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L-carnitine ameliorates immune-metabolic response and improves antioxidant status in goats with pregnancy toxemia

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ABSTRACT

According to the literature, there have been limited studies describing the efficacy of L-carnitine (LC) administration in goats. The present study was designed to evaluate the influence of orally administered LC on some immune-metabolic variables, as well as the redox status in goats with experimentally induced pregnancy toxemia (PT). The study included eighteen clinically healthy Baladi goats at 110 ± 5 days of gestation. The animals were randomly allocated into three equally-sized groups: control, toxemic (PT), and toxemic treated with LC (TLC). On day 110 ± 5 of gestation, the goats in the TLC group received 10 mL of LC given as an oral drench once daily. Administration of LC was continued for 20 consecutive days. At day 130 of gestation, PT was experimentally induced in the animals of the PT and TLC groups by means of feed withdrawal for 72 hours. For biochemical analyses, blood samples were collected from each investigated doe via jugular vein puncture before PT induction (T0), and once daily for five consecutive days (T1, T2, T3, T4, and T5). The clinical findings of PT appeared in all the goats of the PT group after 72 hours of feed withdrawal, while the goats of the TLC group did not show any clinical symptoms throughout the study period. Administration of LC elicited initial and sustained low serum levels of malondialdehyde (MDA), tumor necrosis factor (TNF-α), and high serum glucose, superoxide dismutase (SOD) and interleukin (IL)-10 at T0 compared with those of the control and PT groups. At T3, goats that received LC showed significantly lower values of β-hydroxybutyric acid, non-esterified fatty acid, triacylglycerols, MDA, TNF-α, IL-1β, IL-6, and higher values of total cholesterol, glutathione peroxidase, SOD, and IL-10 than those of the PT group. Our data suggest that orally administered LC could be useful in ameliorating the immune status and improving lipid metabolism in goats with PT.

Key words: pregnancy toxemia; L-carnitine; cytokine; oxidative stress

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Introduction

Pregnancy toxemia (PT) is a metabolic disease caused by a negative energy balance occurring in pregnant ewes and does, particularly in those carrying multiple offspring. The disease occurs during the late gestation period (the last 4-6 weeks of pregnancy) when about 60% of fetal growth takes place (LIMA et al., 2012). During that time, approximately 33-36% of blood glucose is directed to the fetoplacental unit to satisfy its energy demands (LIMA et al., 2012). The increased energy required by the fetuses, combined with hormonal alterations, has a great impact on the carbohydrate and lipid metabolism of pregnant animals, meaning that they are in a stressful condition, with the likelihood of developing PT (ANDREWS, 1997). The natural incidence of PT in intensively farmed sheep is approximately 2% of pregnant ewes, but the disease may affect the majority of late pregnant ewes if there are severe deficiencies in management of the disease (RADOSTITS et al., 2007). In a study of sheep diseases in Canada, 19% of flocks were reported to have PT (DOHOO et al., 1985). In Jordanian goats, the overall prevalence of the disease has been reported to be 13.3%; while the herd prevalence was 87.5% (ISMAIL et al., 2015). The major biochemical alterations observed in toxemic goats include hyperketonemia, hypoglycemia and marked metabolic acidosis (LIMA et al., 2016).

Accurate and timely diagnosis of the disease is crucial to treat the affected animals because toxemic goats have high fatality rates, exceeding 80% in untreated animals, and their condition can deteriorate quickly in cases of delayed medical treatment (ROOK, 2000; LIMA et al., 2016). Hence, disease prevention is important to reduce the deleterious consequences of the disease. Several effective strategies have been applied recently to prevent PT in ewes, including control of body condition score in late pregnancy, addition of concentrated feed, as well as administration of certain drugs (CAL-PEREYRA et al., 2015; TEMIZEL et al., 2015).

Application of L-carnitine (LC), a vitamin-like quaternary ammonium compound, synthesized endogenously from lysine and methionine in liver and kidney (REBOUCHE and ENGEL, 1980), holds much promise in a number of disorders in humans and laboratory animals but there is a paucity of information relating to sheep and goats. There has been growing interest in using LC to control inflammation in human patients with inflammatory bowel disease (MOEINIAN et al., 2013), and those suffering from Coronary Artery Disease (LEE et al., 2015). However, little is still known regarding the efficacy of LC for immunity in goats with PT. An earlier report found that LC administration could protect cell membranes against oxidative damage in aging rats (KALAISELVI and PANNEERSELVAM, 1998). Administration of LC could improve animal performance, and could stimulate the physiological processes (FATHI and FARAHZODI, 2014). It could also act as an antioxidant to protect cell membranes against oxidative damages in aging rats (KALAISELVI and PANNEERSELVAM, 1998). Recent studies have shown that LC could be effective in several disorders affecting sheep (PANCARCI et al., 2007; CITIL et al., 2009) and goats during the transition period (KACAR et al., 2010), and in growing sheep fed diets containing non-protein nitrogen (CHAPA et al., 2001). However, the influence of orally administered LC in goats with PT has not been fully addressed. Therefore, the present study was performed to evaluate the influence of orally administered LC on some immune-metabolic variables, as well as the redox status in goats with experimental PT. We hypothesized that administration of LC could help potentiate immune-metabolic status and influence the antioxidant activity in goats with PT.

