Serum biochemical parameters, and liver enzyme activity of ewes on the day of parturition and of their newborn lambs in response to selenium supplementation during late pregnancy

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ABSTRACT

This study was designed to evaluate the influence of dietary supplementation with selenium-enriched yeast (SeY) during late gestation on critical biochemical parameters, liver enzyme activity, and thyroid hormone status in periparturient ewes and their newborn lambs, hypothesising that SeY would mitigate the metabolic and oxidative stress characteristic of this period. Eighteen pregnant ewes (n=18) were equally and randomly allocated to one of three daily supplementation groups: a Control group (C) receiving 0 mg Se/kg Dry Matter (DM), a low-dose SeY group (T1) receiving 1.0 mg Se/kg DM, and a high-dose SeY group (T2) receiving 2.0 mg Se/kg DM. Blood samples were collected from the ewes on the day of parturition and from their newborn lambs during the first week of age. Serum was subsequently analysed for concentrations of total protein, urea, total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), creatinine, and the activity of the hepatic enzymes aspartate aminotransferase (AST) and alanine aminotransferase (ALT). The results demonstrated a significant, dose-dependent metabolic improvement in supplemented ewes: serum total protein and urea concentrations were notably higher in both T1 and T2 groups compared to the Control group ($P < 0.05$), indicating enhanced protein utilization. Conversely, markers of potential stress or impaired lipid metabolism specifically total cholesterol, LDL, and creatinine were significantly higher in Control ewes than in both SeY-supplemented groups. Furthermore, the elevated activity of AST and ALT enzymes recorded in Control ewes was significantly reduced in the T1 and T2 groups, suggesting effective hepatoprotection conferred by SeY. Crucially, these maternal benefits were conferred to the offspring: lambs born to Control ewes exhibited higher concentrations of cholesterol, HDL, LDL, and creatinine, along with significantly greater AST and ALT enzyme activities, compared to lambs from SeY-supplemented ewes. In conclusion, dietary SeY supplementation during late pregnant ewes successfully regulated maternal protein and lipid metabolism, reduced indicators of hepatic stress in the dam, and effectively transferred protective effects, resulting in improved metabolic and hepatic health profiles in newborn lambs. These results confirm the clinical value of SeY during late gestation to optimize the peripartum health trajectory for both the ewes and their offspring.

PAROLE CHIAVE

Selenium; Late pregnancy; Ewes; Enzyme; Biochemical.

INTRODUCTION

The essential trace mineral, selenium (Se), is of fundamental importance to animal health (1). As a constituent of selenoproteins, selenium has structural and enzymic roles, in the latter context being best known as an antioxidant and catalyst for the production of thyroid hormone active (20). Selenium is needed for the proper functioning of the immune system (23). Previous studies have linked selenium deficiency to several disease risks, although other conditions involved oxidative stress (23). Additionally, Se is a component of several selenoproteins involved in metabolism, immunity, serum biochemical parameters and other physiological functions (9).

It has been reported that pregnancy, especially late pregnancy can impose oxidative stress in ewes (25) and, thus, supplying Se as antioxidants could improve ewes' fertility by decreasing the oxidative damage of their body tissue (24). Furthermore, Se can improve some physiological functions of ewes during late pregnancy and also lead to improved newborn lamb performance and survival (2). Several previous studies reported that Se deficiency may lead to numerous physiological problems in pregnant ewes including compromised immune system, spontaneous abortion, retained placenta, and neonatal disorders (2). A well-known clinical condition that primarily occurs in newborn lambs due to Se deficiency in the diet of their maternal ewes is muscular dystrophy (17). The digestibility of selenium-enriched yeast as an organic form of Se is about 66%, while the digestibility of inorganic form of Se is about 50% (28). To meet Se requirements of newborn lambs, Se supplementation

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must be offered to ewes during late pregnancy because Se has the ability to cross the placental barrier into fetal tissue and also can reach the newborn lams through colostrum (17). To our knowledge the supplementation of different levels of selenium-enriched yeast as organic selenium (SeY) during late pregnancy in ewes and their effect on serum biochemical and liver enzyme activity on the day of parturition have not been investigated. Although late pregnancy is considered the critical physiological phase in ewes (16), their side effects can influence the physiological function of female animals on the day of parturition (29). Therefore the aim of the present study is to evaluate the effect of different levels of selenium-enriched yeast supplementation during late pregnancy on serum biochemical parameters, liver enzymes activity and thyroid hormones of ewes on the day of parturition and of their newborn lambs.

