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Effect of parenteral supplementation of vitamin E plus selenium on nutrient digestibility, productive performance and some serum biochemical indicators of lambs

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ABSTRACT

This study designed to evaluate the effect of parenteral supplementation of vitamin E plus selenium on nutrient digestibility, productive performance and some serum biochemical indicators of Ossimi lambs. The experiment carried out using 24 growing lambs averaged 3 months old and 18.58 ± 1.46 kg BW. Animals were fed on concentrate feed mixture (CFM) and soybean straw (SS) at 70 and 30 %, respectively. Animals were allocated into 3 equal groups (8 lambs each). The first group (C, control) was injected with 1.0 ml/head/biweekly of sterile saline solution (0.9 % NaCl). Animals in the second (ES-1) and third group (ES-2) injected with vitamin E plus Se at rate 0.5 ml/head/biweekly (containing 3.57 IU vitamin E + 0.03 mg Se/head/day) and 1.0 ml/head/biweekly (containing 7.14 IU vitamin E + 0.06 mg Se/head/day), respectively. The nutrient digestibility of DM, OM, EE and NFE increased ($P<0.05$) for lambs of ES-1 and ES-2 than untreated (control). Averages of final body weight increased ($P<0.05$) by 17.26 and 13.44 % for lambs of ES-2 vs. control or ES-1, respectively. Averages of daily gain (DG) were higher ($P<0.05$) for lambs of ES-1 and ES-2 than control. The values were 166.56, 191.89 and 237.89 g/d for lambs of control, ES-1 and ES-2, respectively. There were significant dose-related improvement ($P<0.05$) in feed intakes (DCPI and TDNI) and feed conversion (FCR, DCPI and TDNI) for lambs received ES-1 and ES-2 compared to control. Lambs of ES-2 had higher ($P<0.05$) concentrations of serum total protein and globulin *vs.* control or SE-1. There was a decrease ($P<0.05$) in serum cholesterol levels for lambs of SE-1 and SE-2 *vs.* control. Data indicated that serum concentrations of triiodothyronine (T_3), but not thyroxin (T_4), T_3/T_4 ratio and glutathione peroxidase (GSH-Px) activity, were higher ($P<0.05$) for lambs of SE-1 and SE-2 than control. The increase in T_3 hormone level and GSH-Px activity for lambs of SE-1 and SE-2 had dose-dependent manner.

It conclude that vitamin E plus Se, at doses 0.5 and 1 ml/ head/biweekly in growing lambs, showed useful impacts on improving nutrient digestibility, growth performance, feed conversion rate and some related serum biochemical indicators. The improvements had dose-related manner with vitamin E plus Se injections with superiority to the higher dose.

Key words: *Vitamin E plus Selenium, Dose effect, Nutrient digestibility, Performance, serum biochemical, sheep.*

INTRODUCTION

Trace elements, along with vitamins, are extremely essential micronutrients, which operate in animal body in the same manner **(Tufarelli and Laudadio, 2011)**. For instance, **Makimura *et al.* (1993)** documented that mode of action of vitamin E is closely associated with the metabolism of selenium (Se), and it can make up Se deficiency to a certain degree. Vitamin E and Se are necessary for animal health and production, thus they can influence growth, immune function, reproduction, health, and product quality in ruminants (**Yatoo *et al.*, 2013)**. The element Se has a biological function related to vitamin E, thus Se is an essential component of glutathione peroxidase, an enzyme involved in detoxification of hydrogen peroxide and lipid hydroperoxides. Vitamin E and Se, as antioxidants, act synergistically to protect the cells against the damage induced by lipid peroxides and free radicals produced during normal metabolism **(Rooke *et al.*, 2004)**. As a component of selenoproteins, Se is involved in immune and neuropsychological function in the nutrition of small ruminants **(Meschy, 2000)**. Discovery of various selenoproteins and vitamin E-responsive genes

has contributed to improve understanding about multiple functions of Se and vitamin E that extend beyond the classical antioxidant properties to immuno-modulation and intracellular cell signaling and gene regulation. Given that multiple functions of vitamin E and Se have been recognized. Recent studies have focused on the supra-nutritional supplementation of these micronutrients **(Chauhana *et al*., 2016).**

