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Physiological and blood biochemical responses in Baladi Female Goats treated with Chromium and Selenium-E under hot summer conditions

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Abstract
The present study was conducted during estrous cycle in Baladi female goats to study the effect of chromium and selenium with vitamin E on some blood metabolites to improve the productive performance of female goats under hot summer conditions. Sixty of mature Baladi does with age ranged from 2 to 3 years old and the mean body weight was 26.5±1.3 kg was used under two conditions of winter and summer seasons (30 animals/season). The animals were randomly divided into three groups (ten head in each) during both seasons, the 1st group was kept as control and the 2nd group was supplemented by chromium (chromium chloride trivalent), 0.8 mg/head/day. The 3rd group was intramuscularly injected twice a week with 2ml viteselen®, contained 0.5 mg selenium and 10.7 IU vitamin E (Se-E). Blood metabolites were assessed in the three experimental goats during the estrous cycle. The results demonstrated that serum glucose and urea concentration significantly ($P<0.001$) decrease under hot season during estrous cycle, on contrary AST, TP, albumin, globulin and total cholesterol showed significantly ($P<0.001$) increase under hot condition during estrous cycle phases, except estrus phase for AST, TP, globulin and albumin, and for diestrus and proestrus phase with total cholesterol, while ALT and estradiol 17 β showed non-significant effects for season. Female's goat supplemented with Cr or Se-E showed significantly decreased ($P<0.001$) in serum glucose, total cholesterol and albumin as compare with control during estrous cycle phases except estrus phase for albumin showed significantly increased, on contrast, AST, ALT and estradiol 17 β significantly ($P<0.001$) increased with Cr or Se-E supplementations as compare with control during estrous cycle phases except estrus and metestrus phase for AST and ALT, respectively, urea concentration significantly ($P<0.001$) decreased with Cr or Se-E supplementations as compare with control during diestrus and estrus phases, while in metestrus phase showed significantly increase with Se-E supplementation as compared with Cr and control group. TP concentration significantly ($P<0.001$) increased with Cr and significantly ($P<0.001$) decreased with Se-E supplementations during estrus cycle phases, except estrus phase which showed non-significant. All of the previous parameters showed significantly interactions between treatment and season during all of estrus cycle phases except metestrus phase for glucose concentration and estrus phase for albumin concentration. It can be concluded that Cr and Se-E supplementation can enhanced the blood metabolites and estradiol 17 β hormone concentration of female Baladi goats during estrus cycle under hot summer conditions, In order to achieve improved physiological and reproductive performance for female goats under heat stress conditions in Egypt.
***Keywords:* Chromium, Selenium-E, heat stress, blood metabolites, Goats.**

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I. Introduction

Goats are widely found in tropical and subtropical areas as well as in temperate regions; they are bred mainly for dairy production, but also for meat and fiber [1]. Hot summer season conditions cause infertility in farm animals and appears a major source of economic loss. In response to heat stress, leaders can try out a variety of approaches to progress reproduction. These approaches usually include changing the environment (i.e. attempting to cool animals during reproduction), supplementation of antioxidants in case of semi-intensive system as goats are grazed in the open during the most of day, which protect the body defense system against excessively produced free radicals during heat stress and stabilize health status of the animal, or increasing reproductive management at heat stress periods. Heat stress affects reproduction in all major farm species [2, 3].

The great focus of chromium research was given on the incorporation between chromium and diabetes. It was as late as in the 1990s that chromium also started to be studied intensively as an essential mineral in livestock animals [4]. The major role of chromium in metabolism is promoting glucose uptake by the cells [5]. The beneficial effects of chromium can be spotted more efficiently with environmental, dietary, and hormonal stressors. In ruminants, supplementation of Chromium is recommended during heat stress periods, while, Chromium supplementation decreases the unfavorable effects of heat stress [6].

Selenium (Se) is a perfect trace element, animated for the normal growth and animals healthy. Se has a biological mission related to vitamin E while, Se is the main component of glutathione peroxidase enzyme which involved in detoxification of hydrogen peroxide and lipid hydroperoxides. The vitamin E requirement may, therefore, be defined as the amount required to prevent peroxidation in the particular subcellular membrane which is most susceptible to peroxidation. Furthermore, Se is a main component of selenoproteins and also, involved in immune and neuropsychological function in the nutrition of animals [7]. However, a few are recognized around the effects of vitamin E supplementation on specific reproductive calamities in goats [8].