MATERIALS AND METHODS

The present study was conducted between 7th September and 8th of November 2024 at the Project of Animal Production of the Department of Animal Production, College of Agricultural Engineering Sciences, University of Duhok. The Research Ethics Committee of Animal Production Department, College of Agricultural Engineering Sciences, University of Duhok approved the research protocol.

Experimental animal, housing and management

Pregnant ewes (N=18) with body weight (53.03 ± 4.09kg) and ages (3.21 ± 1.1 years) were used in the present study from six weeks before and one week after parturition. At the start of the study. At the start of the study, the ewes were submitted for detection of any disease. Ewes were housed consciously from week 8 before parturition, until parturition in an individual pen (2 x 2 m). The first 2 weeks were adaptation periods. During housing, a total mixed ration (TMR; barley 49.8%, wheat barn 25%, maize 10%, soybean meal 15%, and premix 0.2%) was provided daily, sufficient for pregnant ewes. Dry matter (DM) (87.95%), CP (12.14% DM), CF (22.8% DM), Fat (2.3% DM), NFE (47.26% DM), ash (5.85% DM), ME (2298.77 kcal/kg) and moisture (12.11%). During adaptation, the ewes were fed twice a day at 9:00 a.m. and 4 p.m. on concentrate (400g) and hay, then the feeding meal quantity was increased gradually by (10%) until it reaches for pregnant ewe's requirements by the start date of the experiment. Water was also provided *ad libitum*.

Pregnancy Diagnoses and Treatments

At the start of the study, pregnant ewes were selected from the main herd using Veterinary Ultrasound Scanner (CD66V; Zhuhai Carellfe Medieal Technology Co., Ltd, China). The ewes were randomly divided into three experimental homogeneous groups (n=6 per group) on the basis of live body weight (53.2 ± 3.96 kg), (53.2 ± 4.04 kg), and (53.57 ± 4.29 kg). Each ewes was supplemented with selenium-enriched yeas (SeY; LALLEMAN ANIMAL NUTRITION, 19, rue de Briquetier-BP 59 31702 Balgnac Cedex-France) with with selenium-enriched yeas (SeY) with 0 mg Se/kg DM (control; C), 1.0 mg Se/kg DM (treatment one; T1) as low SeY group and 2.0 mg Se/kg DM (treatment two; T2) as high SeY group. The SeY were mixed with a feed plate and offered to ewes twice a day at 9:00 a.m. and 4 p.m. after adaptation period for 6 weeks until parturition.

Blood Collection and analytical techniques

Blood was collected from ewes on the day of parturition by jugular venipuncture using a 20 G needle syringe into 10ml vacutainer tubes (Medicalet, Pingshan New District, Shenzhen City 518118, China). Blood samples were also taken from their newborn lambs (n=18) with a body weight of (4.08±0.8 kg). Blood samples were centrifuged at 6000g for 12 min using a SIGMA centrifuge (SIGMA Osterode am Harz, Germany). Serum was separated and stored at -20°C until analyzed for hormonal and biochemical parameters analysis. Serum biochemical parameters and enzyme activity (aspartate aminotransferase (AST), alanine aminotransferase (ALT)) and Lactate dehydrogenase (LDH) of ewes and their newborn lambs were analyzed by cobas 6000 (Hitachi High-Technology Corporation, Tokyo, Japan).

STATISTICAL ANALYSES OF DATA

The data were statistically analyzed using the Genstat statistical analysis software package (Genstat V 14th.19.1.14713 provided by VSN International Ltd, UK). Factorial one-way ANOVA analyses were used to compare the datasets of serum

Table 1 - Effect of selenium-enriched yeast supplementation during late pregnancy on serum biochemical parameters (mean ± SEM) in control and treatment groups of ewes on the day of parturition.