Studies have demonstrated beneficial effects on growth traits and quality of meat products either with vitamin E supplement to lambs **(Macit *et al*., 2003),** or Se to calves **(Tsai and Bukas, 2003)**. In sheep, vitamin E and Se supplement were shown to improve immune responses and antioxidant status (glutathione peroxidase), protecting against oxidative stress concomitant with favourable effects on their growth performance **(Ramos *et al*., 1998; Milad *et al*., 2001)**. Functions of vitamin E and Se, as antioxidant, are interdependent as Se deficiency can partially compensated by vitamin E supplementation. Selenium is a component of enzyme of type I iodothyronine-5´-deiodinase that is required for the conversion of thyroxin (T_4) into the biologically active triiodothyronine (T_3), thus Se affects the growth performance through the formation and activation of thyroid hormones. So, thyroid malfunction which in turn results in growth retardation could occurred with vitamin E and Se deficiency **(Nampoothiri and Ganga Devi, 2017)**.

In a recent report by **Nampoothiri and Ganga Devi (2017)**, supplementation of vitamin E and Se can be done *via* different routes such as intra-ruminal and parenteral administration. The results of improving ruminants' growth responses will be better and quicker with parenteral supplementation **(Yuhua*et al*., 1996 and Castellan *et al*., 1999)**. Supplemental Se, especially at high-dose, could play an important role in sheep nutrition **(Xun *et al*., 2012)**. However, studies regarding the effect of vitamin E plus Se on nutrient digestibility are very limited. The present study, therefore, aimed to evaluate the effect of parenteral supplementation of various doses of vitamin E plus Se on nutrient digestibility, productive performance, and some related serum biochemical indicators on growing Ossimi lambs.

MATERIAL AND METHODS

Animals:

Twenty four growing Ossimi lambs averaged three months old and 18.58 ± 1.46 kg body weight were used in this study at the Farm of Animal Production Department, Faculty of Agriculture, Minia University. The experiment was carried out for three months through January to April 2015.

Experimental treatments:

The animals randomly allocated into three equal groups of similar initial body weights (8 lambs each). The first group served as control (C) and injected with 1.0 ml/head sterile saline solution (0.9 % NaCl). Animals in the second (ES-1) and third groups (ES-2) injected with vitamin E plus Se at rates 0.5 ml/head (containing 3.57 IU vitamin E + 0.03 mg Se/head/day) and 1.0 ml/head (containing 7.14 IU vitamin E + 0.06 mg Se/head/day), respectively. Each ml of vitamin E and Se injected solution (Myogaster-E) contained 100 mg vitamin E acetate and 2.0 mg sodium selenite pentahydrate ($Na_2SeO_3.5H_2O$) (eq. to 0.913 mg Se) for veterinary use and manufactured by the VMD-Belgium (Intermedica Vet-Egypt). The injected solution was administered biweekly and continued for 12 weeks of the experimental period.

Feeding and management:

Animals were fed on concentrate feed mixture to cover their nutrient requirements according to live body weight **(NRC, 2007)**. The concentrate feed mixture contained 48 % wheat bran, 17 % yellow corn, 13 % soybean meal (44 % CP), 10.8 % sunflower meal, 4.2 % molasses, 4 % rice hulls, 2 % calcium carbonate and 1 % sodium chloride. The calculated concentrations of vitamin E and Se in the concentrate mixture fed were 13.09 and 0.22 mg/kg DM, respectively. The **NRC (2007)** requirements for growing lambs of vitamin E and Se are between 20 - 25 IU/kg DM and 0.20-

0.30 ppm, respectively. Animals fed soybean straw *ad libtum*. Feed offered twice a day at 8 am and 2 pm and drinking water was available along the experiment. The animals were apparently healthy and proved to be free from internal and external parasites.

Dietary Sampling and laboratory analysis:

Dietary samples were collected daily in the last week of each month along the experimental period and a composite sample was performed. A portion of the composite sample was dried at 105 °C in a forced air oven until constant weight for DM determination. The rest of composite sample was dried at 70 °C for a constant weight, ground and kept in closely tied jars for laboratory analysis. Diets were analysed for dry matter (DM), organic matter (OM), crude protein (CP), crude fibre (CF), ether extract (EE) and ash according to **AOAC (2003)**. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to **Goring and Van Soest (1970)**. Grasp faecal samples were collected before feeding at 7 am and 1 pm from each lamb at last week of each month and mixed together, dried at 70 °C till constant weight and analysed for DM, OM, CP, CF, NDF, ADF, EE and ash.