Considering, the above circumstances, the Objective of this work was to study the effect of chromium and selenium-E supplementations on some blood metabolites of does under heat stress conditions through estrous cycle phases to alleviate heat stress on native Baladi female goats in order to achieve improved physiological and reproductive performance for female goats under Egyptian conditions.

II. Materials and Methods

1. Experimental location and ethics

The present study was carried out in Goats Experimental Farm, Nuclear Research Center, Atomic Energy Authority, which was conducted in the desert region of Inshas, Egypt. (Latitude 310 12' N to 220 2' N, longitude 250 53' E to 350 53' E). This work was reviewed and approved by the Animal Care and Welfare committee of Egyptian Atomic Energy Authority standard operating procedures. These ethics contain relevant information on the endeavor to reduce animal suffering and adherence to best practices in veterinary care according to the international Council for Laboratory Animal Science guidelines. The experimental procedures were carried out according to the Local Experimental Animals Care committee and approved by the institutional ethics committee.

2. Animal and Experimental design

The current study was carried out for two successive estrous cycles in mature female goats, while, Sixty mature female goats (30 animals/ season) aged 2-3 years old with average body weight 26.5 ± 1.3 kg were randomly divided into three groups (ten head in each) during both seasons, animals in the 1st group were kept as control, the 2nd group was supplemented by chromium (chromium chloride trivalent), 0.8 mg/head/day as capsules [9] and the 3rd group was intramuscularly injected with 2 ml viteselen®, contained 0.5 mg selenium and 10.7 IU vitamin E/head/day.

3. Animals feeding and management

The experimental animals were healthy and clinically free of external and internal parasites and were fed a basal ration of concentrate feed mixture (CFM) according to the allowances of **NRC,** [10] of goats. The CFM composed of 37.4% wheat bran, 27% yellow corn, 12.5% soybean meal, 10.0% undecorticated cottonseed cake, 5% rice bran, 4% sugarcane molasses, 3% limestone, 1% sodium chloride and 0.1 vitamin and minerals premix. Feed mixture was offered once daily at 9:00 a.m., based on 3.5% of body weight. Berseem hay was offered ad libitum. Fresh drinking water was always available to all animals in clean basins full of freshwater. All experimental animals were protected in semi-open yards with force shade and ventilation during day and night in summer and protection from rain in winter and kept under the same environmental and managerial conditions to the termination of the trail. The does were allowed to graze five hours daily at least.

4. Meteorological data

This experiment was carried out for two successive estrous cycles, under both of mild and hot environmental conditions , air temperature (AT) and the relative humidity (RH) during day and night were recorded in the farm area, which collected from the nearest meteorological station. These data were used to calculate the daily temperature humidity index (THI), and the average of each item was calculated, temperature humidity index (THI) was calculated during mild and hot seasons according to **Marai et al., [11]** as: THI = db ℃ – [(0.31- 0.31RH) × (db ℃ -14.4)] Where, THI= temperature humidity index, db ℃ = dry bulb temperature in Celsius and RH = relative humidity ÷100. The values obtained are then classified as follows: <22.2 = Absence of heat stress, 22.2 to <23.3 = Moderate heat stress, 23.3 to < 25.6 = Severe heat stress and 25.6 and more = Very severe heat stress **[11]**.

Table 1: The values of THI during the experimental period

Seasons	Ambient temperature℃		Relative humidity %		THI	
	Max	Mini	Max	Mini	Max	Mini
Mild	23.47 ± 0.22	14.24 ± 0.20	80.01 ± 0.78	27.44 ± 0.52	22.9	13.9
Hot	34.15 ± 0.32	23.28 ± 0.35	77.91 ± 0.62	20.30 ± 0.46	32.8	23.5

5. Estrus Synchronization and Blood Sampling:

All groups received 10 ml of PGF2α (lutalyse) in double dose (5 mg/ dose, IM) at 11 day-intervals, followed by 500IU of hCG; then after 24 hours three fertile bucks (one buck for each group) were introduced to the does and allowed to be with does for two successive estrous cycles for estrous detection and natural mating. Blood samples were collected from the jugular vein by jugular venipuncture using disposable syringes. Serum was separated from clotted blood by centrifugation (20 min, 3000 × *g*) and clear serum collected and stored at -20°C until the biochemical and hormonal determinations. Samples were collected throughout different stages of estrous cycle, according to **Fatet et al., [1]**.