Parameters	Treatments			P-value
	C	T1	T2	
Glucose (mg/dl)	182 ± 56.3	157 ± 51.2	151 ± 23.7	0.547
Total Protein (g/dl)	4.93 ± 0.61^{b}	5.9 ± 0.65^{a}	5.8 ± 0.16^{a}	0.012
Cholesterol (mg/dl)	59.8 ± 6.4^{b}	50.2 ± 7.9^{a}	50.2 ± 6.7^{a}	0.021
Triglyceride (mg/dl)	20.8 ± 4.5	18.8 ± 3.4	16.1 ± 3.2	0.155
HDL (mg/dl)	24.1 ± 4.9	21.2 ± 6.8	21.9 ± 5.3	0.251
LDL (mg/dl)	32.4 ± 3.3^{a}	26.9 ± 5.2^{b}	25.7 ± 5.3^{b}	0.044
Urea (mg/dl)	26.7 ± 6.4^{b}	30.7 ± 6.2^{b}	38.6 ± 2.5^{a}	0.005
Creatinine (mg/dl)	1.07 ± 0.03^{a}	0.84 ± 0.11^{b}	0.75 ± 0.27^{b}	0.017

C = Control, T1 = Treatment one and T2= Treatment two. Means with different superscript letters in rows differ (p<0.05).

glucose, total protein, cholesterol, triglyceride, HDL, LDL, urea and creatinine of different groups of ewes and of their newborn lambs of C, T1 and T2 groups of ewes on the day of parturition. Factorial one-way ANOVA was also used to compare datasets of serum LDH, AST and ALT enzymes of different groups of ewes and of their newborn lambs from C, T1 and T2 groups of ewes on the day of parturition. The comparison between C, T1 and T2 groups of ewes and their newborn lambs was analyzed by the Tukey test. Differences were reported as significant at P<0.05 and trends were reported when the P-value is between <0.1 and >0.05.

RESULTS AND DISCUSSIONS

The effect of SeY supplementation during late pregnancy on serum biochemical parameters of ewes on the day of parturition

The effect of SeY supplementation during late pregnancy on serum biochemical parameters on the day of parturition of ewes are illustrated in Table 1. The results of the present study found that serum glucose (mg/dl) was not significantly affected by SeY supplementation during late pregnancy. Similarly, Novoselec et al. (18) found no significant effect (p=0.158) of dietary organic selenium (0.3 mg/kg) supplementation on the glucose concentration in ewes. However, in contrast to the results of the present study, Chung et al. (4) reported an increase in glucose concentration in goats fed a feed with organic selenium supplementation. This may be due to the fact that Chung et al. (4) supplemented organic selenium with goats. Goats unlike ewes, always graze in high altitude areas which are characterized by low selenium content in the soil (7). This may be due to the fact that low Se concentrations in goat feeds in high-altitude areas cause a long-term deficiency of Se in goat farms (29). Selenium has been washed away in high-altitude areas by soil erosion and flooding as a result of high rainfall levels (7). In the present study, selenium-enriched yeast supplementation during late pregnancy significantly increased serum total protein levels (p=0.012). Ewes in the T1 and T2 treatment groups exhibited significantly higher total protein concentrations compared to the control (C) group, while there were no differences between T2 and T1 groups, which is in accordance with results of the study of Ibrahim and Mohamed (9), who found that sheep supplemented with 0.30 mg/kg DM had significantly higher (p<0.05) concentrations of serum total protein compared with the control group. Furthermore, Pechova et al. (21) also found that supplementation with SY in goats caused an increase (p<0.05) in concentrations of serum total protein. This suggests a potential role of selenium in enhancing protein metabolism or synthesis during gestation (20). This may be also due the fact that supplementing ewes during late pregnancy with SeY had an effective role as antioxidant to improve protein synthesis and metabolism (9).

. Selenium-enriched yeast (SeY) supplementation during late pregnancy also had a significant effect on serum cholesterol concentration on the day of parturition (p=0.021). The finding of the current study was in accordance with Novoselec *et al.* (18), who found that the Se supplementation significantly (p<0.05) reduced cholesterol concentration in pregnant ewes. Serum LDL of ewes on the day of parturition was also significantly decreased (p=0.055) on the day of parturition by SeY supplementation during late pregnancy. These findings agree with those shown by previous studies by Novoselec et al. (18) who found that ewes fed nutrients with Se supplementation had significantly lower (p<0.05) concentrations of LDL in comparison to the control group. The relationship between SeY as an antioxidant and the concentration of cholesterol in the blood is unknown. Although, Herrera *et al.* (11) reported that SeY may influence lipid metabolism during the periparturient period. Furthermore, previous studies aimed to investigate the relationship between antioxidants and serum cholesterol conducted on rats by Karada (13) found that rats fed a high cholesterol level with selenium supplementation had significantly lower (p<0.05) concentrations of cholesterol. The present study found no significant effect of SeY during late pregnancy on the concentration of serum triglyceride (p=0.155) and HDL (p=0.251) on the day of parturition.