Table 1: Approximate analysis of concentrate feed mixture (CFM), soybean straw (SS) and total mixed ration (TMR) fed to growing lambs (on DM basis %).

Items	CFM [1]	SS	TMR
DM	88.40	90.03	88.89
OM	89.66	88.35	89.27
CP	18.76	3.93	14.30
EE	3.13	1.08	2.52
CF	10.22	40.34	19.28
NDF	40.10	64.70	47.50
ADF	13.92	49.92	24.75
NFE	57.55	43.00	53.17
Ash	10.34	11.65	10.73

CFM[1] = Concentrate feed mixture contained 48 % wheat bran, 17 % yellow corn, 13 % soybean meal,10.8 % corticated sunflower meal, 4.2 % molasses, 4 % rice hulls, 2 % calcium carbonate and 1 % sodium chloride.

Total tract digestibility of DM, OM, CP, CF, NDF, ADF, EE and NFE were determined using acid insoluble ash as an internal marker according to **Van Keulen and Young (1977)**. Approximate analysis of concentrate feed mixture (CFM), soy straw (SS) and total mixed ration (TMR) are presented in Table (1).

Blood sampling and biochemical measurements:

Non-heparinized blood samples were collected from the jugular vein of each lamb then left to clot at room temperature for at least 4 h. The clots were removed and sera were cleared and stored at -20 ºC for later assay. Serum total protein, albumin, cholesterol and glucose concentrations were determined colorimetrically using Bio-diagnostic product kits (Egypt). Serum globulin concentrations were calculated by the difference between total protein and albumin concentrations. Serum triiodothyronine (T_3) and thyroxin (T_4) concentrations determined by ELISA (Enzyme-Linked Immune-Sorbent Assay) technique using EIA kits (Prechek Bio, Inc., Atlaslink technology, California-USA). Glutathione peroxidase (GSH-Px) activities were analysed colorimetrically by STAT-LAB SZSL60-SPECTRUM, using Bio-diagnostic kits (Bio-diagnostic Company, Egypt). The analyses were performed at Cairo University Research Park (CURP), Faculty of Agriculture, Cairo University.

Statistical analysis:

Data were analysed by least square means analysis of variance using General Linear Models (GLM) procedure of the statistical analysis system **(SAS, 2000)**. The model used to analyse different treatments studied for lambs was as follows:

$$Yij = \mu + Ti + eij$$

Where: Yij = Observation, μ = Overall mean; Ti = Effect of i^{th} treatments and eij= Experimental error. Duncan's Multiple Range test used to detect differences between means of the experimental groups **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Digestibility coefficients and feeding values:

Data presented in Table (2) show the effect of vitamin E plus Se injection at rate 0.50 ml/head (ES-1) and 1.0 ml/head (ES-2) on nutrient digestibility coefficients and nutritive values for lambs. Digestibility coefficients of DM, OM, EE and NFE increased (P<0.05) for lambs of ES-1and ES-2 than untreated control (C). Also, these nutrients digestibility coefficients were higher (P<0.05) for lambs of ES-2 compared with ES-1. Meanwhile, results indicated no significant differences in digestibility of CP, CF, NDF and ADF due to experimental treatments. A non-significant increase in CP digestibility amounted by 2.51 % was noticed for lambs of ES-2 compared to untreated control. Although DCP and TDN values were not significantly (P>0.05) different among lambs of ES-1, ES-2 and untreated control, where a slight increase amounted by 2.51 and 2.10 % in DCP and TDN for lambs of ES-2 *vs.* control was detected.

Table 2: Effect of parenteral supplementation of vitamin E plus selenium on nutrients digestibility coefficients and nutritive values of experimental treatments (Mean ± SEM).

Parameters	Treatments			SEM	Sig.
	C	ES-1	ES-2		
	Nutrient digestibility (%)				
DM	73.60 ^{c}	76.67 ^{b}	78.64 ^{a}	0.468	*
OM	73.34 ^{c}	75.00 ^{b}	77.67 ^{a}	0.367	*
CP	72.40	73.68	74.22	0.589	NS
EE	68.28 ^{b}	68.99 ^{b}	70.29 ^{a}	0.237	*
CF	65.98	66.83	65.46	0.705	NS
NDF	60.13	59.66	58.99	1.606	NS
ADF	51.75	51.28	51.14	0.478	NS
NFE	77.39 ^{b}	78.91 a	79.56 ^{a}	0.603	*
	Nutritive value (%)				
DCP	10.35	10.53	10.61	0.084	NS
TDN	68.09	69.29	69.52	0.449	NS

^{a,b,c} means within the same row having different superscripts significantly different (*P<0.05). NS = not significant

C = Control, ES-1 = Vitamin E plus Se (0.5 ml/head), ES-2 = Vitamin E plus Se (1.0 ml/head).