6. Biochemical and hormonal analysis

All the following parameters were determined using commercial kits manufactured by Diamond Diagnostic Company (Egypt). These parameters were total protein, albumin, total cholesterol and urea-N to indicate kidney functions. For liver function evaluation we evaluated serum concentration of aspartate amino transferase (AST) and alanin amino transferase (ALT). Serum concentrations of glucose was also determined. Globulin value was calculated by subtraction of albumin value from their corresponding total protein value. Estradiol17β (E2) hormones were estimated using Radioimmunoassay technique by commercial kits provided by Diagnostic product corporation, Los Angeles, USA. The unknown samples or standards are incubated with ^{125} I-RIA and antibody-coated tubes. And then, the liquid contents of the tube are aspirated and the radioactivity is determined in computerized gamma counter. All determinations were carried out in the tracer bioclimatology unit, Department of Biological Application, Nuclear research center, Atomic Energy Authority, Inshas, Cairo, Egypt.

7. Statistical analysis

Data were statistically analyzed using the general linear model procedure of GLM ANOVA procedure of ***SAS, [12].*** The statistical model used was: Yijk = µ +Si+ Tj + (S*T)ij+ eijk . Where, Y = the dependent variable, µ = the overall mean, S_i = the fixed effect of season (1= mild, 2= hot), T_j = the fixed effect of treatment (1= control, 2= chromium, 3 = selenium-E), S*Tij= the effect of interaction between season and treatment, e_{ijk} = random error. Significant differences between the means were verified by ***Duncan [13].***

III. Results

The effects of hot summer conditions and (Cr and Se-E) supplementations during estrus cycle in female goats on serum:

1- Proteins

Serum total proteins concentrations of female goats during estrous cycle increased significantly (P<0.0001) under hot conditions during different stages of estrous cycle, except estrus phase which showed insignificant effect (Table. 2). Supplementation of does with Cr showed significant (P<0.0001) increase in TP during estrous cycle, except estrus phase, compared to control and Se-E. The highest TP concentration by10.42 g/dl was at proestrus phase due to Cr supplementation versus 7.57 and 7.53 g/dl for control and Se-E, respectively.

On the other hand, treating animals with Se-E revealed fluctuated effect on TP concentration during estrous cycle. Se-E treatment significantly (P<0.0001) increased TP by 7.85 g/dl at diestrus phase more than control 7.05 g/dl, and showed significant decrease 6.66 g/dl at metestrus. Whereas, there is no significant difference in TP concentration at proestrus phase due to Se-E treatment compared with control. Similar trend of insignificancy in TP was obtained at estrus phase due to Cr and Se-E treatments (Table. 2). Data presented in Table (2) showed a significant (P<0.0001) interactions between treatments and season (mild or hot conditions) in estrous cycle phases of female goats on TP concentration.

Table 2. Serum total protein concentration of does during estrous cycle as affected by season, treatment and their interaction.

Item	Total Proteins (g/dl)			
	Diestrus	Proestrus	Estrus	Metestrus
Season (S)				
Mild	7.13 ±0.10	7.24 ±0.15	7.39 ±0.26	7.05 ±0.18
Hot	8.50 ±0.28	9.77 ±0.42	7.82 ±0.28	8.63 ±0.33
***P*- value**	0.0001	0.0001	0.109	0.0001

Treatments (T)				
Control	7.05^{C} ±0.10	7.57^{B} ±0.12	7.51 ±0.23	7.09^{B} ±0.04
Cr	8.55^{A} ±0.40	10.42^{A} ±0.56	7.59 ±0.47	9.78^{A} ±0.37
Se-E	7.85^{B} ±0.06	7.53^{B} ±0.32	7.73 ±0.22	6.66^{C} ±0.17
***P*- value**	0.0001	0.0001	0.785	0.0001
Interaction (S*T) Item				
Mild				
Control	7.03^{cd} ±0.11	7.44^{c} ±0.15	8.59^{ab} ±0.01	7.13^{c} ±0.04
Cr	6.60^{d} ±0.06	7.88^{c} ±0.01	5.73^{d} ±0.09	8.10^{b} ±0.29
Se-E	7.75^{b} ±0.12	6.39^{d} ±0.30	7.87^{bc} ±0.46	5.93^{d} ±0.19
Hot				
Control	7.07^{cd} ±0.18	7.69^{c} ±0.18	6.42^{d} ±0.27	7.06^{c} ±0.06
Cr	10.49^{a} ±0.36	12.96^{a} ±0.36	9.45^{a} ±0.55	11.46^{a} ±0.01
Se-E	7.94b^{c} ±0.02	8.68^{b} ±0.30	7.58^{c} ±0.05	7.38^{c} ±0.04
***P*- value**	0.0001	0.0001	0.0001	0.0001

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different.