Serum urea concentration was significantly higher in the T3 group (38.6 ± 2.5 g/dL) compared to T1 (30.7±6.2 g/dL) and T2 (26.7±6.4 g/dL) groups (p=0.005), while there was no significance different between C and T1 groups. Similarly, Novoselec *et al.* (18) found that ewes fed a total mixed ration with Se supplementation in the form of Selplex® and sodium selenite significantly increased the concentration of blood urea in ewes. Slavik *et al.* (27) reported a significantly higher serum urea concentration of cows fed a Se supplement in the form of sodium selenite compared to cows fed a normal ration. Furthermore, Juniper *et al.* (2008) also found a significant change in the concentration of blood urea in cows after treatment with Se. Previous studies reported that the concentration of urea in the blood is the main nitrogen indicator of catabolism of amino acids (15). The significant increase in blood urea concentration observed in ewes on the day of parturition is likely associated with increased amino acid catabolism or heightened physiological stress due to the parturition process and pain. It is reasonable to speculate that in the current study that a higher concentration of blood urea in response to SeY supplementation in T3 groups of ewes, which may be due to that Se has resulted in epigenetic changes that fundamentally affected the blood urea nitrogen metabolism. Previously, it has been reported that increase concentrations of blood urea nitrogen possibly were caused by Se status-induced epigenetic effects (10). This significant increase in serum urea in the T3 group may indicate altered protein catabolism or reduced renal clearance associated with the higher level of SeY supplementation (18).

Serum creatinine concentration was also significantly higher in the control group (C) (1.07 ± 0.03 mg/dL) compared to the T1 (0.84±0. 11 mg/dL) and T2 (0.75±0.27 mg/dL) groups supplemented with selenium-enriched yeast (p=0.017), while there was no significance different between T1 and T2 groups. The results of the present study are in accordance with the results reported by Jia *et al.* (10) who observed that the Se supplementation significantly (P≤0.02) decreased serum creatinine with the progress time of Se supplementation. Although there is a lack of published information about the effect of SeY supplementation on the concentration of serum creatinine in ewes. The results of the current experiment are confirmed by Piccione *et al.* (22) who found that the concentration of blood creatinine in pregnant dairy cows decreased during late pregnancy and reached a minimum level at the 1st week before calving. Then, it has been supposed that in pregnant ewes the mobilization of protein starts during gestation through late

pregnancy, reaching its peak on the day of lambing, during which a lower concentration of serum creatinine was detected (19). Furthermore, it has also been reported that Se concentration was significantly negatively (r = -0.443, $p<0.01$) correlated with blood serum creatinine (10). The reduction in serum creatinine levels in SeY-supplemented groups may be due to a protective effect of SeY on renal function or decreased muscle breakdown during the peri-parturient period (10).

The effect of SeY supplementation during late pregnancy on LDH, ALT and AST enzyme activity of ewes on the day of parturition

Although not statistically significant, serum lactate LDH activity was numerically higher in the control group of ewes (362±37.21 IU/L) compared to the T1 (335±41.01 IU/L) and T2 (321±33.91 IU/L) groups, which supplemented with SeY. The present study found no significant effect (p=0.681) of SeY supplementation during late pregnancy on serum LDH enzyme activity in ewes on the day of parturition (Figure 1). Similar to the present finding, Shi *et al.* (26) found that dietary Se supplementation had no significant effect on the activity of serum LDH in goats. However, the results of the current study disagree with those reported by Li *et al.* (14) who found a higher ($p<0.01$) serum activity of LDH in the ewes group supplemented with 5 mg Nano-Se (BW/kg/day). This may due to that Li *et al.* (14) used higher doses and different type of Se than the present study.