The presented results are, partially, in agreement with similar observations reported by **Abd El-Hafez *et al.* (2016)**. They found that vitamin E plus Se supplement improved (P<0.01) the digestibility coefficients of DM, OM, CP, EE, NFE and feeding values (TDN and DCP) in Sohagi lambs. These findings could explained by the fact that vitamin E and Se, as essential components of the antioxidant defence system, play a complementary role in metabolism through their participation in critical enzymes and enzyme reactions **(Willshire and Payne, 2011)**. The role of vitamin E could be through improving the growth of rumen microorganisms as noticed in *in vitro* rumen fermentation study **(Naziroğlu *et al.*, 2002)**. So, the positive influence of vitamin E on animal growth could attribute to its effect on nutrient digestibility and N metabolism **(Wei *et al.*, 2016)**. The beneficial effect of vitamin E plus Se to enhance nutrients digestibility could be ascribed more to the role of Se. In this respect, vitamin E supplementation had no effect on all nutrient digestibility of DM, OM, CP, EE, CF, NDF, ADF and NFE in sheep **(Almeida *et al.*, 2016)** or beef cattle **(Wei *et al.*, 2016)**, while supplementation of Se at levels 150 and 300 ppm significantly (P<0.05) improved digestibility of DM, CP, EE and NFE in lactating dairy cows compared with control as reported by **Wang *et al.* (2009)**, who attributed this improvement to the increase in rumen fermentation.

In addition, **Shi *et al.* (2011)** reported an improvement in total nutrient digestibility with adding Se, from 0.15 to 0.45 mg Se/kg DM. Also, high-dose of supplemental Se (4 mg/kg DM) increased nutrient digestibility in the total tract in sheep **(Xun *et al*., 2012)**. The role of Se in improving nutrient digestibility could relate to its effect on increasing rumen microbial population and activity **(Faixova *et al*., 2007)**. It suggested that Se supplementation, in sheep diets particularly, improved rumen fermentation and ruminal microbial activity as reported by **Xun *et al*. (2012)** who concluded that absorption and availability of Se was closely related to chemical form of Se in ruminant. To this point, absorption and availability of Se improved contamination with increased OM and NDF digestibility when high Se (0.9 mg/kg DM) was supplemented, as sodium selenite, in male lambs and this Se availability in the rumen facilitates its use by the ruminal microorganisms **(Del Razo-Rodriguez *et al*., 2013)**.

Productive performance:

The data presented in Table 3 showed the effect of vitamin E plus Se injection at 0.50 ml/head (ES-1) and 1.0 ml/head (ES-2) on productive performance of growing lambs. The averages of final body weight (FBW) increased (P<0.05) for lambs of ES-2 compared with control or ES-1. The averages of FBW were 34.13, 35.28 and 40.02 kg for control, ES-1 and ES-2, respectively. The averages of daily gain (DG) increased (P<0.05) by 15.20 and 42.83 % for lambs of ES-1 and ES-2 compared with control, respectively. The improvement in DG was higher (P<0.05) for lambs received ES-2 than those received ES-1.The differences in feed intakes of SSI, DMI and TDMI were not significant among treatments *vs*. control. There were significant improvement (P<0.05) in feed intakes (DCPI and TDNI) for lambs received ES-1 and ES-2 when compared to control. The increments in DCPI and TDNI were estimated by 6.72, 18.49 % and by 7.02, 18.14 % for lambs received ES-1 and ES-2 compared with control, respectively. Also, feed conversion (FCR, DCPI and TDNI) improved (P<0.05) for lambs received ES-1 and ES-2 compared to control. The values were 6.90, 6.31 and 5.95; 0.715, 0.662 and 0.593; 4.701, 4.367 and 3.888 kg feed / kg gain for lambs of control, ES-1 and ES-2, respectively.