Materials and methods

Animals. The present study included eighteen, clinically healthy, multiparous Baladi goats, at 3-5 years of age and 35-40 kg body weight, with a body condition score of 3-3.5 (on a scale of 1-5). The study was carried out at the Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Mansoura University, during the period between March to May 2015. All procedures were performed in accordance with the Guidelines for the Care and Use of Agricultural Animals in Research and Teaching, 3rd ed. (http://www.fass.

org/), and those of Mansoura University Animal Care. Procedures were approved by the Ethical Committee of Mansoura University. Animals were subjected to thorough clinical examinations before and throughout the experimental period. The gestation time and the number of fetuses were determined ultrasonographically using a 5MHz trans-abdominal probe (CUS2000, Carewell, China). The investigated animals were at 110 ± 5 days of gestation (means ± SD), and each doe carried at least two fetuses. The animals were kept in separated pens, under the same environmental conditions, and were fed 250 g concentrate/head/day, consisting of a mixture of ground yellow corn, wheat bran, and cotton seed meal, while berseem hay and water were offered *ad libitum.*

Study design and allocation of animals. The animals were randomly allocated into three equally-sized groups (of six goats each) as follows: control, toxemic (PT), and toxemic treated with LC (TLC). On day 110 ± 5 of gestation (means ± SD), LC (Carnivit 50 mg/mL, Vetsintez" LLC, Ukraine) was given as an oral drench to goats in the TLC group, at a dose of 500 mg active ingredient/head/day, according to a method previously described (CITIL et al., 2009). LC administration continued for 20 consecutive days. At day 130 of gestation, PT was induced in animals of the PT and TLC groups by means of feed withdrawal for 72 hours, with free access to water. Food was offered to the animals once clinical signs of PT appeared. All the animals were kept under complete supervision and were thoroughly monitored throughout the experiment. The investigated animals were clinically examined by three independent clinicians. Particular emphasis was laid on recording vital signs, including rectal temperature, heart rate, respiratory rate, and visible mucous membrane color, besides observing the potential alterations in general demeanor, eyesight and rumen motility.

Sampling. Blood samples were collected for biochemical analyses from each investigated doe by jugular vein puncture at 9.00 A.M before the morning meal and before induction of PT (T0; *i.e.* at the day 129), and once daily for five consecutive days (T1, T2, T3, T4, and T5).

The blood samples were collected into tubes without anticoagulant for serum separation. Only clear non-hemolyzed serum was collected and kept frozen at -20 ºC for further biochemical analysis of glucose, β-hydroxy butyric acid (BHBA), non-esterified fatty acid (NEFA), total cholesterol, triacylglycerols, malondialdehyde (MDA), glutathione peroxidase (GSH-Px), superoxide dismutase (SOD), tumor necrosis factor (TNF)-α, interleukin (IL)-1β, IL-6 and IL-10. The following commercial kits were used for quantifying the values of the different serum variables according to the suppliers' standard protocols: glucose (Spinreact, Spain), BHBA (Biochemical Enterprise), total cholesterol (Spinreact, Spain), triacylglycerols (Spinreact, Spain), MDA (Northwest Life Science Specialist, LLC), GSH-Px, and SOD (Cayman Chemical Company, USA). NEFA were analyzed according to a chemical method previously described by SCHUSTER (1979).

Concentrations of circulating cytokines were determined in undiluted serum by using goat specific ELISA kits, according to the instructions supplied by the manufacturer. The plates were read at 450nm and a reference wavelength of 550 nm, using an automated microplate ELISA reader (Bio TEC, ELX800G; USA). Values were expressed as pg/mL. Samples were run in duplicate for all the cytokines tested. The test kits used for estimating the respective cytokines were as follows: TNF-α (Cloud-Clone Corp, USA), IL-1β (Genorise Scientific, INC., USA), IL-6 (Cloud- Clone Corp, USA) and IL-10 (Genorise Scientific, INC, USA).

Statistical analysis. Data analyses were performed using a statistical program (SPSS, version 15. USA). As the data were normally distributed using the Shapiro-Wilk normality test, the mean values and standard deviation for each variable at each time point were presented. A two-way repeated measure ANOVA with the Bonferroni post hoc test was performed to assess the effect of treatment, time, and time × treatment interaction on the tested variables. Differences at $P<0.05$ were considered statistically significant.

