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IMPACT OF SPIRULINA PLATENSIS ALGAE AND VITAMIN A SUPPLEMENTATION TO LATE PREGNANT EWES ON THEIR LAMB'S SURVIVABILITY AND PERFORMANCE

MABROUK A. ABD ELDAIM [1,4]; SAMEH. G.A. RAMADAN [2*]; MABROUK ELSABAGH [3] and HAMADA D.H. MAHBOUB [2]

[1] Department of Biochemistry and Chemistry of Nutrition, Faculty of Veterinary, Menoufia University, Sheben Elkom 32721, Egypt.
[2] Department of Husbandry and Animal Wealth Development, Faculty of Veterinary Medicine, University of Sadat City, Sadat City 32897, Egypt
[3] Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Kafr El-Sheikh University, Kafr El-Sheikh 33516, Egypt
[4] Present address: Division of Applied Biosciences, Graduate School of Agriculture, Kyoto University, 606-8502, Japan

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ABSTRACT

Micronutrient supplementation during late gestation can enhance the metabolic profile and physiological wellbeing of ewes and their lambs. This study was carried out to evaluate the impact of *Spirulina platensis* (SP) and vitamin A supplementation during late gestation on the pregnant ewes' health and their newly born lambs' viability and performance. One month before lambing, thirty six pregnant ewes (47.4±0.52 kg BW) were randomly assigned into three experimental groups (n=6 with 2 replicates for each treatment) and received one of three treatments: intramuscular injection of 1 mL saline per ewe twice a week (control); 1 g/10 kg BW of ewes /day of Spirulina platensis powder (SP) was added to the concentrate mixture; and intramuscular injection of 1 mL vitamin A (50,000 IU) per ewe twice a week. Results revealed that significantly ($P< 0.05$) decreased in the ewes' serum alanine aminotransferase (ALT) activity and increased the serum creatinine level of control group after lambing. However, supplementation with SP and vitamin A normalized serum ALT activity and creatinine level after lambing. Also, SP enhanced serum levels of glucose, triacylglycerol and total cholesterol after lambing. In addition, supplementation of late pregnant ewes with SP increased total leucocytes count and serum vitamin A concentration of their newly born lambs. Furthermore, SP and vitamin A supplementation to the pregnant ewes increased newly born lambs' birth weights and body temperatures, while they decreased the stillbirth by 56% (11.1%) and 43% (14.3%), respectively compared to those of the control group (25%). Finally, SP and vitamin A ameliorated the lambing-induced stress in ewes and lambs represented by reducing serum levels of tumor necrosis factor alpha in both ewes and their lambs. Thus, supplementation of pregnant ewes with SP and vitamin A improved their health at lambing and enhanced their lambs' survivability and performance.

Key words: Spirulina platensis, vitamin A, late pregnancy, Lambing, TNF-α.

INTRODUCTION

The transition from gestation into lactation in various domestic animals is associated with major metabolic and endocrine changes that may negatively, if not managed properly, when affect the fetal metabolism as well as the growth of the offspring postnatally (Bell, 1995; Wu *et al.,* 2006). Several studies in sheep highlighted the importance of maternal nutrition and welfare states as driving factors controlling the magnitude of these changes (Charismiadou *et al.,* 2000; Yokus *et al.,* 2006; Balıkcı *et al.,* 2007; Tygesen *et al.,* 2008; Cal-Pereyra *et al.,* 2015). The intensive metabolism and the stress of onset of lambing and lactation may compromise the metabolic profiling and antioxidative status of late pregnant ewes (Yokus *et al.,* 2006; Balıkcı *et al.,* 2007; Taghipour *et al.,* 2011). Thus, proper nutritional management, especially during the third trimester of gestation where the increase in fetal growth and udder development reach to the maximum rate (Mellor, 1983; Mellor and Murray, 1985; Robinson *et al.,* 1999), is crucial for enhancing ewes' health and their lambs' viability. Micronutrients, trace minerals and vitamins, supplementation, to pregnant ewes can enhance the metabolic profile and physiological