Female goats showed slightly higher in albumin (Alb) concentrations in hot than mild season during estrous cycle. Significant (P<0.0001) increase was recorded at proestrus and metestrus phases with mean concentrations of 3.35 and 3.36 g/dl for hot season versus 2.81 and 3.02 g/dl for mild, respectively, as shown in Table (3).

Cr and Se-E treatments showed significant (P<0.001) difference in Alb concentrations at proestrus and estrus phases compared with control. At proestrus phase, Cr and Se-E showed albumin concentrations 2.93 and 3.08 g/dl, respectively lower than control group 3.24 g/dl. Whereas, Cr and Se-E significantly increased Alb at estrus phase more than control, with concentrations of 3.26, 3.22 and 2.99 g/dl, respectively. Albumin concentrations showed significantly (P<0.01) interaction between season and treatment during estrous cycle, except estrus phase female goats (Table 3).

Table 3. Serum albumin concentrations of does during estrous cycle as affected by season, treatment and their interaction.

Item	Albumin(g/dl)			
	Diestrus	**Proestrus**	**Estrus**	**Metestrus**
Season (S)				
Mild	3.06 ±0.08	2.81 ±0.06	3.13 ±0.03	3.02 ±0.04
Hot	2.97 ±0.10	3.35±0.07	3.18 ±0.06	3.36±0.03
***P*- value**	0.43	0.001	0.40	0.001
Treatments (T)				
Control	3.05 ±0.08	3.24^{A} ±0.13	2.99^{B} ±0.04	3.21 ±0.06
Cr	3.12 ±0.16	2.93^{B} ±0.08	3.26^{A} ±0.04	3.13 ±0.05
Se-E	2.87 ±0.04	3.08^{B} ±0.01	3.22^{A} ±0.08	3.23±0.06
***P*- value**	0.19	0.001	0.001	0.21
Interaction (S*T) Item				
Mild				
Control	3.02^{ab} ±0.16	2.69^{c} ±0.13	2.98 ±0.07	3.14^{bc} ±0.09
Cr	3.42^{a} ±0.05	2.64^{c} ±0.05	3.18 ±0.01	2.90^{d} ±0.02
Se-E	2.73^{b} ±0.01	3.10^{b} ±0.02	3.22 ±0.08	3.01^{cd} ±0.06
Hot				
Control	3.08^{ab} ±0.03	3.79^{a} ±0.01	2.99 ±0.02	3.29^{ab} ±0.06
Cr	2.82^{b} ±0.29	3.21^{b} ±0.12	3.35 ±0.08	3.36^{a} ±0.01
Se-E	2.99^{ab} ±0.06	3.05^{b} ±0.01	3.22 ±0.14	3.45^{a} ±0.03
***P*- value**	0.01	0.01	0.539	0.014

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different.

Table 4: Serum globulin concentration of does during estrous cycle as affected by season, treatment and their interaction.

Item	Globulin (g/dl)			
	Diestrus	**Proestrus**	**Estrus**	**Metestrus**
Season (S)				
Mild	4.07 ±0.18	4.53 ±0.20	4.27 ±0.28	4.04 ±0.22
Hot	5.54 ±0.27	6.42 ±0.45	4.63 ±0.29	5.27 ±0.34
***P*- value**	0.0001	0.0001	0.225	0.0001
Treatments (T)				
Control	3.99^{C} ±0.21	4.48^{B} ±0.17	4.52 ±0.27	3.89^{B} ±0.12
Cr	5.43^{A} ±0.47	7.49^{A} ±0.53	4.33 ±0.48	6.65^{A} ±0.32
Se-E	4.98^{B} ±0.08	4.46^{B} ±0.34	4.51 ±0.26	3.43^{C} ±0.20
***P*- value**	0.0001	0.0001	0.843	0.0001
Interaction (S*T) Item				
Mild				

Control	4.01^{c} ±0.38	5.07^{b} ±0.15	5.61^{ab} ±0.10	3.99^{c} ±0.19
Cr	3.18^{d} ±0.11	5.24^{b} ±0.04	2.55^{e} ±0.09	5.20^{b} ±0.26
Se-E	5.02^{b} ±0.15	3.29^{c} ±0.39	4.65^{bc} ±0.53	2.92^{d} ±0.04
Hot				
Control	3.99^{c} ±0.20	3.89^{c} ±0.18	3.44^{de} ±0.29	3.78^{c} ±0.13
Cr	7.68^{a} ±0.07	9.75^{a} ±0.48	6.11^{a} ±0.62	8.09^{a} ±0.01
Se-E	4.94^{b} ±0.04	5.62^{b} ±0.30	4.36^{cd} ±0.09	3.93^{c} ±0.08
***P*- value**	0.0001	0.0001	0.0001	0.0001

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different.