Results

The clinical signs of the disease appeared in all goats of the PT group after 72 hours of feed withdrawal. The clinical symptoms observed were teeth grinding (4 out of 6), sternal recumbent posture (1 out of 6), while muscular tremors, rumen hypomotility and disinclination to move were all detected in goats of the PT group. The vital signs, including heart rate and respiratory rate, were significantly (P<0.05) higher in the PT group than those of the TLC group (Table 1); however, the rectal temperature was not significantly (P>0.05) different between the three groups. All clinical symptoms abated once feed was offered. None of the animals in the TLC group showed any signs of toxemia and were clinically healthy throughout the study period.

Table 1. Means ± SD of some clinical variables in goats with pregnancy toxemia (PT-group), L-carnitin treated group (TLC) compared with control at T3 of feed withdrawal

Clinical variables	Control Group (n = 6)	PT-Group (n = 6)	TLC-Group (n = 6)
Rectal temperature (°C)	39.37 ± 0.55	38.7 ± 0.60	39.12 ± 0.40
Heart rate (beats/min)	80 ± 10[a]	110 ± 9[b]	75 ± 5[a]
Respiratory rate (breaths/min)	20 ± 2[a]	35 ± 5[b]	18 ± 3[a]
Rumen motility (/2 min)	3.0 ± 0.1	1.0 ± 0.1	3.0 ± 0.1
Appetite	Normal (n = 6)	Inappetence (n = 3) Anorexia (n = 3)	Normal (n = 6)

[a, b] Variables with different superscript within the same row are significantly different at P<0.05

The treatment affected glucose concentration (P<0.0001), which was greater in the TLC group than the PT and control groups. Time also affected glucose concentration (P<0.0001) which was greater in the TLC group at T0 and T1 than in the other groups. There was also a significant effect from the interaction of time and treatment (P<0.0001), as glucose levels did not change over time in the control group, whereas in the PT and TLC groups they declined from T0 to T3, and then rose to the level of the control group (Fig. 1). In general, the TLC group had greater concentrations of glucose than the PT group throughout the observation period.

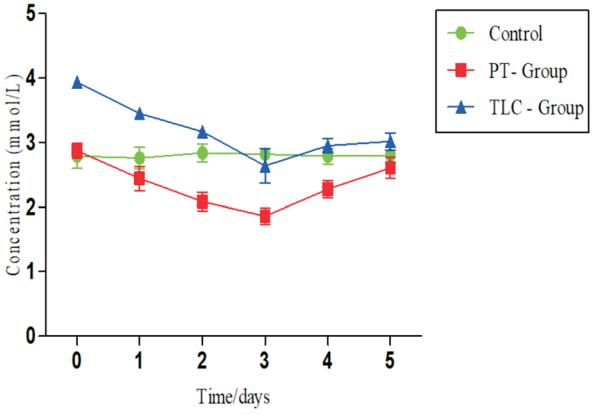

Fig. 1. The time course (mean ± SD) of serum glucose concentration (mmol/L) in goats with pregnancy toxemia (PT-group) and the L-carnitine-supplemented group (TLC group) compared with the control. Effect of treatment (F = 302.06; P<0.0001), effect of time (F = 55.44; P<0.0001) and the interaction of time and treatment (F = 20.65; P = 0.0001).

Concentrations of BHBA, NEFA, and triacylglycerols were significantly affected by treatment and time (P<0.0001), and were higher in the PT group at T2 to T3 (for BHBA), T1 to T4 (for NEFA), and T3 to (T4 for triacylglycerols) than those of the other groups, and then declined to the levels of the control group (Fig. 2A, 2B, 2D). There was also a significant effect from the interaction of time and treatment (P<0.0001) as these variables did not change over time in the control group. On the other hand, concentrations of total cholesterol were significantly affected by treatment (P<0.0001) and time (P<0.0001), being lower in the PT group at T3 than in the other groups, but they then rebounded to the level of the control group. The interaction also affected cholesterol concentration (P<0.0001) as its level did not change over time in the control group (Fig. 2C).