According to the presented results, vitamin E plus Se injection at 0.50 ml/head and 1.0 ml/head improved (P<0.05) daily gain (DG), feed intakes (DCPI and TDNI) and feed conversion (FCR, DCPI and TDNI) for growing lambs received ES-1 and ES-2 compared to control. In male lambs, supplement of vitamin E alone was effective (P<0.05) to improve FCR and DG by 8.8 % and 6.7, respectively **(Macit *et al*., 2003)**. In addition, intramuscular injection of 1200 IU DL-α-tocopheryl acetate in lambs did not influence final live weight, but increased ADG significantly (P<0.05) during suckling, whereas it did not affect the DMI **(Maiorano *et al*., 2007)**.
Vitamin E alone had positive effect (P<0.01) on improving lambs' viability and health status, thereby increase its growth performance efficiency **(Ali *et al*., 2004)**. Such beneficial effect (P<0.05) of vitamin E on improving DG and FCR was also noticed on buffalo calves **(Amer and Hashem, 2008)**.

In case of Se supplementation alone, the beneficial effects on animal performance were detected in studies on sheep **(Kumar *et al*., 2009)** and goats **(Kamdev *et al*., 2015)**. Supplemental Se may indirectly improve performance *via* strengthening the immune status of animal **(Milad *et al*., 2001)**. However, no significant effect of Se was observed on averages of DG in buffalo calves **(El Ayouty *et al*., 1996)** and rams **(Sushma *et al*., 2015)**.

The subject that combined vitamin E plus Se injections, at doses used in the current study, positively enhanced the lambs' performance are strongly supported by the results that dietary vitamin E and Se improved daily feed intake, gain and maintained oxidative balance in lambs (**Chauhan *et al*., 2016)**.

Table 3: Effect of parenteral supplementation of vitamin E plus selenium on productive performance of growing lambs (Mean ± SEM).

Parameters	Treatments			SEM	Sig.
	C	ES-1	ES-2		
Body weight:					
Initial body weight (kg)	19.14	18.01	18.61	1.46	NS
Final body weight (kg)	34.13 ^{b}	35.28 ^{b}	40.02 ^{a}	1.29	*
Daily gain (kg/day)	166.56 ^{c}	191.89 ^{b}	237.89 ^{a}	7.94	*
Feed intake:					
SSI	0.35	0.36	0.40	0.02	NS
DMI	0.80	0.85	0.93	0.06	NS
TDMI (kg/head/day)	1.15	1.21	1.33	0.05	NS
DCPI	0.119 ^{c}	0.127 ^{b}	0.141 ^{a}	0.001	*
TDNI	0.783 ^{c}	0.838 ^{b}	0.925 ^{a}	0.005	*
Feed conversion:					
FCR (kg feed/kg gain)	6.90 ^{a}	6.31 ^{b}	5.59 ^{c}	0.39	*
DCPI/g	0.715 ^{a}	0.662 ^{b}	0.593 ^{c}	0.024	*
TDNI/g	4.701 ^{a}	4.367 ^{b}	3.888 ^{c}	0.157	*

^{a,b,c} means within the same row having different superscripts significantly different (*P<0.05). NS = not significant

C = Control, ES-1 = Vitamin E plus Se (0.5 ml/head), ES-2 = Vitamin E plus Se (1.0 ml/head).

At this point, the presented results are also reinforced by a similar observations reported by **El-Barody *et al.* (2000)** that injection of vitamin E plus Se in buffalo calves improved their growth performance concomitant with an increase in thyroid hormone levels. This was the case in the present work where the active thyroid hormone (T_3), which control the general metabolism, was dose-dependently increased (P<0.05) for lambs received ES-1 and ES-2 when compared with control (Table, 4). Meanwhile, Se plays important roles on metabolism and growth *via* expression of the iodothyronine deiodinases that regulate active T_3 hormone production in thyroid and peripheral tissues **(Rooke *et al.*, 2004)**. It is interesting to notice that the enhancement gained in performance parameters for lambs received different doses of vitamin E plus Se (ES-1and ES-2) was accompanied with dose-related improvement in their nutrient digestibility (DM, OM, EE and NFE) and a trend to increase CP digestibility as well as the nutritive values of DCP and TDN. However, some studies showed that injection of vitamin E plus Se had no significant effect on Ossimi rams' performance **(Mahmoud *et al.*, 2013)** who suggested that young lambs are possibly more sensitive to Se supplement than lambs reaching physiological maturity **(Abd El-Ghany *et al.*, 2008)**.

