Lipid oxidation of meat is a great non-microbiological object included in the deterioration of meat quality during refrigerated storage (Insani *et al.*, 2008). In addition, it can cause undesirable impacts on the nutritional value of meat and meat products that are highly essential for consumers (Henchion *et al.*, 2014).

Lipid oxidation in a retail display increases with the increased time of display (Ponnampalam *et al.*, 2014). Furthermore, the oxidative damage can increase during storage and cooking depending on time and temperature (Roux *et al.*, 2011). Whereas, the deterioration changes in meat and meat products can be controlled by antioxidants (Ennajar *et al.*, 2009). The concentration of α -tocopherol in muscles depends on different factors such as doses, the route of administration, metabolism, total fat content and stress (Ponnampallam *et al.*, 2012). Vitamin E has a desirable influence on meat. For example, feeding lamb α -tocopherol enriched concentrate during the last 10 days before slaughter reduced lipid oxidation in lamb meat (Rippol *et al.*, 2013). Furthermore, dietary supplementation of vitamin E increased the level of vitamin E in the brain and muscles of ewes (Capper *et al.*, 2005). Likewise, supplementation of vitamin E in the diet prevented lipid oxidation in buffalo meat and prolonged shelf life (Cascone *et al.*, 2007). Moreover, increase oxidative stability and vitamin E content in frozen meat of broilers supplemented with vitamin E (Konieczka *et al.*, 2015). Additionally, Feeding kids goats 100 IU of vitamin E reduced malondialdehyde (MDA) concentration in meat (Sethy *et al.*, 2014). The information about the influence of feed on lipid oxidation of chevon is very few (Lee *et al.*, 2008). In spite of many studies had investigated the influence of vitamin E on calves, lambs, and chickens, limited research has been done on its impact on goats and kids (Ramadan *et al.*, 2018). The

objective of this study was to investigate the influences of dietary vitamin E on growth performance, carcass characteristics, pH, I/M fat, MDA and vitamin E content in meat and liver.

MATERIALS AND METHOD

Animals

The experiment was performed on 24 male kids (Mahali breed) 3-4 months of age, average life weight of 10-15 kg, purchased from local markets. The study was carried out in a private farm in Tarhuna city about 80 km south of Tripoli. As the animals arrived at the farm, they were rested, ear-tagged, and then divided randomly into four groups according to the level of vitamin E. Each animal was allotted in an individual shaded well ventilated separate pen. The animals were allowed visual contact with each other with free access to water. The initial weight of each animal was taken at the time of arrival to the farm. In addition, the final weight was recorded at the end of the trial. All diets with hay to concentrate ration formulated to meet all nutrient requirements for goat kids (NRC, 2007). The concentrate ration consisted of 48% crushed maize grain, 26% soybean meal, 24% wheat bran, 0.5% common salt, 1.4% limestone and 0.1% vitamins and minerals, and the ration contained 46 IU vitamin E/kg.

Adaptation period

Goats had an adaptation period for two weeks before the experiment. They were provided with a basal diet of a mixture of 75% barley hay and 25% concentrate according to NRC, (2007), each animal received 150g/animal/day concentrate and 450g/ animal /day barley hay to meet all nutrient requirements, the percentage of concentrate 1% of live body weight, while the barley hay constitutes 3% of live body weight.

Treatments

The kids were supplied with particular levels of vitamin E with concentrates and hay for

each group as follow, the 1st group is control (C), the 2nd group (300 E) received 300 IU vitamin E /animal/day, the 3rd group provided with 500 IU/animal/day vitamin E, and the 4th group had 1000 IU vitamin E/animal/day, the experiment lasted for 2 months.

Slaughtering procedure

At the end of the trial, all animals were slaughtered "halal method" in the commercial abattoirs after being fasted for 24 hr. prior to slaughter as described (Ponnampalam *et al.*, 2001; Zhao *et al.*, 2013). After slaughter, warm carcass weight was taken. Carcasses were chilled for 24 hr at 4 °C and the cold carcasses were recorded. The dressing percentage was calculated by dividing the cold carcass weight by the weight before slaughter and multiplied by 100. Samples from each *longissimus dorsi* muscle were collected from each animal for the determination of pH, and I/M fat. Other samples from *longissimus dorsi* muscle and liver samples were immediately collected from each animal after slaughtering and kept in the fridge at -18 °C for one month for determination of vitamin E content and lipid oxidation.