Averages of globulin concentrations of female Baladi goats during estrous cycle period significantly (P<0.0001) higher under hot season than mild season. It noticeable that, Glb at estrus phase did not significantly affected by season as shown in Table (4).

It can be observed from (Table. 4) Glb concentrations increased significantly (P<0.0001) in Cr treatment at estrous cycle period, except estrus phase as compared to control and Se-E groups. Proestrus phase recorded the highest concentration in Glb by 7.49 g/dl due to Cr effect, while the lowest concentration was 4.33 g/dl at estrus phase.

On the other side, Se-E treatment showed significantly (P<0.0001) decreased in Glb concentration as compared to control and Cr during proestrus and metestrus phases by 4.46 and 3.43 g/dl, respectively. Data presented in Table (4) showed a significant (P<0.0001) interactions between treatments and season (mild or hot conditions) in estrous cycle phases of female goats on Glb concentration. While, the highest Glb concentration due to Cr treatment was of 9.75 and 9.09 g/dl at proestrus and metestrus, respectively, under hot condition.

2- Glucose

It's obviously clear that, serum glucose concentration in does showed a significant (P<0.01) decrease under hot summer condition during estrus and metestrus phase of estrous cycle as compared with mild condition with means value 36.53 and 38.25 mg/dl, respectively. On contract, proestrus phase showed significant (P<0.01) increase in glucose concentration under hot condition in compared to mild condition with mean value 40.17 mg/dl (Table 5).

Cr and Se-E treatments showed significant (P<0.0001) decrease in glucose during estrous cycle phases, when compared with control (Table. 5). And also, data presented in Table (5) showed a significant (P<0.0001) interactions between treatments and season (mild or hot conditions) in estrous cycle phases except, metestrus phase, while, The lowest glucose concentration due to Cr was of 25.89 mg/dl at estrus phase, whereas it was about 24.87 mg/dl at diestrus due to Se-E treatment under hot condition. The highest glucose concentration due to Cr was of 42.28 mg/dl at diestrus and 45.89 mg/dl at estrus for Se-E treatment under mild condition.

Table 5: Serum glucose concentration of does during estrous cycle as affected by season, treatment and their interaction.

Item	Glucose (mg/dl)			
	Diestrus	**Proestrus**	**Estrus**	**Metestrus**
Season (S)				
Mild	39.65 ±2.1	37.59 ±1.3	42.72 ±1.2	45.77 ±3.2
Hot	39.08 ±2.3	40.17 ±2.5	36.53 ±2.6	38.25 ±1.7
***P*- value**	0.803	0.024	0.01	0.01
Treatments (T)				
Control	48.41^{A} ±2.3	53.25^{A} ±1.80	49.75^{A} ±2.3	57.63^{A} ±3.5
Cr	39.38^{B} ±2.9	32.33^{B} ±1.50	32.71^{C} ±1.8	33.19^{B} ±1.3
Se-E	30.29^{C} ±1.2	31.06^{B} ±0.29	36.40^{B} ±2.0	35.21^{B} ±1.0
***P*- value**	0.0001	0.0001	0.0001	0.0001
Interaction (S*T) Item				
Mild				
Control	40.94^{b} ±3.0	45.66^{b} ±0.38	42.73^{bc} ±2.5	63.78 ±6.6
Cr	42.28^{b} ±5.6	35.21^{c} ±2.70	39.53^{c} ±2.2	35.91 ±2.2
Se-E	35.71^{b} ±0.7	31.89^{cd} ±0.48	45.89^{b} ±0.7	37.63 ±1.8
Hot				
Control	55.88^{a} ±1.6	60.83^{a} ±1.8	56.78^{a} ±2.4	51.48 ±1.6
Cr	36.48^{b} ±1.7	29.46^{d} ±0.41	25.89^{d} ±0.1	30.48 ±0.9
Se-E	24.87^{c} ±0.20	30.23^{d} ±0.04	26.91^{d} ±0.8	32.78 ±0.5
***P*- value**	0.0001	0.0001	0.0001	0.402

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different

3- Liver function

Data presented in Table (6) about serum ALT activity showed non-significant differences according to season effect in does during estrous cycle. serum AST activity in does showed a significant (P<0.01) increase under hot summer condition during diestrus and metestrus phases of estrous cycle as compared with mild condition with means value of 62.54 and 62.55 U/L, respectively. While, serum AST activity appears non-significant differences during proestrus and estrus phases according to season effect (Table 7).