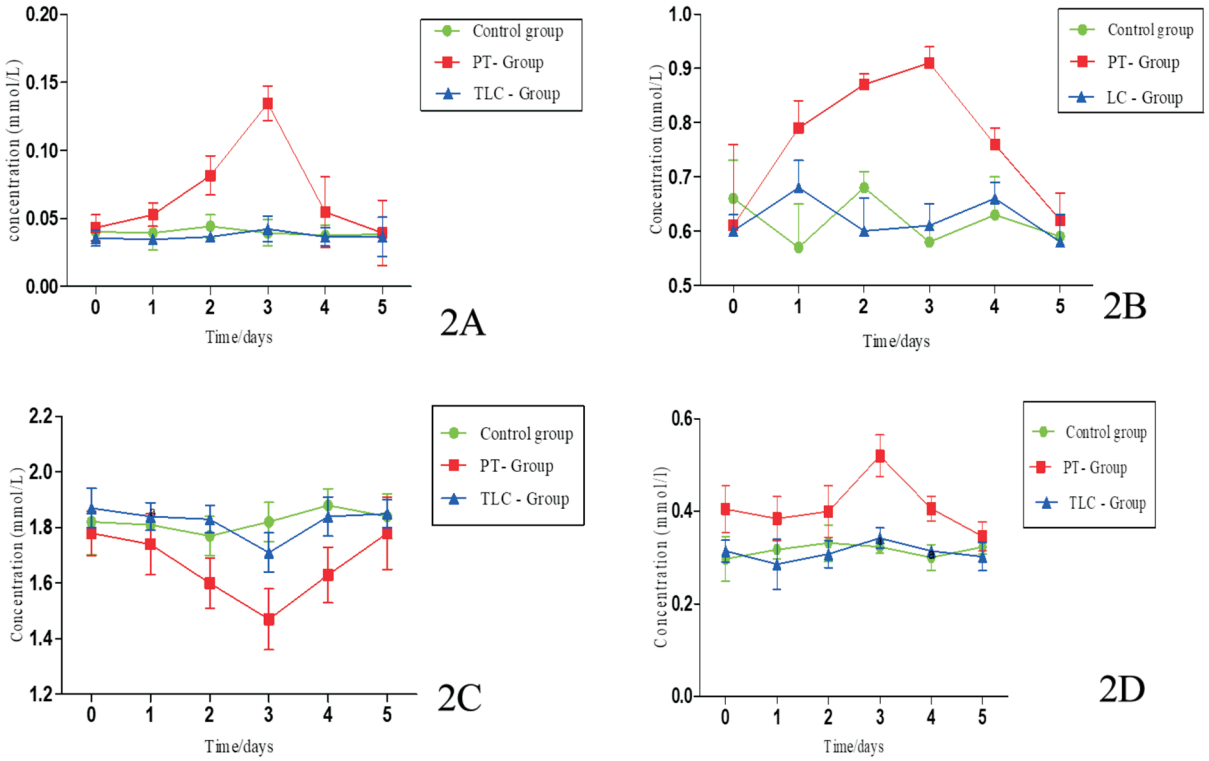

Fig. 2. Time course (means ± SD) of serum β-hydroxy butyrate (mmol/L) [A], non-esterified fatty acids (mmol/L) [B], total cholesterol (mmol/L) [C] and triacylglycerols concentrations (mmol/L) [D] in goats with pregnancy toxemia (PT-group) and L-carnitine-supplemented group (TLC group) compared with the control. For BHBA: effect of treatment (F = 72.52; P<0.0001), effect of time (F = 21.23; P<0.0001) and interaction between time and treatment (F = 16.73; P = 0.0001). For NEFA: effect of treatment (F = 17.51; P<0.0001), effect of time (F = 18; P = P<0.0001) and interaction between time and treatment (F = 80.02; P<0.0001). For cholesterol: effect of treatment (F = 41.29; P<0.0001), effect of time (F = 9.83; P<0.0001) and interaction between time and treatment (F = 3.59; P = 0.0005). For triacylglycerols: effect of treatment (F = 82.83; P<0.000), effect of time (F = 8.67; P<0.0001) and interaction between time and treatment (F = 4.34; P<0.0001).

The treatment affected MDA concentrations (P<0.0001), which were lower in the TLC group than the PT and control groups. Time also affected MDA concentration (P<0.007), which was lower in the TLC group from T0, T1 to T2 than in the other groups. The interaction of time and treatment also affected its concentrations (P = 0.021), whereas in the PT group, its levels peaked at T3 then declined from T4 to the level of the control group (Fig. 3A). Concentrations of SOD were affected by treatment (P<0.0001), and time (P<0.0001), and were higher in the TLC group at T0 than in the other groups.

The interaction of time and treatment also affected its concentrations (P = 0.0001). Its level declined in the PT group from T2, T3 to T4, then gradually recovered to the level of the control group (Fig. 3B). Levels of GSH-Px were affected by treatment (P<0.0001), and time (P<0.0002), and were lower at T3 in the PT and TLC groups compared with the control, then gradually recovered to the level of the control group. The interaction of time and treatment also affected its concentration (P = 0.0001), as GSH-Px levels did not change over time in the control group (Fig. 3C).