Analytical techniques

Meat pH was measured using a portable pH meter (PT- 380, BOECO, Germany), after slaughter and 24 hr post-slaughtering of the animals by inserting the tip of a probe in meat as described by Kerth *et al.* (1999). The I/M fat was determined using the Soxhlet apparatus following the method of Santos-Cruz *et al.* (2008). Meat and liver

samples were sent to the lab for evaluation of vitamin E content in the liver and meat samples followed the method of Pfalzgraf *et al.* (1995). In addition, the evaluation of lipid oxidation in meat samples following the method of Buege and Aust, (1978). The analysis was performed at the Animal Health Research Center in the Arab Republic of Egypt.

Statistical analysis

The experimental data were analyzed by one-way analysis of variance ANOVA, Minitab (release No.; South College, Pa.). The differences between means were compared using Tukey's method and 95.0% confidence. Two factors with repeated measures on one factor (weeks). Comparison made using ANOVA to determine the influence of vitamin E on meat parameters. The results of this study are presented as mean values with standard deviation.

RESULTS

Growth performance

The influence of vitamin E on growth performance in the current study was presented in table (1). The result showed that vitamin E had no significant ($p>0.05$) influence on growth performance in the three groups of vitamin E treatments compared with the control. The weight gain and average daily gain were low in all groups of this study except for the group that received 500IU of vitamin E had the highest weight gain and ADG compared with other groups.

Table 1: Effect of vitamin E on growth performance of male goat kids (n=24).

	Control	300 E	500 E	1000 E	Sed	P-value
Initial weight (kg)	13.7	12.6	14.5	15.2	0.6	NS
Final weight (KG)	15.3	14.3	14.7	16	0.7	NS
Weight gain (kg)	1.8	1.3	2.8	1	0.5	0.04
ADG (g)	40	29	63	22	14.8	0.03

AVG: average daily gain, NS: non- significant.

Carcass characteristics

Vitamin E had no significant ($p>0.05$) influence on warm carcass weight in the three treated groups compared with the control. The warm carcass weight were 6.9, 6.12, 6.24 and 7.2 for the control, 300 E, 500 E, and 1000 E groups respectively. Likewise, there was no significant ($p>0.05$) influence of α -tocopherol on cold carcass weight in all groups of vitamin E compared with the control. In addition, α -tocopherol had no significant ($p>0.05$) impact on dressing percentage in all groups of α -tocopherol compared with the control. The mean value of dressing % for control was 45.05, while, it was 42.5, 43, and 45.5 for 300 E, 500 E, and 1000 E groups, respectively. Vitamin E significantly ($p<0.001$) reduced the pH value after slaughtering in 300 E, 500 E and 1000 E treated groups compared with the control. In addition, it significantly ($p<0.001$) reduced the pH value after 24 hr in the vitamin E supplemented groups compared with the control. The highest reduction of pH was in the group 1000 E, then group 500 E, and then group 300 E compared with the control. The mean values for the pH after 24 hr were 5.7, 5.63, 5.58, and 5.54 for the control, 300 E, 500 E, and 1000 E, respectively. Moreover, vitamin E significantly ($p<0.001$) reduced I/M fat in the three treated groups of α -tocopherol compared with the control. This indicates that there was an effect of the three concentrations of vitamin E on I/M fat. The result showed that the impact of 1000 E and 500 E in reducing I/M fat was more than the impact of 300 E, and the effect of 1000 E was higher than the impact of 500 E in decreasing I/M fat. The differences in the impact of vitamin E on I/M fat content between vitamin E treated groups were significant

Vitamin E content in meat

The result in table (2) showed that α -tocopherol had significantly ($p<0.001$) increased vitamin E content in meat of the α -tocopherol treated groups compared with the control. The highest level of α -tocopherol in meat was in group 1000 E, followed by the 500 E group, while group 300 E had the lowest concentration of α -tocopherol in meat compared with the other α -tocopherol groups.