However, serum AST enzyme activity (IU/L) was significantly higher (p=0.003) in C group (87.5±18.49 IU/L) of ewes in comparison to T1 (57.3±14.53 IU/L) and T2 (56.8±9.10 IU/L) groups of ewes, which received SeY supplementation during late pregnancy (Figure 2). There was also a significant effect (p=0.005) of SeY supplementation on serum ALT enzyme activity (Figure 3). Significantly higher concentrations of GPT enzyme were recorded in C group of ewes, while there were no differences between T2 and T1 groups. Elrayah *et al.* (5) also found a negative correlation between Se and AST enzyme activity. In contrast to the results of the present study, Li *et al.* (14) found that the orally administration of 5 mg Nano-Se increased the activities of serum AST and ALT significantly ($p<0.01$). Shi *et al.* (26) also found that dietary Se supplementation significantly ($p<0.05$) improved AST enzyme activity, while showing that Se had no effect on ALT activity in goats. An increase in the activity of ALT and AST enzymes on the day of parturition in C group of ewes in the present study was due to the fact that ewes of C groups suffered from high stress compared to treated groups of ewes with SeY, which led to high metabolic rate in C group. These findings suggest also that SeY supplementation may exert a hepatoprotective effect during late pregnancy, as indicated by reduced levels of liver enzyme activity in supplemented ewes (17). While in supplemented group of ewes SeY act as an antioxidant which is likely to be correlated with the energy balance of ewes (8) on the day of parturition.

Effect of SeY supplementation in ewes during late pregnancy on serum biochemical parameters of newborn lambs

The effects of SeY supplementation in ewes during late pregnancy on the biochemical parameters of their newborn lambs are presented in Table 2. Serum glucose concentrations were not significantly affected by maternal SeY supplementation. Similarly, there was no significant effect on serum total protein levels (mg/dL) in the newborn lambs. In constant to the results of the present study, Novoselec *et al.* (17) reported no significant effect of maternal selenium supplementation on the serum

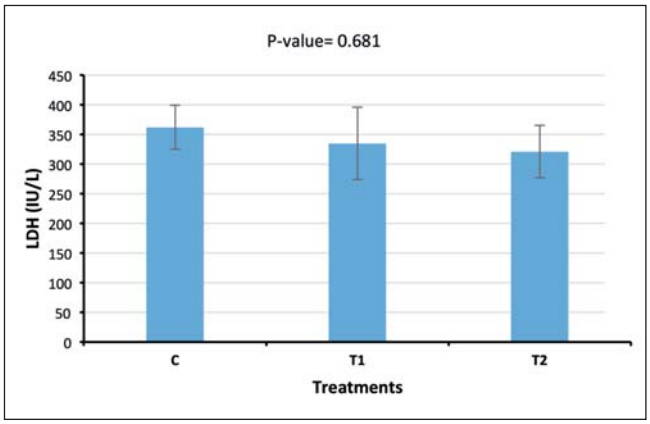

Figure 1 - Effect of selenium-enriched yeast supplementation during late pregnancy on serum LDH (IU/L) enzyme activity of ewes on the day of parturition. C = Control, T1 = Treatment one and T2 = Treatment two. Error bars = SEM.

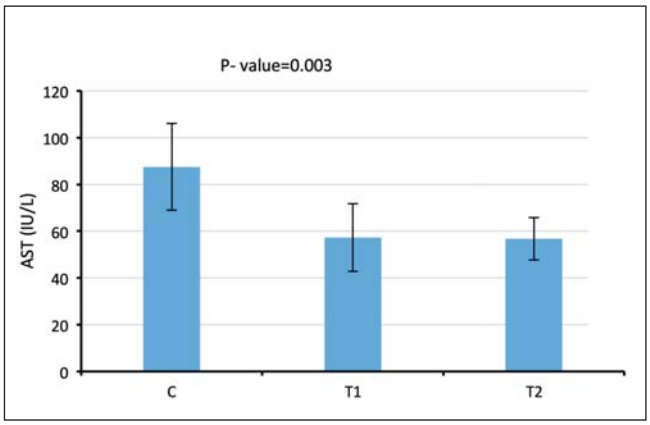

Figure 2 - Effect of selenium-enriched yeast supplementation during late pregnancy on serum AST enzyme activity (IU/L) of ewes on the day of parturition. C = Control, T1 = Treatment one and T2 = Treatment two. Error bars = SEM. Different superscript letters represent significant differences (p<0.05).