Corresponding author: SAMEH G.A. RAMADAN
E-mail address: sameh.ramadan@vet.usc.edu.eg
Present address: Department of Husbandry and Animal Wealth Development, Faculty of Veterinary Medicine, University of Sadat City, Sadat City 32897, Egypt

wellbeing of ewes and their lambs (Rooke *et al.*, 2008; McCoard *et al.*, 2017); however, studies manipulating micronutrient supplementation during late gestation are quite limited. Particularly, vitamin A received a little attention in late pregnant ewes' nutrition based on the presumption that vitamin A requirements could be met by its precursor β-carotene from herbage, and the hepatic store of vitamin A can buffer its deficiency (Rooke *et al.*, 2008). In their review, Rooke *et al.* (2008) highlighted that pregnant ewes may experience a vitamin A depletion in practice. Vitamin A is an essential micronutrient for normal fetal development and growth as well as for the postnatal performance (Zile, 2001; Rodrigues *et al.*, 2004; Gómez *et al.*, 2006); however, there is no much information on the effects of vitamin A administration to late pregnant ewes on the vitamin A status of their lambs. Previous studies indicated that vitamin A supplementation to cows (Puvogel *et al.*, 2008) and goats (Abd Eldaim *et al.*, 2015) during late pregnancy can enhance the vitamin A status of their offspring.

As a rich source of natural micronutrients and bioactive compounds such as carotenoids, *Spirulina platensis*, a blue-green microalga (SP), holds promising health benefits in human and animal nutrition (Belay *et al.*, 1996). Although an intensive research work has been conducted on the health and productivity promoting effects of SP as a functional feed supplement for various species of livestock, poultry and aquaculture (Holman and Malau-Aduli, 2013; Yaakob *et al.*, 2014; Madeira *et al.*, 2017), there is limited information on its benefits for pregnant ewes and their lambs. Specifically, a single study indicated that lambs born to ewes receiving a 2 g SP day starting from the 120^{th} day of pregnancy have a higher growth performance than those born to control ewes (Shimkiene *et al.*, 2010). With their inherent antioxidant and immunostimulatory properties, we hypothesize that either vitamin A or SP may enhance the health and metabolic status of Egyptian sheep, frequently subjected to nutritional stress being mainly fed on grazing pasture of fluctuated nutritive value, and consequently their offspring. Therefore, this study was carried out to evaluate the impacts of SP and vitamin A supplementation on the pregnant ewe's health and their newly born lambs' viability and performance.

MATERIALS AND METHODS

This study was carried out at the Animal Production Research Station, Kafr El-Sheikh Governorate, Egypt. All experimental procedures were approved by the Research Ethics Committee of the Faculty of Veterinary Medicine, University of Sadat City, Egypt (No: VUSC-010-1-16).

Animals management and experimental design

Eighteen ewes of Rahmani breed of the same parity and weight were synchronized for estrus using intra-vaginal progesterone sponges (Hamilton, New Zealand) for 14 days, followed by intramuscular injection of 400 IU of PMSG (Pregnant Mare Serum Gonadotropin, Folliogon, Intervet, Egypt) per ewe after sponge removal. Ewes were naturally inseminated with rams of the same breed, and pregnancy diagnosis was confirmed by transrectal ultrasound scanning at day 40 of pregnancy. After 120 days from breeding, the 18 pregnant ewes (47.4 ± 0.52 kg average body weight) were randomly assigned into three experimental groups (n=6), housed in separate pens, and received one of three treatments: intramuscular injection of 1 mL saline per ewe twice a week (control); SP powder was incorporated daily in the concentrate of each ewe at a rate of 1 g/10 kg BW/ewe/day (HERBAFORCE LTD, UK); and intramuscular injection of 1 mL vitamin A (50,000 IU) per ewe twice a week. The treatments continued until lambing. The dose of SP was adopted from a previous work on fattening lambs (Elsabagh *et al.*, 2014) and the vitamin A dose was adopted from a previous work on pregnant goats (Abd Eldaim *et al.*, 2015). During the experiment, ewes were fed a common basal diet of 1.0 kg/head/day of a commercial concentrate mix (16.6% crude protein, 73.4% TDN) with free access to green fodder (Trifolium Alexandrium) and fresh drinking water. The ewes were offered 10 g/ewe/day of a mineral mixture containing 10 ppm of selenium. Ewes were received anthelmintic drench, Netobimin, (Hapadex) 20 mL/50 kg of body weight, (Schering-Plough Company, USA) at the beginning of the experiment. The ewes were vaccinated subcutaneously with Clostridia vaccine (Covexin, Schering-Plough Company, USA) at the 17^{th} week of pregnancy. Two weeks prior to the expected lambing date, the ewes were moved to large straw-bedded lambing pens.