Serum biochemical indicators:

Data presented in Table (4) showed that lambs of ES-2 had higher (P<0.05) concentrations of serum total protein (TP) and globulin with no significant change in serum albumin compared to control and ES-1. Serum concentrations were 6.80, 6.90, and 7.75 g/dl for total TP, 3.20, 3.00 and 3.10 g/dl for albumin and 3.60, 3.90 and 4.65 g/dl for globulin in control, ES-1 and ES-2 groups, respectively. This finding could pointed out that combined administration of vitamin E plus Se to lambs of ES-2 improved protein synthesis and metabolism. These results stand with those of **El-Shahat and Abd El-Monem (2011)** who noticed similar increases in serum TP and globulin, but not albumin, on Baladi sheep supplemented with vitamin E plus Se. The results are also keeping similar trend of serum TP and globulin for Ossimi rams received injection of vitamin E plus Se, as noticed by **Mahmoud *et al.* (2013)** who also explained that the significant increases in blood TP and its

fractions may be attributed to an improve in protein anabolism and decrease of protein catabolism. Such beneficial effects of co-administration of vitamin E plus Se on blood TP may be ascribed to the improve in feed efficiency induced by vitamin E plus Se supplement which reflects the improvements in lamb' performance in the present study, and overall animal health and/or reproductive performance detected by others **(Mahmoud *et al.*, 2013)**. In contrast to the presented results, **Shinde *et al.* (2009)** showed no effect of vitamin E plus Se supplement on serum TP and globulin in buffalo calves.

Table 4: Effect of parenteral supplementation of vitamin E plus selenium on serum biochemical indicators of growing lambs (Mean ± SEM).

Parameters	Treatments			SEM	Sig.
	C	ES-1	ES-2		
Total protein (g/dl)	6.80 ^{b}	6.90 ^{b}	7.75 ^{a}	0.27	*
Albumin (g/dl)	3.20	3.00	3.10	0.24	NS
Globulin (g/dl)	3.60 ^{b}	3.90 ^{b}	4.65 ^{a}	0.20	*
Glucose (mg/dl)	49.6	51.4	53.1	4.75	NS
Cholesterol (mg/dl)	59.90 ^{a}	50.42 ^{b}	51.33 ^{b}	3.70	*
T_3(ng/ml)	1.35 ^{c}	1.70 ^{b}	1.98 ^{a}	0.12	*
T_4(ng/ml)	46.0	48.0	50.5	4.50	NS
T_3/T_4 ratio	0.029 ^{c}	0.035 ^{b}	0.040 ^{a}	0.003	*
GSH-Px (mU/ml)	5.56 ^{c}	7.43 ^{b}	9.78 ^{a}	0.05	*

^{a,b,c} means within the same row having different superscripts significantly different (*P<0.05). NS = not significant.
C = Control, ES-1 = Vitamin E plus Se (0.5 ml/head), ES-2 = Vitamin E plus Se (1.0 ml/head).

The differences in serum glucose concentrations, in the current study, were not significant in response to co-administration of vitamin E plus Se in lambs of ES-1 and ES-2 *vs.* control. This finding agree with the similar trend of unchanged blood glucose concentrations in lambs **(Soliman *et al.*, 2001)** and in buffalo calves **(Shinde *et al.*, 2008)** due to vitamin E plus Se supplementation. **Mahmoud *et al.* (2013)**, however, found serum glucose levels increased with supplemental vitamin E plus Se in Ossimi rams.

As shown in Table (4), there was a significant (P<0.05) decrease in serum cholesterol levels estimated by 15.83 and 14.31 % in lambs of ES-1 and ES-2 compared with control. Similar decrease in total plasma cholesterol concentrations was previously observed in sheep fed Se and vitamin E-supplemented diets as reported by **Gabryszuk *et al.* (2007)**, but they noticed an increase in high density lipoprotein (HDL) fraction. Lipid metabolism could modified by increasing HDL and triglycerides in cattle **(Falkowska *et al.* 2000)**. In case of vitamin E supplement alone, no change was detected in serum cholesterol or triglyceride concentrations **(Njeru *et al.*, 1994)**, whereas Se supplement alone remarkably decreased serum total cholesterol levels in rats **(Bunglavan *et al.*, 2014)**.