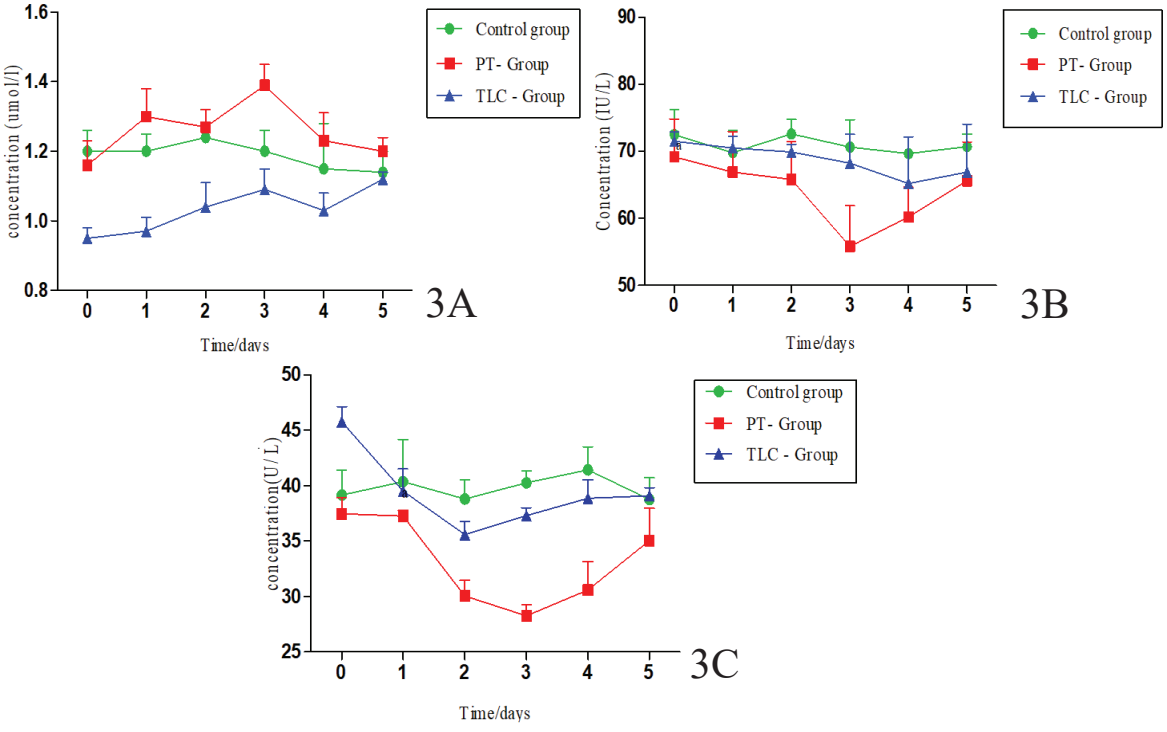

Fig. 3. Time course (means ± SD) of malondialdehyde levels (µmol/L) [A], glutathione peroxidase activity (IU/L) [B], superoxide dismutase activity (U/L) [C] in goats with pregnancy toxemia (PT-group) and the L-carnitine supplemented group (TLC group) compared with the control. For MDA: effect of treatment ($F = 56.60$; $F = 2.51$; $P<0.0001$), effect of time ($F = 3.76$; $P<0.007$) and interaction between time and treatment ($F = 2.51$; $P = 0.021$). For GSH-Px, effect of treatment ($F = 22.71$; $P<0.0001$), effect of time ($F = 5.39$; $P<0.0002$) and interaction between time and treatment ($F = 1.92$; $P = 0.052$). For SOD: effect of treatment ($F = 71.41$; $P<0.0001$), effect of time ($F = 13.12$; $P<0.0001$) and interaction between time and treatment ($F = 5.76$; $P = 0.0001$).

The serum concentrations of TNF-α were affected by time ($P<0.0002$), and treatment ($P<0.0001$), and were lower in the TLC group at T0 than in the PT and control groups. The interaction of time and treatment also affected its concentration ($P = 0.0001$) as its levels did not change over time in the control group. In the PT group, the levels of TNF-α rose from T3 to T4 then declined to the level of the control group.

On the other hand, the treatment affected levels of IL-1β ($P<0.0017$), IL-6 ($P<0.0038$) and IL-10 ($P<0.0001$), which were higher (for IL-1β and IL-6) and lower (for IL-10) in the PT group than those of other groups, while their levels were not affected either by time ($P = 0.056$, $P = 0.757$, $P = 0.0771$), or the interaction of time and treatment ($P = 0.106$, $P = 0.543$, $P = 0.187$) (Fig. 4A-D).