Table 6: Serum ALT activity of does during estrous cycle as affected by season, treatment and their interaction.

Item	ALT (U/L)			
	Diestrus	Proestrus	Estrus	Metestrus
Season (S)				
Mild	40.60 ±0.31	40.29 ±0.37	41.99 ±0.31	37.44 ±0.6
Hot	40.37±1.04	41.28 ±0.88	42.16 ±0.55	38.34 ±0.8
***P*- value**	0.8	0.072	0.696	0.112
Treatments (T)				
Control	37.62^{B} ±0.83	37.51^{C} ±0.83	40.65^{B} ±0.69	37.52 ±0.9
Cr	42.32^{A} ±0.56	43.62^{A} ±0.23	43.05^{A} ±0.42	38.42 ±0.4
Se-E	41.53^{A} ±1.10	41.25^{B} ±0.74	42.54^{A} ±0.35	37.74 ±1.1
***P*- value**	0.0001	0.0001	0.0001	0.404
Interaction (S*T) Item				
Mild				
Control	39.43^{b} ±0.01	39.77^{b} ±0.33	42.94^{bc} ±0.64	39.78^{b} ±0.17
Cr	40.00^{b} ±0.31	43.05^{a} ±0.21	41.36^{d} ±0.31	39.99^{b} ±0.17
Se-E	42.38^{ab} ±0.61	38.08^{b} ±0.34	41.69^{cd} ±0.55	32.54^{d} ±0.4
Hot				
Control	35.81^{c} ±1.5	35.25^{c} ±1.39	38.36^{e} ±0.80	35.26^{c} ±1.5
Cr	44.64^{a} ±0.48	44.18^{a} ±0.34	44.75^{a} ±0.37	36.84^{c} ±0.5
Se-E	40.68^{b} ±2.1	44.43^{a} ±0.62	43.39^{ab} ±0.31	42.94^{a} ±0.23
***P*- value**	0.0001	0.0001	0.0001	0.0001

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different.

Table 7: Serum AST activity of does during estrous cycle as affected by season, treatment and their interaction.

Item	AST(U/L)			
	Diestrus	Proestrus	Estrus	Metestrus
Season (S)				
Mild	58.34 ±1.1	49.79 ±1.5	54.29 ±0.96	50.02 ±0.97
Hot	62.54 ±2.5	47.65 ±2.0	54.41 ±1.8	62.55 ±3.4
***P*- value**	0.013	0.172	0.94	0.01
Treatments (T)				
Control	48.81^{B} ±1.7	37.56^{B} ±1.3	53.25 ±1.2	46.05^{C} ±0.8
Cr	65.91^{A} ±1.6	55.86^{A} ±0.9	55.51 ±1.7	57.76^{B} ±2.3
Se-E	66.60^{A} ±1.9	52.74^{A} ±1.9	54.29 ±2.3	65.04^{A} ±4.4
***P*- value**	0.0001	0.0001	0.52	0.0001
Interaction (S*T) Item				
Mild				
Control	53.26^{c} ±2.1	42.16^{c} ±0.4	56.72^{b} ±0.63	47.36^{c} ±1.6
Cr	59.15^{b} ±1.7	52.91^{b} ±0.9	47.36^{c} ±0.94	50.02^{c} ±2.3
Se-E	62.62^{b} ±0.52	54.29^{ab} ±3.6	58.80^{ab} ±0.84	50.14^{c} ±0.10
Hot				
Control	44.36^{d} ±1.9	32.96^{d} ±1.8	49.78^{c} ±1.8	44.74^{c} ±0.11
Cr	72.67^{a} ±0.42	58.80^{a} ±1.0	63.67^{a} ±0.42	62.55^{b} ±3.3
Se-E	70.59^{a} ±3.5	51.18^{b} ±1.7	49.79^{c} ±4.2	79.95^{a} ±6.5
***P*- value**	0.0001	0.001	0.001	0.0001

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different.

Cr and Se-E treatments showed significant ($P<0.0001$) increase in serum ALT activity during estrous cycle phases, except, metestrus phase when compared with control (Table 6). The significant ($P<0.0001$) interactions between season (mild or hot conditions) and treatments in estrous cycle phases are presented in (Table 3) showed highest ALT activity due to Cr treatment was of 44.75, 44.64 and 44.18 U/L at estrus, diestrus and proestrus, respectively, under hot condition, and the highest ALT activity due to Se-E treatment was of 44.43 U/L at proestrus under hot condition.