Vitamin E content in the liver

The influence of α -tocopherol on vitamin E content in the liver was highly significant ($p<0.001$) in the three treatments of vitamin E groups, table (2). Dietary supplementation of α -tocopherol showed a significant ($p<0.001$) elevation in the level of vitamin E in the liver of the three vitamin E groups compared with the control. The highest amount of α -tocopherol was in group 1000 E followed by group 500 E, whereas the lowest concentration of α -tocopherol was in group 300 E compared with vitamin E supplemented groups. Obviously, the addition of vitamin E to the diet resulted in the rise of α -tocopherol content in the liver more than in meat samples in the three groups of vitamin E.

Lipid oxidation in meat

Regarding the impact of vitamin E on the level of MDA in meat, α -tocopherol caused a significant ($p<0.05$) reduction in the amount of MDA in meat in the three treated groups of vitamin E compared with the control. Group 1000 E reduced the amount of MDA in meat to the lowest level among other treated groups, followed by group 500 E, then group 300 E as presented in table (2).

Table 2: Influence of vitamin E on carcass characteristics, vitamin E in meat and oxidative stability of kid meat.

Parameters	control	300 E	500 E	1000 E	Sed	Statistical Significance
Warm carcass wt. (kg)	6.9 ^a	6.12 ^a	6.24 ^a	7.2 ^a	0.89	N.S.
Cold carcass wt. (kg)	6.47 ^a	5.7 ^a	5.75 ^a	6.7 ^a	0.88	N.S.
Dressing %	45.05 ^a	42.5 ^a	43 ^a	45.5 ^a	2.4	N.S.
pH after slaughter	6.21 ^a	6.24 ^b	6.15 ^c	6.11 ^d	0.05	p<0.001
pH 24 hr	5.7 ^a	5.63 ^b	5.58 ^c	5.54 ^d	0.07	p<0.001
I/M fat %	2.32 ^a	2.13 ^b	1.53 ^c	1.23 ^d	0.45	p<0.001
Vit E. in f. Liver mg/kg	122 ^a	411 ^b	827 ^c	1066 ^d	54	p<0.001
Vit. E in meat mg/kg	94 ^a	343 ^b	677 ^c	1025 ^d	94	p<0.001
MDA in f. meat mg/kg	0.5 ^a	0.3 ^b	0.14 ^b	0.09 ^b	0.18	p<0.05

Vit. E, vitamin E; MDA, malondialdehyde; F. meat, frozen meat. I/M fat, intramuscular fat.

DISCUSSION

Mahali goat kids in Libya had low growth performance, this was mentioned by (Magid *et al.*, 2007). In the present study vitamin E had a non-significant influence on growth performance in the three vitamin E supplemented groups compared with the control. This was supported by Ramadan *et al.* (2018) in goats. While, it was in disagreement with Ipek and Dikmen, (2014), who suggested that vitamin E improved growth performance in poultry. Zhao *et al.* (2013) suggested that supplementation of vitamin E at a level over 100 IU suppresses the growth of Tan sheep lambs. Moreover, the kids were early weaned at the age of 30 days, there was an evidence that early-weaned kids had a low growth rate as proposed by (Memis *et al.*, 2009). Vitamin E increased the weight gain and ADG in the group of 500 E which was supplemented with 500 IU compared with the control, but it was less than the normal ADG for the Mahali kids as mentioned by Akraim, (2012). In addition, vitamin E had no influence on warm and cold carcasses'

weight and dressing percentage, which is consistent with Atay *et al.*, (2009).

However, high ultimate pH produced meat more susceptible to pathogen infection (De la Fuente *et al.*, 2010). In this study, α -tocopherol reduced pH values post-slaughtering in 300 E, 500 E and 1000 E groups, the pH values were 6.24, 6.15, 6.11 for vitamin E groups and 6.25 for the control. The ultimate pH values (ranged from 5.55- to 6.33) for goat meat (Webb *et al.*, 2005). In addition, vitamin E significantly minimized the pH at 24 hr in the three α -tocopherol treated groups, which goes along with the study of Zhao *et al.* (2013) who supposed that a considerable decrease in pH value at 24 hr after supplementation of Tan sheep with above 100 IU vitamin E. In contrast, the result was in disagreement with the outcome of a study by do Carmo *et al.*, (2017) on Nelore cattle.