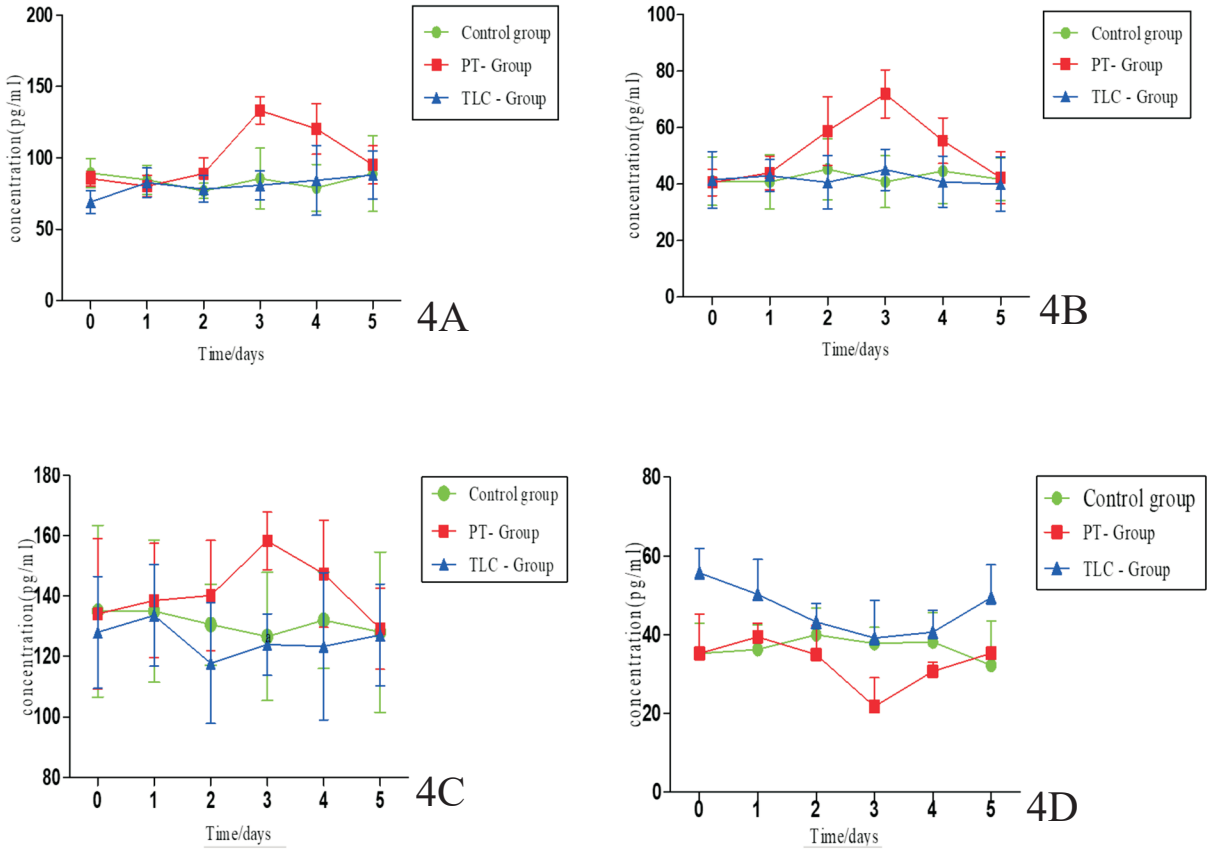

Fig. 4. Time course (means ± SD) of tumor necrosis factor-α levels (pg/mL) [A], IL-1β levels (pg/mL) [B], interleukin-6 levels (pg/mL) [C] and interleukin-10 levels (pg/mL) [D] in goats with pregnancy toxemia (PT-group) and the L-carnitine supplemented group (TLC group) compared with the control. For TNF-α: effect of treatment ($F = 20.06$; $P<0.0001$), effect of time ($F = 5.44$; $P<0.0002$) and interaction between time and treatment ($F = 4.91$; $P = 0.0001$). For IL-1β: effect of treatment ($F = 7.63$; $P<0.0017$), effect of time ($F = 2.40$; $P = 0.056$) and interaction between time and treatment ($F = 1.75$, $P = 0.1069$). For IL-6: effect of treatment ($F = 5.93$; $P<0.0038$), effect of time ($F = 0.52$; $P = 0.757$) and interaction ($F = 0.89$; $P = 0.543$). For IL-10, effect of treatment ($F = 17.51$; $P<0.0001$), effect of time ($F = 2.19$; $P = 0.0771$) and interaction between time and treatment ($F = 1.48$; $P = 0.187$).

Discussion

Our data clearly suggest that orally administered LC could be useful in ameliorating both immune response and lipid metabolism in goats with PT. It is worth mentioning that the goats in the TLC group did not exhibit any clinical signs, and remained clinically sound with normal vital signs throughout the experiment. These results are promising and would suggest the potentially ameliorative role of LC in goats with PT. Nevertheless, toxemic goats (PT group) exhibited variable clinical symptoms after 72 hours of feed withdrawal which were in harmony with those described by GONZALEZ et al. (2011). The clinical signs observed could be linked to the hypoglycemia and/or hyperketonemia associated with experimental PT (RADOSTITS et al. 2007).

A marked drop in serum glucose concentration was detected in the PT group, particularly at T3, compared with those of the TLC group, and the values were somewhat restored after feed supply. These findings were in agreement with those found by ALBAY et al. (2014), and were attributed to starvation and the increased requirements of the developing fetuses (ANDREWS, 1997).

A high ketone body concentration could also impair the endogenous production of glucose, which in turn exacerbates the development of PT (SCHLUMBOHM and HARMEYER, 2004).