The data presented in Table (4) indicate that serum triiodothyronine (T_3), but not thyroxin (T_4), concentrations and T_3/T_4 ratio were increased (P<0.05) for vitamin E plus Se-injected lambs (ES-1 and ES-2) *vs.* control. The increases in serum T_3 concentrations were amounted by 25.93 and 46.67 % in lambs of ES-1 and ES-2 compared with control. The increases in T_3 concentrations and T_3/T_4 ratio noticed to be dose-related. This enhancement in T_3 levels could be clarified by the fact that type I iodothyronine-5´-deiodinase enzyme, used for deiodination of T_4 into a more biologically active T_3, is a Se-dependent enzyme. So, the present results may indicate that the metabolic processes of vitamin E plus Se-injected in lambs were reinforced, accounting for the improvement observed in their nutrient

digestibility and productive performance (Table, 3). The present results are consistent with the studies showed a beneficial effect of supplemental Se alone on increasing T_3 concentrations in goats **(El-Sisy *et al.*, 2008)** and in calves **(Awadeh *et al.*, 1998)** as well as in buffalo calves **(El-Barody *et al.*, 2000)**. In the same way, cows received combined vitamin E plus Se injection exhibited significantly higher T_3 concentrations with increasing T_3/T_4 ratio **(Pavlata *et al.*, 2004)**. Similar trend of increasing T_3 levels, but not T_4 or T_4/T_3 ratio, due to vitamin E plus Se supplement, detected in buffalo calves **(Shinde *et al.*, 2009).**

Data indicated that activity of serum glutathione peroxidase (GSH-Px) was higher ($P<0.05$) for lambs received ES-1 and ES-2 than control. The increases in serum GSH-Px activity were estimated by 33.63 and 75.90 % for lambs of ES-1 and ES-2 compared with control. This increase in serum GSH-Px activity was related to the injected doses of vitamin E plus Se where levels for lambs of ES-2 were significantly ($P<0.05$) higher than those of ES-1 (Table, 4). This response of higher activated serum GSH-Px levels, due to vitamin E and Se supplement, was also detected in lambs **(Hamam and Abou-Zeina, 2007)**, goats **(Abou-Zeina, 2002)** and cattle **(Ceballos *et al.*, 2003)**. The trend of higher serum GSH-Px activity could be seen with either Se **(Qin *et al.*, 2007)** or vitamin E **(Hong *et al.*, 2010)** alone in small ruminants. The present results strongly revealed that vitamin E plus Se injection in growing lambs act synergistically to improve their antioxidant status. This synergistic role of Se and vitamin E to improve the antioxidant status was also proved in cattle **(Zhao *et al.*, 2008)**. Vitamin E increased antioxidant recycling and improved synergistic antioxidant effect **(Ramos *et al.*, 1998)**; and Se exerts central role in enzymatic defence pathways against oxidative damage in tissues. This favourable effect of vitamin E plus Se injection on antioxidant status of growing lambs, detected in the present study, may account for the improvement noticed in their productive performance. So, co-supplementation of vitamin E plus Se in sheep improve their antioxidant status, immune competence and performance **(Hamam and Abou-Zeina, 2007)**.

CONCLUSION

The present study show that parenteral supplementation of vitamin E plus Se, at doses 0.5 and 1.0 ml / head/ biweekly, to Ossimi growing lambs had useful impacts on feed intakes (DCPI and TDNI), nutrients digestibility (DM, OM, EE, and NFE), growth performance (FBW and DG), feed conversion (FCR, DCPI and TDNI) and some related serum biochemical indicators especially active thyroid hormone (T_3) and antioxidant enzyme (GSH-Px). These improvements had dose-related manner with vitamin E plus Se injection with superiority to the higher dose of 1 ml containing 7.14 IU vitamin E + 0.06 mg Se/head/day.

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Effect of parenteral supplementation of vitamin E plus selenium on nutrient digestibility, productive performance and some serum biochemical indicators of lambs

الملخص العربى

تأثير الإمداد بفيتامين هـ والسيلينيوم على معاملات الهضم الغذائيه ، الأداء الإنتاجي ، وبعض المؤشرات البيوكيميائية للحملان