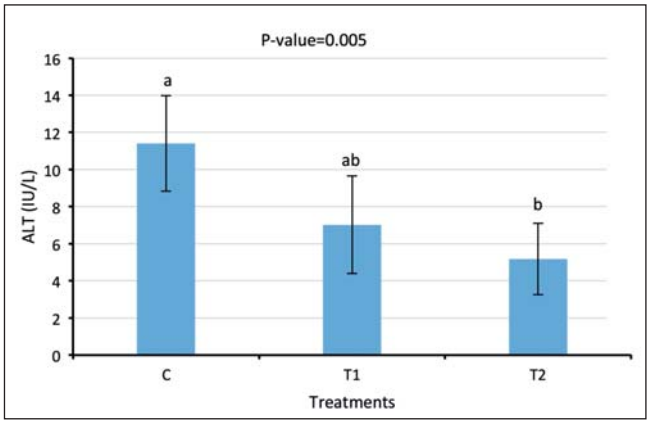

Figure 3 - Effect of selenium-enriched yeast supplementation during late pregnancy on serum ALT enzyme activity (IU/L) of ewes on the day of parturition. C = Control, T1 = Treatment one and T2 = Treatment two. Error bars = SEM. Different superscript letters represent significant differences (p<0.05).

Table 2 - Effect of selenium-enriched yeast supplementation during late pregnancy in ewes on serum biochemical parameters (mean ± SEM) in control and treatment groups of newborn lambs.

Parameters	Treatments			P-value
	C	T1	T2	
Glucose (mg/dl)	121.7 ± 12.43	139.7 ± 23.07	127 ± 4.93	0.115
Total Protein (g/dl)	5.27 ± 0.38	4.77 ± 0.90	5.25 ± 0.29	0.283
Cholesterol (mg/dl)	192.2 ± 20.42[a]	147.3 ± 14.33[b]	138.2 ± 16.64[b]	0.007
Triglyceride (mg/dl)	45.3 ± 10.45	42.2 ± 9.84	42.1 ± 9.73	0.993
HDL (mg/dl)	87.8 ± 12.06[a]	75.9 ± 4.9[b]	70.3 ± 3.39[b]	0.005
LDL (mg/dl)	95.6 ± 20.83[a]	62.7 ± 10.05[b]	59.3 ± 16.35[b]	0.016
Urea (mg/dl)	37.9 ± 4.39	38.1 ± 7.19	40.3 ± 4.00	0.693
Creatinine (mg/dl)	0.745 ± 0.11[a]	0.678 ± 0.08[b]	0.607 ± 0.03[b]	0.037

C = Control, T1 = Treatment one and T2= Treatment two. Means with different superscript letters in rows differ ($p<0.05$).

glucose and total protein concentrations in their newborn lambs. Serum cholesterol (mg/dl) was significantly higher ($p=0.007$) in C group (192.2±20.42 mg/dl) compared with newborn lambs of supplemented groups of ewes. These results agree with those of Novoselec *et al.* (17) who found a significantly ($p<0.05$) lower blood cholesterol concentration in lambs of ewes supplemented with Se compared to lambs of the control group of unsupplemented ewes. While there was no significant effect of SeY supplementation on serum triglyceride (mg/dl). Similarly, Antunovi *et al.* (3) found no significant effect ($p>0.05$) of Se supplementation on the concentrations of triglycerides of lambs. There was a significant ($p=0.005$) effect of SeY supplementation on serum HDL (mg/dl). In contrast to the results of the present, Novoselec *et al.* (17) reported no significant effect of Se additive in the dietary of ewes on the blood HDL concentration of their lambs. This may due to that in the current study organic form of SeY was used. This may be due to a potential maternal influence of SeY on lipid metabolism in offspring, possibly enhancing neonatal lipid profiles through prenatal nutritional modulation (25). There was also a significant ($p=0.016$) effect of SeY supplementation on serum LDL (mg/dl). Significantly lower concentrations of LDL were recorded in T1 (62.7±10.05 mg/dl) and T2 (59.3±16.35 mg/dl) compared with the lambs of control group (95.6 ± 20.83 mg/dl) of ewes. A similar results of the current study Novoselec *et al.* (17) showed that dietary Se supplementation of the dam caused a significant ($p=0.039$) decrease in blood LDL concentration in lambs compared with the control group. This finding indicates that maternal SeY supplementation may influence lipid transport and metabolism in the offspring during early postnatal life (35).