Vitamin E decreased the concentration of I/M fat in the three groups of vitamin E, the result was in agreement with the outcome of Zhao *et al.* (2013) and Bhatt *et al.* (2015) in

Tan sheep and lamb respectively. In contrast, I/M fat was not affected by vitamin E supplementation in beef cattle (Mir *et al.*, 2002). As the level of vitamin E increase, the concentration of I/M fat decrease in the three treated groups of vitamin E. However, the concentration of vitamin E in muscles depends on the level and duration of vitamin E supplementation. The greater the amount of vitamin E, the fastest accumulation of vitamin E in the muscles of lambs (Jose *et al.*, 2016). In the present study, α -tocopherol caused an elevation of α -tocopherol in the meat of goat kids. This was supported by Leal *et al.* (2019) in lambs. Supplementation of vitamin E in the diet raised its content in the liver, this result was consistent with the results of Jose *et al.* (2016) in lambs.

Obviously, dietary α -tocopherol elevated vitamin E content in the liver more than it is content in muscles. The result agreed with the outcome of (Jose *et al.*, 2016) in lamb. The concentration of vitamin E in the liver was higher than in meat due to the presence of a tocopherol-binding protein (TAP: tocopherol-associated protein) in the liver. Which is responsible for the amount of α -tocopherol in the liver. In addition, the presence of hepatic receptors increases the uptake of α -tocopherol in the liver (Azzi and Stocker, 2000).

The result of the present study found that α -tocopherol in the diet reduced MDA content in meat. This outcome agrees with the study of Bellés *et al.* (2018), who suggested that dietary α -tocopherol caused a significant reduction in the level of MDA in lamb meat. However, there is no argument in the literature about increasing α -tocopherol content in liver and meat, and decreasing lipid oxidation in meat after supplementing animals with an α -tocopherol containing diet.

CONCLUSION

Dietary supplementation of α -tocopherol had no significant influence on growth

performance, warm carcass weight, cold carcass weight, and dressing %. By comparison, it significantly reduced the level of meat pH, MDA in meat, and I/M fat. On the other hand, it increased the amount of α -tocopherol in meat and liver. There is a further study needed on the influence of α -tocopherol on sun-dried salted lamb meat (Kadeed) in Libya.

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تأثير إضافة فيتامين هـ إلى غذاء الجديان على معدل النمو وخصائص الذبيحة وأكسدة الدهون وكمية فيتامين هـ في لحم وكبد الجديان المحلية في ليبيا

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تسبب أكسدة الدهون في التقليل من جودة اللحوم خلال التصنيع والتخزين. إضافة فيتامين هـ في غذاء الماشية له دور مهم في تثبيط أكسدة الدهون. أجريت هذه التجربة على 24 جدياً أوزانهم تتراوح بين 10-15 كجم، قسمت بشكل عشوائي إلى أربع مجموعات وزودت بنسب مختلفة من فيتامين هـ. المجموعة الأولى (الظابطة)، المجموعة الثانية (300 E) زودت ب 300 وحدة دولية من فيتامين هـ، المجموعة الثالثة (500 E) زودت ب 500 وحدة دولية من فيتامين هـ، المجموعة الرابعة (1000 E) زودت ب 1000 وحدة دولية من فيتامين هـ. تم تغذية الحيوانات على علف مركز وتبن الشعير لتلبية جميع الاحتياجات الغذائية طبقاً NRC (2007). تم تسجيل وزن الحيوانات أسبوعياً بالإضافة إلى وزن الحيوانات في بداية التجربة ووزن الحيوانات في نهاية التجربة. وفي نهاية التجربة ذبحت الحيوانات وأخذ وزن الذبيحة الحار ثم تم تسجيل وزن الذبائح بعد تبريدها (وزن الذبيحة البارد) وكذلك حساب نسبة التصافي. أخذت عينات اللحم من العضلة الظهرية الطويلة (*longissimus dorsi*) لحساب الأس الهيدروجيني ونسبة الدهون العضلية ونسبة فيتامين هـ وأكسدة الدهون كما حسبت نسبة فيتامين هـ في الكبد. وفي الختام أظهرت النتائج عدم وجود تأثير واضح لفيتامين هـ على معدل النمو ووزن الذبائح ونسبة التصافي، بينما كان لإضافة فيتامين هـ تأثير واضح في التقليل من نسبة الدهون العضلية والأس الهيدروجيني وأكسدة الدهون (المالونألدهيد) في اللحم. ومن ناحية أخرى أدى فيتامين هـ إلى زيادة كبيرة في نسبة فيتامين هـ في العضلة الظهرية الطويلة والكبد.