Samples collection and analyses

Blood samples were collected from ewes at 2 weeks before lambing and from both ewes and their lambs within 2 h post-lambing, A 3.5-mL blood sample from each animal was taken from the Jugular vein. Each blood sample was divided into two portions. The first portion of the blood sample was placed into EDTA-containing tubes to measure the white blood cells (WBCs) count according to Wilkinson (1981). The other portion of the blood sample was placed into non-EDTA containing tubes, left to clot at room temperature, centrifuged at 3000 rpm for 15 minutes, and sera were kept at -20°C until biochemical assay. Lambs' birth weights and rectal temperatures were recorded at 2 h post-lambing. The incidences of stillbirth were also recorded within 24 h post-lambing.

Details of serum biochemical assays were previously described (EL-Sabagh *et al.*, 2014; Abd Eldaim *et al.*, 2015). Briefly, a calorimetric determination was performed for serum total protein and albumin

(Young 2001), alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities (Reitman and Frankel, 1957), and triglycerides (Fossati and Prencipe, 1982). Serum globulin was calculated by subtracting albumin from total protein. Serum total cholesterol, urea, and creatinine were measured spectrophotometrically (Spekol 11, Carl Zeiss Jena, Germany) according to *Allain et al.* (1974); Young (2001); Larsen (1972); Coulombe and Favreau (1963), respectively. Glucose levels in whole blood were measured by a spectrophotometer (Spekol 11, Carl Zeiss Jena, Germany) according to the instructions of the manufacturer following the descriptions of Berth and Delanghe (2004). The WBCs count was determined according to Cheesbrough (2000); the blood with EDTA was diluted in 1:20 glacial acetic acid reagent which haemolyzed the red cells leaving the WBCs to be counted. The glacial acetic acid is a weak acid solution to which gentian violet was added to stain the nuclei of WBCs. Then, WBCs was counted under a microscope in a haemocytometer and the number of WBCs per litre of blood was calculated.

Serum vitamin A concentrations were spectrophotometrically determined following procedures described by Suzuki and Katoh (1990) and Abd Eldaim *et al.* (2010, 2015). In brief, 50 mL of ethanol and 150 mL of hexane was added to 50 mL of serum. The hexane phase was recovered after 40-min mixing and 10 min centrifugation at 6500 *g*. Vitamin A concentration was calculated based on the absorbance of hexane extracts at 325 nm and 453 nm using the equations described by Suzuki and Katoh (1990).

Serum concentrations of tumor necrosis factor alpha (TNF-α) of both ewes and newly born lambs at 2h after lambing were determined by using TNF-α ELISA diagnostic kit for sheep according to the manufacturer protocol (Catalogue No. 201-07-0060; Shanghai Sunred Biological Technology Co., Ltd). Briefly, double antibody sandwich ELISA was used to assay the serum level of sheep TNF-α. Fifty and forty µL of standard and serum respectively were added to wells that pre-coated with sheep TNF-α monoclonal antibody, incubated and excess antibody was washed. TNF-α secondary antibody labeled with biotin, and combined with Streptavidin-HRP to form an immune complex was added; incubated and finally, excess secondary antibody was washed to remove the uncombined enzyme. Then, chromogen solutions A and B were added, the color of the liquid changed into the blue, and the color finally becomes yellow. The optical densities of both standard and samples were read at wavelength 450 nm using Absorbance Microplate Reader (ELx808, BioTek, USA). Serum TNF-α level was calculated by using the standard curve.

Statistical analysis

The results were expressed as means ± SE. Statistical analysis was performed by using one-way ANOVA and Fischer's post hoc test, with $p<0.05$ being considered statistically significant. Stillbirth was tested using a chi-square test and are expressed as a percentage.

RESULTS

Ewe's metabolic health

The effects of SP and vitamin A supplementation on pregnant ewes' blood metabolites before and after lambing are shown in Figure 1A-C, Figure 2 and Table 1. Lambing significantly reduced ($P< 0.05$) serum ALT activity (Fig. 1A). However, it significantly increased serum level of creatinine (Fig.1B). Supplementation of pregnant ewes with SP and vitamin A normalized serum levels of ALT and creatinine after lambing, that were altered due to lambing in the control group. In addition, SP and vitamin A significantly enhanced ($P< 0.05$) blood glucose level of ewes after lambing compared to that of the corresponding control ewes (Fig.1C). To investigate whether SP *and* vitamin A relieve the lambing-induced stress on ewes, serum levels of TNF-α, as stress biomarker, was quantified in ewes' serum immediately after lambing. SP and vitamin A supplementation to pregnant ewes decreased serum levels of TNF-α after lambing compared to that of the corresponding control group (Fig.2). In addition, SP significantly enhanced serum levels of triacylglycerol ($P< 0.05$) with a tended increase in total cholesterol ($P<0.1$) of ewes after lambing compared to those of the corresponding control ones, while vitamin A administration reduced total cholesterol in ewes postnatally (Table 1). There were no significantly differences among treatment in serum levels of total protein, albumin, globulin, AST and urea (Table 1).