The current study found no significant effect of SeY supplementation on serum urea (mg/dl). These results are consistent with those previously reported by Kaneko *et al.* (12) and Antunovi *et al.* (3) who found that dietary Se supplementation had no significant influence on the concentration on blood urea. However, the present study showed a significant ($p=0.037$) effect of SeY supplementation on serum creatinine (mg/dl). The lambs of the control group of ewes had higher serum concentrations of creatinine. This may due to that SeY effect the renal capacity of glomerular filtration results in higher filtration of creatinine from serum in lambs of supplemented ewes during late pregnancy because serum creatinine is the most efficient indirect marker of glomerular filtration rate in mammals (12). This finding also recommends that maternal SeY supplementation during pregnancy may influence renal function or muscle metabolism in neonatal lambs (3). In contrast to the results of the present study Antunovi *et al.* (3) reported no significant effect of dietary Se supplementation had no significant effect on the concentration of blood urea in lambs. This may be due to the fact that Antunovi *et al.* (3) used Se supplementation in lambs from weaning to slaughter ages. It has been reported that there is a significantly negative correlation between whole blood Se and serum creatinine (10).

The effect of SeY supplementation during late pregnancy on LDH, ALT and AST enzyme activity of newborn lambs

There was no significant effect of SeY supplementation during late pregnancy in ewes on serum lactate dehydrogenase (LDH) activity in their newborn lambs (p=0.531; Figure 4). Although not statistically significant, the present study observed numerically higher serum LDH activity in lambs from the control group (674 ± 85.04 IU/L) compared to those from the T1 (642 ± 72.04 IU/L) and T2 (584 ± 81.04 IU/L) groups, whose dams were supplemented with SeY during late pregnancy. Previous studies have reported that elevated serum LDH activity may result from nutritional muscular dystrophy, a con-

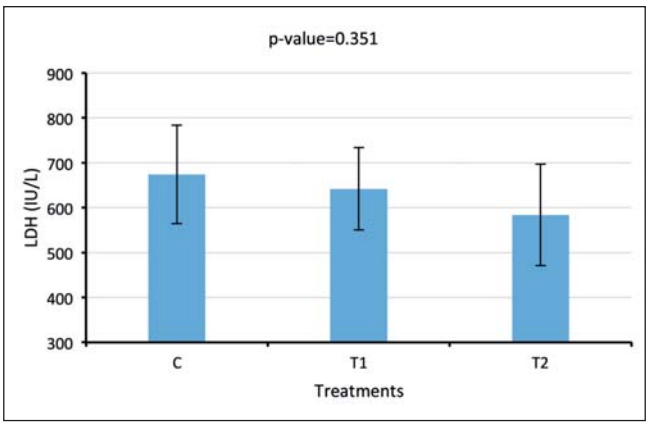

Figure 4 - Effect of selenium-enriched yeast supplementation during late pregnancy in ewes on the serum LDH enzyme activity (IU/L) of newborn lambs. C = Control, T1 = Treatment one and T2 = Treatment two. Error bars = SEM.

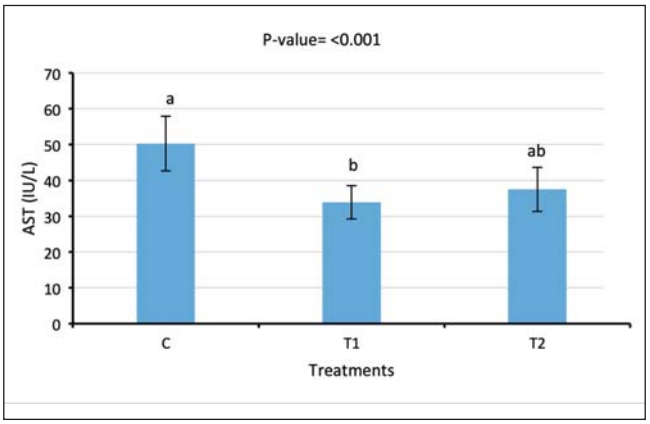

Figure 5 - Effect of selenium-enriched yeast supplementation during late pregnancy in ewes on the serum AST enzyme activity (IU/L) of newborn lambs. C = Control, T1 = Treatment one and T2 = Treatment two. Error bars = SEM. Different superscript letters represent significant differences (p<0.05).

dition associated with selenium deficiency in lambs (17).