Goats that received LC exhibited initial and sustained hyperglycemia at T0 compared with the other groups. The improved glycemia in the TLC group has also been documented in previous reports (CHAPA et al., 2001 and KACAR et al., 2010) and is probably attributed to the role of LC as a co-factor for transporting long-chain fatty acids into the mitochondria, in order to produce energy in the peripheral tissues (HOPPEL, 2003). It has also been found that parenteral administration of LC in Halep (Damscus) goats can lead to continuous elevation of serum glucose levels in the 2nd and 3rd weeks prior to parturition (KACAR et al., 2010). Other reports have confirmed the same effect of LC in growing lambs (CHAPA et al., 2001). Administration of LC has been suggested to improve glucose status in dairy cattle by decreasing liver lipid accumulation, and stimulating hepatic glucose output, which diminish the risk for developing metabolic disorders during the early lactation period (CARLSON et al., 2007). In contrast, parenteral administration of LC to fat tailed ewes did not affect serum glucose levels during the transition period (PANCARCI et al., 2007).

Serum values of BHBA, NEFA, and triacylglycerols rose progressively in the PT group at various time points, with maximum alterations recorded at T3, while serum values of total cholesterol were significantly altered at the same time point, but in an inverse manner. These findings are in line with previous reports (SCHLUMBOHM and HARMEYER, 2004; GONZALEZ et al., 2011; LIMA et al., 2012; ALBAY et al., 2014). The resulting hyperketonemia and the alterations in lipid profile could be attributed to starvation and increased lipolysis in the adipose tissue due to hypoglycemia and the liberation of long chain fatty acids that form ketone bodies in the liver. Interestingly, administration of LC provoked a positive effect on the metabolic variables tested, in the form of lowering serum values of BHBA NEFA, and triacylglycerols, and elevating total cholesterol, particularly at T3. These results were in agreement with those reported in sheep and goats (CITIL et al., 2009; KACAR et al., 2010), and were attributed to the role of LC in β-oxidation of fatty acids, or its antioxidant properties.

Our data show that the goats in the PT group had high serum values of oxidative stress marker MDA, with low antioxidant activities, particularly at T3. These findings clearly demonstrate a state of oxidative stress and were in line with those reported by GURDOGAN et al. (2014). In a previous study, it was thought that elevated values of BHBA could up-regulate MDA, and down-regulate antioxidant parameters in cattle hepatocytes (SHI et al., 2014). Nevertheless, the mechanism of how BHBA induces oxidative stress in cattle hepatocytes is still unknown. Interestingly, administration of LC provoked an initial and sustained decrease in circulating MDA, and enhanced the activities of antioxidant enzymes, including SOD and GSH-Px. These findings could highlight the potential importance of LC as an antioxidant for protection of the cell membrane against oxidative damages. A similar antioxidant role of LC was previously suggested in rats (KALAISELVI and PANNEERSELVAM, 1998). The efficacy of LC in combating oxidative injury could be attributed to the inhibition of free radical dissemination, and its role in the repair of the oxidized membrane phospholipids (DERIN et al., 2004). Moreover, the antioxidant role of LC could also be linked either to its ability to chelate free Fe^{2+} ions, with a subsequent reduction in free radical generation, or its capability to stimulate ATP production, thereby improving the overall activity of antioxidant enzymes in the cell (LEE et al., 2015).

Although the etiopathology of PT is not precisely known, some evidence has suggested that insufficiency of the uterine spiral arteries in perfusion of the placenta could likely contribute to causing the disease (ROBERTS et al., 1989). Hypoxia, due to reduced blood perfusion, could also induce placental production of inflammatory cytokines, including IL-1α and TNF-α (BENYO et al., 1997). These cytokines can be produced either locally or originate from the circulation, and can influence maternal-placental immune interaction, trophoblast invasion and differentiation, and the metabolic

and endocrine regulation of the placenta (YARIM et al., 2007). Recently, it was demonstrated that cytokines (eg. IL-2, interferon-gamma, and TNF-β) are customarily harmful to a successful pregnancy and can induce cell-mediated cytotoxicity, as well as inflammatory responses, while IL-4, IL-5, IL-6, and IL-10 are beneficial for humoral response, have a pivotal role in a successful pregnancy, and are able to induce antibody production, and improve mast cell and eosinophil granulocyte differentiation (ZHANG et a., 2019). Our data clearly confirm that goats in the PT group had high values of circulating pro-inflammatory cytokines, including TNF-α, IL-6 and IL-1β, which suggests an ongoing inflammatory cascade. These findings were in part similar to those presented by YARIM et al. (2007) and ALBAY et al. (2014) in ewes and goats with naturally occurring PT. In the earlier study, the authors demonstrated higher levels of circulating TNF-α, IL-1β, and monocyte chemotactic protein 1 in the diseased ewes than in the control, and the severity of the disease was worse when the values of these cytokines were high. However, the authors of the later study stated that PT in goats was associated with a sharp increase in serum TNF-α level that was higher in clinical cases than sub-clinical ones. In a recent study, it was suggested that BHBA can enhance production of proinflammatory cytokines in cattle hepatocytes, through activation of nuclear factor kappa B (NF-κB) and upregulating oxidative stress markers, such as MDA and nitric oxide (SHI et al., 2014). The authors added that the activated nuclear factor kappa B (NF-κB) could induce hepatocyte injury by translocating to the nucleus and increasing the DNA binding activity to propagate the transcription of TNF-α, IL-6 and IL-1β. Along the same lines, in an earlier study being conducted on women with PT (SARGENT et al., 2003), it was shown that these patients demonstrated excessive systemic inflammation and increased production of inflammatory cytokines. The authors attributed these alterations to defects of trophoblast cells, and to the destruction of placental debris.