Lambs' survivability and performance

The effects of SP and vitamin A supplementation to late pregnant ewes on their lambs' survivability and performance are shown in Table 2 and Figure 2. Supplementation of pregnant ewes with SP and vitamin A injection induced a significant ($P< 0.05$) and a tended ($P<0.1$) increased in serum vitamin A concentrations of their newly born lambs compared to those of lambs born to control ewes (Table 2). In addition, SP significantly ($P< 0.05$) increased WBCs count of their lambs compared to those of the other groups (Table 2). Both SP and vitamin A had no significant effects on serum TP, albumin, globulin, AST and ALT of lambs (Table 2). Supplementation of ewes during the late stage of pregnancy with SP and vitamin A significantly increased birth weight and body temperature of the newly born lambs compared to lambs born to the control ewes (Table 2). In addition, SP and vitamin A decreased the stillbirth of lambs by 56% (11.1%) and 43% (14.3%), respectively, compared to those of the control group (25%) (Table 2). Finally, SP and vitamin A ameliorated the laming-induced stress on the lambs as indicated by the significantly (P< 0.05) reduced serum levels of TNF-α of the newly born lambs compared to those of lambs born to the control group (Fig.2). Thus, SP and vitamin A supplementation to the pregnant ewes during the late stage of pregnancy enhanced their lambs' survivability and performance and relieved the lambing-induced stress in lambs.

Table 1: Effect of *spirulina platensis* algae and vitamin A supplementation on ewes' serum metabolites before and after lambing.

Items	Treatment					
	Pre-lambing			Post-lambing		
	Control	Vitamin A	Spirulina	Control	Vitamin A	Spirulina
TP (g/dl)	6.16 ± 0.14	5.97 ± 0.12	5.60 ± 0.13	5.86 ± 0.20	5.56 ± 0.12	6.03 ± 0.03
Albumin (g/dL)	3.32 ±0.10	2.88 ± 0.12	2.88 ± 0.11	3.10 ± 0.02	2.55 ± 0.07	3.00 ± 0.04
Globulin (g/dL)	2.84 ± 0.16	3.09 ± 0.17	2.73 ± 0.16	2.76 ± 0.18	3.05 ± 0.11	3.03 ± 0.06
AST IU	79.7 ± 6.19	70.3 ± 6.30	78.0 ± 6.23	70.7 ± 2.18	67.7 ± 6.33	69.7 ± 2.85
Urea (mg/dL)	40.3 ± 7.50	38.7 ± 7.63	40.4 ± 7.37	48.6 ± 5.23	52.7 ± 1.63	48.1 ± 14.2
TG (g/dL)	31.7 ± 5.13^{ab}	24.9 ± 5.18^{b}	30.4 ± 5.10^{ab}	28.8 ± 5.23^{b}	30.4 ± 2.18^{ab}	58.6 ± 5.10^{a}
T-CHO (g/dL)	64.9± 6.62^{ab}	63.6 ± 5.88^{ab}	82.2 ± 7.72^{a}	65.0 ± 4.64^{ab}	51.5 ± 5.88^{b}	75.3 ± 4.72^{ab}

TP, Total protein; AST, Aspartate amino transferase; TG, Triacylglycerol; T-CHO, Total cholesterol. Data is expressed as mean ± SE (standard error). Mean values carrying different letters in the same row are significantly different at $P < 0.05$.

Table 2: Effect of *spirulina platensis* algae and vitamin A supplementation on newly born lambs' survivability, performance and blood indices.