Serum AST enzyme activity (IU/L) was significantly higher (p=0.001) in C group of newborn lamb (50.3±7.64 IU/L) compared with newborn lambs T1 (33.9±4.64 IU/L) and T2 (37.5±6.17 IU/L) of supplemented groups of ewes with SeY (Figure 5). Novoselec *et al.* (18) also found that dietary Se supplementation in growing lambs had a significant effect on the activity of serum AST. This finding proposes that maternal SeY supplementation in ewes during late may help reduce liver enzyme activity in offspring, indicating potential hepatoprotective effects (25). However, in a recent study conducted by Novoselec *et al.* (17) reported that inorganic Se results in decreased activity of serum AST enzyme in lambs. This may due to that Novoselec *et al.* (17) used inorganic Se as a dietary supplementation, while the current study organic form of Se was used, because previously Stewart *et al.*, (28) reported that the digestibility of inorganic form of Se is about 50%, while the digestibility of organic form of Se is about 66%.

There was also a significant effect of SeY supplementation during late pregnancy in ewes on the serum ALT enzyme activity (IU/L) of newborn lambs (Figure 6). Significantly higher (p=0.003) concentration of ALT enzyme activity was recorded in newborn lambs (4.05±0.64 IU/L) of C group of ewes in

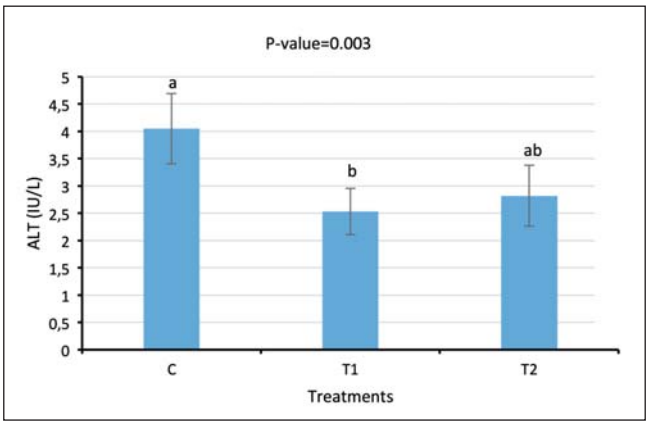

Figure 6 - Effect of selenium-enriched yeast supplementation during late pregnancy in ewes on the serum ALT enzyme activity (IU/L) of newborn lambs. C = Control, T1 = Treatment one and T2 = Treatment two. Error bars = SEM. Different superscript letters represent significant differences (p<0.05).

comparison to T1 (2.53±0.42 IU/L) and T2 (2.82±0.56 IU/L) groups of newborn lamb. Similarly, Gehringer *et al.* (6) found that dietary Se supplementation protected lambs against toxins, which led to decrease the level of serum ALT enzymes activity and also caused to reduce lipid peroxidation levels in the animal tissue. Novoselec *et al.* (17) found that an increase in serum AST activity lead to nutritional muscular dystrophy because of dietary Se deficiency in lambs, which partly results from enhanced tissue damage due to lipid peroxidation. Selenium is a crucial component of antioxidant enzymes such as glutathione peroxidase, which helps protect cells particularly liver cells from oxidative damage (24). Supplementation with SeY during late pregnancy likely enhanced the antioxidant status of the ewes and, consequently, their fetuses (26). This improved antioxidant defense may have led to reduced hepatic (liver) stress or injury in the newborn lambs, as reflected by the lower serum ALT activity in the T1 and T2 groups. ALT is a liver-specific enzyme, and elevated levels are typically associated with hepatocellular damage (4). Therefore, the lower ALT levels in lambs from SeY-supplemented ewes suggest better liver health or reduced oxidative damage.

CONCLUSION

In response to dietary SeY supplementation during late pregnancy can improve total protein and urea and also regulate the activity of AST and ALT enzymes in the ewes. While, SeY supplementation had no effect on the concentration of serum glucose, triglyceride and HDL and also had no effect on LDH enzyme activity of ewes. Dietary supplementation of SeY in pregnant ewes can reduce cholesterol, LDL and creatinine in newborn lambs and can also regulate the activity of AST and ALT enzymes. Dietary SeY supplementation during late pregnancy in ewes had also no effect on the concentration of serum glucose, total protein, triglyceride and urea of newborn lambs.

Conflicts of interest

The author decline that he have on conflict of interest.

Author Contributions

The author certify that he has designed this work or the analysis and interpretation of the data, as well as the writing of the manuscript, to take public responsibility for it. The author believes the manuscript represents a valid work. Furthermore, author certifies that this material or similar material has not been and will not be submitted to or published in any other publication.

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