Our data showed that LC elicited a noticeable anti-inflammatory effect by restoring the observed alterations in the circulating pro-inflammatory cytokines (TNF-α, IL-6 and IL-1β), and enhancing the production of anti-inflammatory marker IL-10. To the best of our knowledge, this is the first study to examine the anti-inflammatory effect of LC in goats with PT. Similar findings were observed in human studies. For example, administration of LC at a dose of 20 mg/kg has also been reported to reduce the level of C reactive protein in patients on hemodialysis (DURANAY et al., 2006), and control inflammation in human patients with inflammatory bowel disease (MOEINIAN et al., 2013). A higher dose of LC (*i.e.* 5000 mg twice daily) could significantly reduce inflammatory status in patients suffering from Coronary Artery Disease.

Conclusion

Administration of LC has a potential impact on disease progression, helps mitigate the appearance of clinical signs, and improves glycaemia. It also has potentially ameliorative antioxidant and anti-inflammatory effects. The information provided in the present study could encourage the advancement of future research in animal welfare and production.

Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contributions

MRE and MAY designed and coordinated the study. MRE and SSE performed clinical examinations and sample collections. MRE wrote the manuscript, interpreted the data and is responsible for all correspondence with the journal. All authors contributed equally in data collection, and analyses. All authors approved the final version of the manuscript for publication.

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EL-ASHKER, M. R., S. S. EL-DEMERDASH, M. A. YOUSSEF: Pozitivan učinak L-karnitina na imuno-metabolički odgovor i antioksidacijski status u koza s gravidnosnom toksemijom. Vet. arhiv 90, 365-375, 2020.

SAŽETAK

Prema podacima iz literature postoji ograničen broj istraživanja primjene L-karnitina (LK) u koza. Cilj ovog rada bio je procijeniti učinak oralno primijenjenog LK-a na određene imuno-metaboličke pokazatelje i redoksni status u koza u kojih je eksperimentalno izazvana gravidnosna tokesmija (GT). Istraživanje je uključilo 18 klinički zdravih koza baladi pasmine čija je gravidnost iznosila 110 ± 5 dana. Životinje su nasumično podijeljene u tri jednake skupine: kontrolnu, toksemijsku (GT) i toksemijsku kojoj je davan LK (TLK). Koze u skupini TLK su od 110. ± 5 dana gravidnosti jedanput dnevno dobivale 10 mL LK-a oralnom drenčer špricom. Primjena LK-a nastavljena je sljedećih dvadeset dana uzastopno. Na 130. dan gravidnosti GT je eksperimentalno izazvan u skupinama GT i TLK, uz uskraćivanje hrane tijekom 72 sata. U svake je koze iz jugularne vene uzeta krv za biokemijsku analizu prije izazivanja GT-a (T0) i jedanput dnevno sljedećih pet dana (T1, T2, T3, T4 i T5). Klinički je GT ustanovljen u svih koza u skupini GT 72 sata nakon što im je uskraćena hrana, dok koze iz skupine TLK nisu pokazale kliničke simptome za vrijeme istraživanja. Primjena LK-a prouzročila je niske serumske vrijednosti malondialdehida (MDA), faktora tumorske nekroze (TNF-α) i visoke serumske vrijednosti glukoze, superoksidne dismutaze (SOD) i interleukina (IL)-10 prije izazivanja GT-a (T0) u usporedbi s kontrolnom i GT skupinom. Treći dan (T3) koze koje su primile LK pokazale su znakovito niže vrijednosti β-hidroksimaslačne kiseline, neesterificirane masne kiseline, triacilglicerola, MDA-a, TNF-α, IL-1β, IL-6 te veće vrijednosti ukupnog kolesterola, glutation-peroksidaze, SOD-a i IL-10 od onih u skupini GT. Rezultati su pokazali da bi oralno primijenjen LK mogao pridonijeti poboljšanju imunosnog statusa i metabolizma masnoća u koza s GT-om.

Ključne riječi: gravidnosna toksemija; L-karnitin; citokin; oksidacijski stres