Items	Treatment		
	Control	Vitamin A	Spirulina
Birth weight (kg)	2.64 ± 0.26^{b}	3.24 ± 0.13^{a}	3.50 ± 0.29^{a}
Lamb BT (^{o}C)	38.4 ± 0.18^{b}	38.9 ± 0.19^{a}	39.3 ± 0.20^{a}
Stillbirth (%)	25 (4/16)^{a}	14.3 (2/14)^{b}	11.1 (2/18)^{b}
Vitamin A µg/mL	11.6 ± 2.11^{b}	15.4 ± 1.52^{ab}	17.7 ± 1.74^{a}
WBCs (x10^{3})	8.72 ± 1.59^{b}	8.90 ± 1.77^{b}	15.8 ± 2.98^{a}
TP (g/dl)	5.93 ± 0.15	5.38 ± 0.15	5.42 ± 0.28
Albumin (g/dL)	3.25 ± 0.17	3.03 ± 0.13	3.07 ± 0.25
Globulin (g/dL)	2.68 ± 0.11	2.35 ± 0.17	2.35 ± 0.16
AST IU	84.9 ± 7.36	78.3 ± 13.3	82.2 ± 9.53
ALT IU	40.7 ± 5.71	44.8 ± 11.1	38.9 ± 6.28

BT, Body temperature; TP, Total protein; AST, Aspartate amino transferase; ALT, Alanine amino transferase. Data is expressed as mean ± SE (standard error). Mean values carrying different letters in the same row are significantly different at $P < 0.05$.

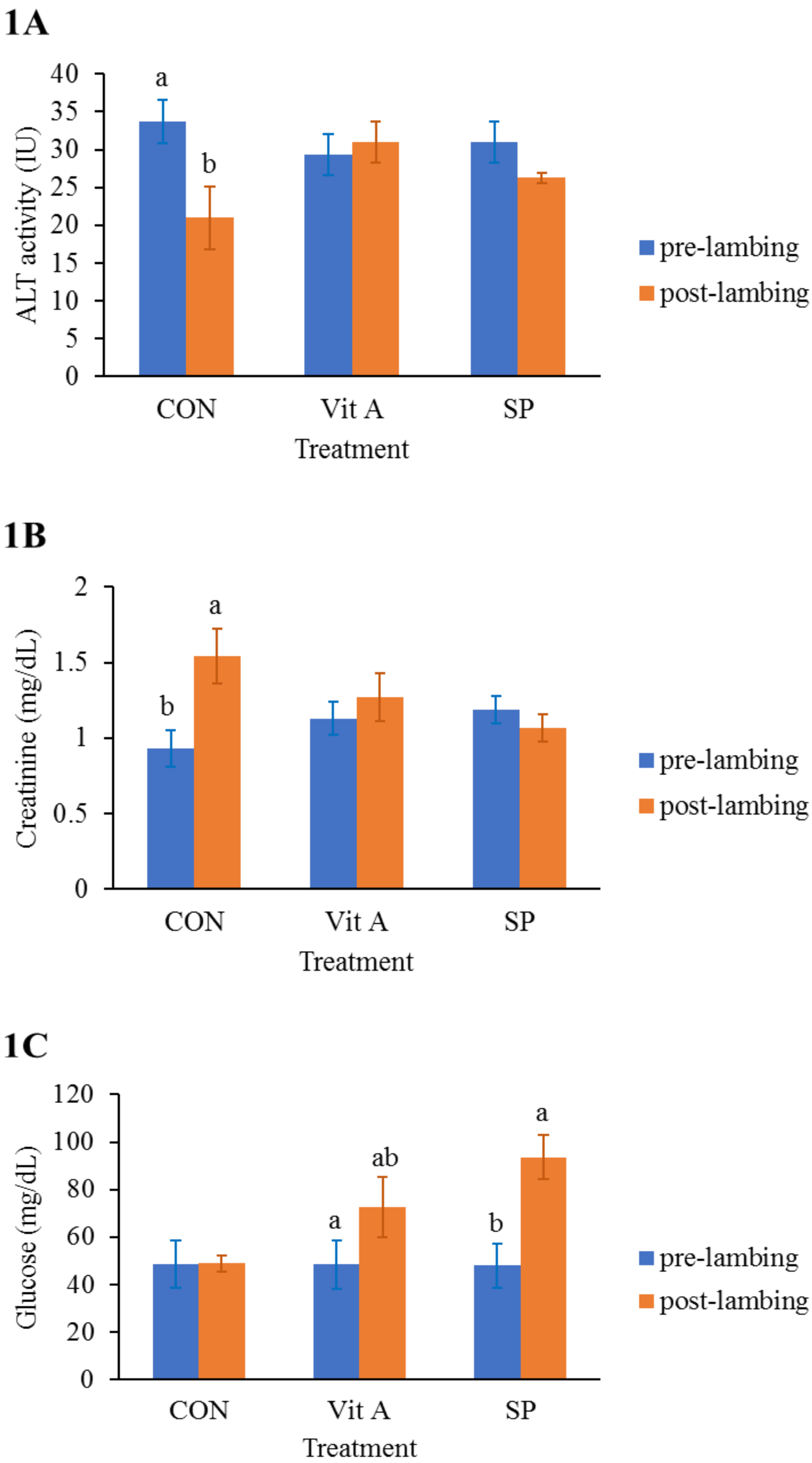

Fig.1: Effect of *spirulina platensis* algae and vitamin A supplementation to late pregnant ewes on their serum alanine amino transferase (ALT) activity (1A) and creatinine (1B) and glucose (1C) status.