Serum AST activities were significantly ($P<0.0001$) higher in treated groups at diestrus, proestrus and metestrus phases than control. However, AST activity at estrus phase did not show significant differences due to Cr or Se-E treatments compared with control. AST differences between Cr and Se-E were not significant except at metestrus Cr treatment had serum AST activity about 7.28 U/L less than Se-E treatment (Table 7).

Data in Table 7 showed that, analysis of variance of obtained data revealed significant effect due to the interaction between season and treatments on AST activity during estrous cycle. While, under mild conditions, highest AST activity 62.62 U/L was recorded at diestrus due to Se-E treatment, and under hot season, highest AST activity was 79.95 U/L found at metestrus due to Se-E treatment. However, the lowest AST due to treatments was 49.79 U/L at estrus phase of Se-E treatment too.

4- Total cholesterol

Serum cholesterol was differed significantly (P<0.0001) due to season at diestrus, estrus and metestrus phases. And the highest concentration of TC 3.82 mg/dl was recorded at metestrus during hot season; moreover, the lowest TC concentration was about 2.38 mg/dl during diestrus at the same season as shown in Table (8)

Female goats supplemented with Cr showed significant (P<0.0001) decrease in TC during estrous cycle, except metestrus phase, compared with control. The lowest TC concentration of 2.35 mg/dl was found due to Cr at estrus phase. Se-E treatment had the same trend of decrement at estrous cycle, but at metestrus Se-E increased (P<0.0001) in TC 3.88 mg/dl as compared with control 2.89 mg/dl. The lowest cholesterol concentration due to Se-E was about 2.66 mg/dl at estrus and diestrus phases (Table 8). Data presented in table (8) showed a significant (P<0.0001) interactions between treatments and season (mild or hot conditions) in estrous cycle phases of female goats on total cholesterol.

Table 8: Serum total cholesterol concentration of does during estrous cycle as affected by season, treatment and their interaction.

Item	Total cholesterol (mg/dl)			
	Diestrus	Proestrus	Estrus	Metestrus
Season (S)				
Mild	3.50 ±0.15	3.05 ±0.08	2.40 ±0.05	2.69 ±0.11
Hot	2.38 ±0.16	2.85 ±0.13	3.10 ±0.15	3.82 ±0.16
***P*- value**	0.0001	0.099	0.0001	0.0001
Treatments (T)				
Control	3.37^{A} ±0.22	3.19^{A} ±0.16	3.24^{A} ±0.21	2.89^{B} ±0.19
Cr	2.79^{B} ±0.23	2.84^{B} ±0.14	2.35^{B} ±0.07	2.99^{B} ±0.14
Se-E	2.66^{B} ±0.21	2.82^{B} ±0.08	2.66^{B} ±0.05	3.88^{A} ±0.21
***P*- value**	0.012	0.018	0.0001	0.0001
Interaction (S*T) Item				
Mild				
Control	3.42^{a} ±0.34	2.73^{c} ±0.14	2.41^{bc} ±0.07	2.20^{d} ±0.12
Cr	3.66^{a} ±0.22	3.39^{ab} ±0.15	2.20^{c} ±0.02	2.98^{c} ±0.25
Se-E	3.43^{a} ±0.26	3.02^{bc} ±0.06	2.61^{b} ±0.10	2.88^{c} ±0.01
Hot				
Control	3.31^{a} ±0.29	3.65^{a} ±0.23	4.08^{a} ±0.23	3.58^{b} ±0.22
Cr	1.93^{b} ±0.18	2.29^{d} ±0.08	2.51^{bc} ±0.14	3.01^{c} ±0.09
Se-E	1.89^{b} ±0.05	2.62^{cd} ±0.11	2.72^{b} ±0.01	4.88^{a} ±0.05
***P*- value**	0.002	0.0001	0.0001	0.0001

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different.

5- Urea-N

As shown in Table 9 urea concentrations were significantly (P<0.0001) higher during estrous cycle at mild than hot season. Serum urea gradually increased in mild season from diestrus phase to reach highest concentration 77.59 mg/dl at estrus phase then decreased to lowest concentration 55.83 mg/dl at metestrus. Whereas, does exhibited fluctuated trend of urea during estrous cycle in hot season, recorded the lowest concentration 41.4 mg/dl at proestrus phase and the highest concentration 63.89 mg/dl at estrus phase.