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صممت هذه الدراسه لتقييم تأثير الإمداد بفيتامين هـ والسيلينيوم على معاملات الهضم الغذائيه ، الأداء الإنتاجي وبعض مؤشرات السيرم البيوكيميائية للحملان الأوسيمي. نفذت التجربه باستخدم 24 من الحملان الأوسيمى النامية بمتوسط ثلاثة شهور من العمر ووزن 18.58 ± 1.46 كجم. غذيت الحيوانات على مخلوط من العلف المركز وتبن فول الصويا بنسبه 70 إلى 30 % على التوالي. تم توزيع الحيوانات إلى ثلاثة مجموعات متساوية (8 حملان لكل منها). المجموعة الأولى (كنترول) تم حقنها بـ 1 مل محلول فسيولوجى (0.9 % كلوريد صوديوم)/رأس/اسبوعين. المجموعة الثانية (ES-1) والمجموعة الثالثة (ES-2) تم حقنها على التوالى بفيتامين هـ والسيلينيوم بمعدل 0.5 مل/رأس/ اسبوعين (يحتوى على 3.57 وحدة دولية من فيتامين هـ + 0.03 ملجم سيلينيوم/رأس/يومياً) و 1.0 مل/رأس/اسبوعين (يحتوى على 7.14 وحدة دولية من فيتامين هـ + 0.06 ملجم سيلينيوم/رأس/يومياً). أظهرت النتائج زياده ($P<0.05$) في معاملات الهضم الغذائيه للماده الجافه ، الماده العضويه، المستخلص الأثيري والكربوهيدرات الذائبه لحملان المجموعه ES-1 و ES-2 عن حملان الكنترول الغير معامله. بينما لم يكن هناك أي فروق معنويه نتيجه للمعاملات في قيم هضم البروتين الخام، الألياف الخام ، الألياف المستخلصه بالمحاليل المتعادله ،الألياف المستخلص بالمحاليل الحامضيه ، والقيمه الغذائيه (البروتين المهضوم و المركبات الغذائيه الكليه المهضومه). زادت متوسطات أوزان الجسم النهائيه ($P<0.05$) بمعدل 17.26 ، 13.44 % لحملان المجموعه ES-2 مقارنه بالكنترول أو المجموعه ES-1 على التوالي. كانت متوسطات معدلات الزيادة اليومية فى الوزن أعلى ($P<0.05$) لحملان المجموعه ES-1 و ES-2 عن حملان الكنترول وكانت القيم 166.56 ، 191.89 ، 237.89 جم / يوم لحملان الكنترول ، ES-1 و ES-2 على التوالي. كانت الفروق في متوسطات المأكول من تبن فول الصويا ، المأكول من الماده الجافه والماكول الكلي من الماده الجافه غير معنويه بين المعاملات مقارنه بالكنترول. كان هناك تحسن معنوي ($P<0.05$) مرتبط بالجرعه من فيتامين هـ والسلينيوم في المأكول من البروتين المهضوم والمركبات الغذائيه الكليه المهضومه ومعدلات التحويل الغذائي للماده الجافه ، البروتين المهضوم والمركبات الغذائيه الكليه المهضومه لحملان ES-1 و ES-2 مقارنه بالكنترول. ارتفعت تركيزات السيرم من البروتين الكلي ، الجلوبيولين ($P<0.05$) لحملان ES-2 مقارنه بالكنترول. لم يحدث أي تغيير معنوي في تركيزات جلوكوز السيرم لحملان ES-1 و ES-2 مقارنه بالكنترول. كان هناك انخفاض ($P<0.05$) في مستوى كوليسترول السيرم لحملان ES-1 و ES-2 مقارنه بالكنترول. أظهرت النتائج ارتفاع تركيزات السيرم من هرمون التراي أيودوثيرونين (T_3)، وليس الثيروكسين (T_4)، ونسبه هرمون T_3 إلى T_4 ونشاط إنزيم الجلوتاثيون بيروكسيديز (GSH-Px) لحملان ES-1 و ES-2 مقارنه بالكنترول. كانت الزياده في مستوى هرمون التراي أيودوثيرونين ونشاط إنزيم الجلوتاثيون بيروكسيديز لحملان ES-1 و ES-2 زياده مرتبطه بالجرعه.

يمكن أن نستخلص من الدراسه أن الإمداد بفيتامين هـ والسيلينيوم بجرعات مختلفة (0.5 ، 1.0 مل/ رأس/ أسبوعين) فى حملان الأوسيمى النامية قد أظهر تأثيرات مفيدة لتحسين معاملات الهضم الغذائيه، الأداء الإنتاجي، معدل التحويل الغذائي وبعض مؤشرات السيرم البيوكيميائيه المرتبطه بها. وأن هذا التحسين كان مرتبطا بالجرعات من فيتامين هـ والسيلينيوم مع الأفضلية للجرعة الأعلى منها.