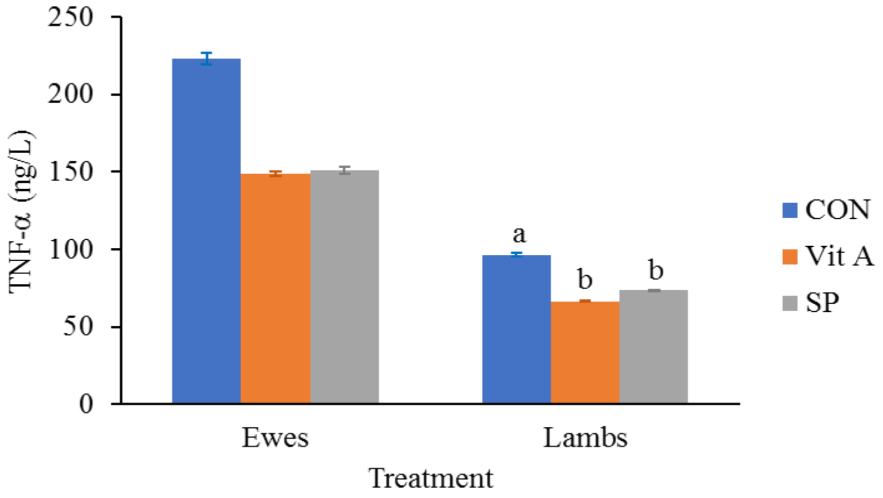

Fig.2: Effect of spirulina platensis algae and vitamin A supplementation to late pregnant ewes on serum TNF-α (ng/L) levels in ewes and their lambs.

DISCUSSION

The current study aimed to address the impact of pre-lambing SP and vitamin A administration on metabolic health of ewes and their lambs' survivability and performance and attempt to minimize the stress associated with the unavoidable nutritional stress in pregnant ewes at late stage.

Declined activity of serum ALT, elevated creatinine and TNF-α levels, and the persistently declined glucose concentrations in control ewes at post lambing may indicate a state of inadequate nutrition or metabolic stress associated with lambing and the onset of lactation. The ALT activity is distributed mainly in the liver and is considered as a good marker for overall health in general and for liver health in particular (Hoffmann and Solter 2008). The declined ALT activity is associated with numerous metabolic and hepatic disorders in which malnutrition may be a risk factor. Subclinical/clinical ketosis in late pregnant ewes has been associated with elevated levels of creatinine (Van Saun, 2000) and the inflammatory cytokine TNF-α (El-Ebissy, 2011; EL-Deeb, 2012). Although glucose levels of late pregnant ewes receiving all treatments and of post-lambed control ewes of our study are far from values indicating subclinical ketosis (< 2.4-2.8 mmol/L; (Lacetera *et al.*, 2001; Kasimanickam, 2016), it is still below, to some extent, the glucose levels of healthy ewes (50-85 mg/dl; (Jackson and Cockcroft, 2002; Pugh, 2002). Although the changes in ALT and creatinine levels are still within the normal physiological values of sheep (Jackson and Cockcroft, 2002), the accompanied declined glucose and elevated TNF-α indicate that the un-supplemented ewes were at risk for metabolic disorders or oxidative stress, and this risk was alleviated by administration of SP and vitamin A. Supplementation of pregnant ewes with SP and vitamin A normalized creatinine and ALT, decreased the TNF-α and increased glucose levels post-lambing that might be attributed to the powerful antioxidant activity of SP (Belay *et al.*, 1996; Belay, 2002) and vitamin A (Imamura *et al.*, 2006; Kamiloğlu *et al.*, 2006). Previous studies demonstrated that SP (El-Sabagh *et al.*, 2014) and vitamin A (Yang *et al.*, 2010) supplementation enhances the antioxidant activity in small ruminants. Furthermore, SP feeding enhanced serum levels of TG, cholesterol and glucose after lambing that might be due to it is a rich source of various nutrients with several health benefits (Holman and Malau-Aduli, 2013). In addition, vitamin A has been reported to increase intestinal glucose absorption and enhance insulin release and sensitivity (Tomimatsu and Horie, 2000; Blumentrath *et al.*, 2001; Rhee and Plutzky, 2012) and this might interpret the higher glucose level with vitamin A post-laming. A similar increase in glucose was reported in pregnant goats supplemented with vitamin A pre-lambing (Abd Eldaim *et al.*, 2015). Glucose is the main energy sources for fetal development and colostrum/milk production (Robinson *et al.*, 1999; Banchero *et al.*, 2006). Thus, with SP and vitamin A, ewes were in a positive energy status. Therefore, supplementation of pregnant ewes with SP and vitamin A decreased the lambing-induced stress on ewes and had beneficial effects on their health after lambing.

The current study showed that, the supplementation of pregnant ewes with SP and vitamin A during the late stage of pregnancy increased birth weight and body temperature of the newly born lambs, while it decreased stillbirth percentages. These findings were matched with the previous studies carried out by Shimkiene *et al.* (2010) who found that supplementation of pregnant ewes with SP deliver heavier lambs compared to those received no Spirulina. This finding might be due to that the

Spirulina is rich in all essential amino acids, vitamins including vitamin A, minerals, carotenoids and fatty acids, especially gamma-linolenic acid which has several health benefits (Howe *et al.,* 2006). Such nutrients, especially vitamin A, has been indicated to increase the birth weight and growth rate of calves born to cows injected with vitamin A during the last third of pregnancy (Salam Abdullah *et al.,* 1987) as vitamin A transports from maternal blood of pregnant ewes to its fetus (Donoghue *et al.,* 1985) and stimulates protein synthesis in neonatal calves (Rufibach *et al.,* 2006). In addition, SP and vitamin A supplementation increased the rectal temperature of the newly born lambs because SP is rich in vitamin A, which has been shown to enhance the expression of brown adipose tissue mitochondrial protein, uncoupling protein, that dissipates the energy produced from nutrients metabolism in the form of heat that aid in warming the newly born animal (non-shivering thermogenesis) (Bonet *et al.,* 2000). Therefore, supplementation of pregnant ewes with SP and vitamin A protects the newly born lambs from hypothermia, which considered one of the important causes of newly born animal's death (Rook *et al.,* 1990).

Furthermore, SP administration to pregnant ewes increased serum vitamin A level and WBCS count in newly born lambs. This result is supported by that of El -Sabagh *et al.* (2014) who indicated that supplementation of fattening lambs with SP increases total leukocytic count and serum vitamin A concentration. Similar improvements in leucocytes production and activity were reported in chickens (Qureshi *et al.,* 1996) and fish (Watanuki *et al.,* 2006) treated with Spirulina. Increased WBCs production might be related to phycocyanin and polysaccharides contents in Spirulina as found by Zhang *et al.* (2001) who reported that supplementation of animals with SP polysaccharide increased WBCs counts. Also, vitamin A supplementation to late pregnant ewes tended to increase vitamin A levels in serum of their lambs. Previous studies indicated that vitamin A supplementation to cows (Puvogel *et al.,* 2008) and goats (Abd Eldaim *et al.,* 2015) during late pregnancy enhanced the vitamin A status of their offspring. Thus, feeding late pregnant ewes with SP and vitamin A may confer immunostimulatory properties to their lambs.

Interestingly, the results of this research revealed that feeding the pregnant ewes diets containing SP or vitamin A injection reduced lambing induced stress in ewes and newly born lambs represented by their lowering effects on serum TNF-α levels. It was indicated that chronic mild stress or acute stress induced by injection of animals by LPS elevates serum TNF-α levels (Manikowska *et al.,* 2014). SP has been shown to have a similar ameliorative effect against inflammatory diseases in animals and humans (Rasool *et al.,* 2006; Coskun *et al.,* 2011). Furthermore, organic extract of SP represses TNF--α expression and secretion in macrophages (Pham *et al.,* 2016). Also, vitamin A and its active form *all-trans* retinoic acid reduce the expression of the pro-inflammatory cytokines interleukin 1 beta and TNF-α while it increases the anti-inflammatory cytokine interleukin-10 in collagen-induced arthritis in rats (Petiz *et al.,* 2017).

Finally, SP and vitamin A supplementation to the pregnant ewes decreased the mortality rate of the newly born lambs either before or after lambing (stillbirth) by 56% and 43% respectively. This decrement of the mortality rates in the newly born lambs can be explained collectively by 1) the protective roles that may SP and vitamin A play against a wide variety of microbes as it was indicated that vitamin A deficiency in animals make them more susceptible to bacterial, viral, and parasitic infections (Chew, 1987); 2) The enhancing effects of SP and vitamin A on the animals' immunity as (Watanuki *et al.,* 2006) found that SP enhances animal immunity while vitamin A deficiency impairs the immune function in lambs (Bruns and Webb, 1990); and 3) their protective effect against hypothermia in newly born lambs.

In conclusion, supplementation of pregnant ewes with *Spirulina platensis* and vitamin A during the late stage of pregnancy improved the ewes' health status after lambing through increasing and decreasing essential and toxic metabolites, respectively in ewes' serum as well as reducing the lambing-induced stress on ewes. Furthermore, they enhanced survivability and performance of the newly born lambs through protecting them from hypothermia, increasing their immunity and birth weight and reducing the lambing-induced stress on the lambs.

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تأثير اضافة طحلب سبيرولينا بلاتنسيس وفيتامين أ للنعاج فى الفترة الاخيرة من الحمل علي حيوية وانتاجية حملانها

مبروك عطية عبد الدايم ، سامح جاد عبد الحق رمضان ، مبروك الصباغ ، حمادة ضاحى حسين محبوب

Email: sameh.ramadan@vet.usc.edu.eg Assiut University web-site: www.aun.edu.eg

اجريت هذه التجربة لدراسة تاثير اضافة طحلب سبيرولينا بلاتنسيس وحقن فيتامين أ للنعاج فى الفترة الاخيرة من الحمل على صحة النعاج والحملان الناتجة وكذلك على الاداء الانتاجى وحيوية الحملان. تم تقسيم عدد ٣٦ نعجة عشار فى الشهر الاخير من الحمل (متوسط وزنها ٥٢. ٠±٤٧,٤٠ كجم) عشوائيا الى ثلاث مجموعات حسب نوع المعاملة الغذائية (كل مجموعة ٦ نعاج - حيث تم تكرار كل مجموعة مرتين). المجموعة الاولى (المجموعة الضابطة) تم حقن كل نعجة ١ ملليترمن محلول الملح فى العضل مرتين اسبوعيا. المجموعة الثانية: تم اضافة طحلب سبيرولينا بلاتنسيس الى مخلوط المركزات يوميا بمعدل ١جم/١٠كجم من وزن الحيوان. المجموعة الثالثة: تم حقن كل نعجة ١ ملليترمن فيتامين أ (٥٠٠٠٠ - وحدة دولية) فى العضل مرتين اسبوعيا. وقد اظهرت النتائج قلة نشاط انزيم ALT معنويا وزيادة مستوي الكرياتينين معنويا فى مصل الدم للنعاج فى المجموعة الضابطة بعد الولادة. ولكن اضافة طحلب سبيرولينا وفيتامين أ ادى الى معادلة نشاط انزيم ALT ومستوي الكرياتينين فى مصل النعاج بعد الولادة. ايضا ادى اضافة طحلب سبيرولينا الى زيادة مستوي الجلوكوز والدهون الثلاثية والكلوستيرول الكلى فى مصل دم النعاج بعد الولادة. وكذلك ادى اضافة طحلب سبيرولينا الى النعاج العشار فى الفتره الاخيرة من الحمل الى زيادة عدد كريات الدم البيضاء فى الدم وزيادة تركيز فيتامين أ فى مصل دم الحملان بعد الولادة. بالاضافة الى ذلك تميزت الحملان الناتجة من النعاج التى تم تدعيمها بطحلب سبيرولينا وفيتامين أ بوزن ودرجة حراره جسمية اعلى ونسبة نفوق اقل للحملان بنسبة ٥٦% (١١,١%) و ٤٣% (١٤,٣%) على التوالى مقارنة بالحملان الناتجة من نعاج المجموعة الضابطة (٢٥%). أدى اضافة طحلب سبيرولينا الى عليقة النعاج العشار وحقن فيتامين أ للنعاج فى الفتره الاخيرة من الحمل الى تقليل الاجهاد الناتج من الولادة على كل من الام والحملان وذلك نتيجة تقليل مستوى TNFα فى مصل الدم لكلا من الام والحملان الناتجة. لذلك فان اضافة طحلب سبيرولينا بلاتنسيس وحقن فيتامين أ للنعاج فى الفترة الاخيرة من الحمل ادى الى تحسن صحتها عند الولادة وتعزيز انتاجية وحيوية حملانها.