Data in Table 9 showed that female goats treated with Cr revealed significant (P<0.0001) decrease in serum urea at diestrus and proestrus phases, the latest had marked urea decrease 30.69 mg/dl as compared with control. Se-E group had significant (P<0.0001) decrease in urea during estrous cycle, except proestrus, in compared to control. The lowest urea concentration showed due to Se-E treatment by 35.73 mg/dl at metestrus phase. Urea concentrations showed significantly (P<0.0001) interaction between season and treatment during estrous cycle in female goats (Table 9).

Table 9: Serum urea concentration of does during estrous cycle as affected by season, treatment and their interaction.

Item	Urea (mg/dl)			
	Diestrus	Proestrus	Estrus	Metestrus
Season (S)				
Mild	60.59 ±2.4	73.19 ±5.5	77.59 ±3.2	55.83 ±3.7
Hot	50.24 ±2.1	41.40 ±2.6	63.89 ±3.4	46.08 ±2.1
***P*- value**	0.0001	0.0001	0.0001	0.0001
Treatments (T)				
Control	66.08^{A} ±3.0	71.11^{A} ±2.9	78.05^{A} ±5.6	43.65^{B} ±0.61
Cr	59.27^{B} ±1.2	30.69^{B} ±0.37	77.31^{A} ±2.5	73.48^{A} ±3.10
Se-E	40.89^{C} ±1.5	70.11^{A} ±7.8	56.86^{B} ±2.4	35.73^{C} ±0.89
***P*- value**	0.0001	0.0001	0.0001	0.0001
Interaction (S*T) Item				
Mild				
Control	77.72^{a} ±2.9	81.53^{b} ±3.6	102.99^{a} ±1.5	41.31^{d} ±0.65

Cr	57.34^{bc} ±1.6	31.28^{d} ±0.73	67.17^{c} ±1.0	86.51^{a} ±1.90
Se-E	46.74^{d} ±0.65	106.79^{a} ±1.2	62.64^{c} ±2.7	39.68^{d} ±0.33
Hot				
Control	54.44^{c} ±0.20	60.68^{c} ±1.7	53.11^{d} ±4.2	45.99^{c} ±0.35
Cr	61.21^{b} ±1.70	30.11^{d} ±0.05	87.46^{b} ±2.7	60.46^{b} ±2.40
Se-E	35.05^{e} ±1.8	33.42^{d} ±3.2	51.09^{d} ±3.4	31.79^{e} ±0.63
***P*- value**	0.0001	0.0001	0.0001	0.0001

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different.

6- Estradiol-17β

Data in Table (10) showed there was no significant difference in serum estradiol-17β concentrations of female goats as affected by season, during estrous cycle, except at diestrus while, E2 concentration was higher in hot 29.20 pg/ml than mild season 22.80 pg/ml; also, E2 concentrations were insignificantly higher at estrus and metestrus phases in hot than mild season. E2 showed the regular traditional pattern of increase and decrease during estrous phases, while, the highest level was showed estrus phase with mean values of 45.97 and 48.44 pg/ml for mild and hot season, respectively (Table 10).

Analysis of variance for obtained data revealed highly significant ($P<0.0001$) effect due to treatments on serum E2. In general, treatment groups showed E2 concentrations higher than control during estrous period. Se-E treatment showed significantly increased in E2 concentrations during estrous cycle more than Cr and control groups. The highest level was about 62.49 pg/ml for Se-E versus 35.02 and 44.11 pg/ml for control and Cr, respectively during estrus phase. In addition, treatment of Cr showed significant increase in E2 concentration at diestrus and estrus phases more than control with values of 25.26 and 44.11 pg/ml versus 21.61 and 35.02 pg/ml, respectively for control group (Table 10). E2 concentrations showed significantly ($P<0.0001$) interaction between season and treatment during estrous cycle in female goats (Table 10).

Table 10: Serum Estradiol-17β concentration of does during estrous cycle as affected by season, treatment and their interaction.

Item	Estradiol-$_{17\beta}$ (pg/ml)			
	Diestrus	**Proestrus**	**Estrus**	**Metestrus**
Season (S)				
Mild	22.80 ±1.50	30.45 ±3.9	45.97 ±4.2	25.48 ±2.9
Hot	29.20 ±0.72	29.71 ±1.1	48.44 ±1.6	27.21 ±1.5
***P*- value**	0.0001	0.74	0.348	0.426
Treatments (T)				
Control	21.61^{C} ±1.2	21.98^{B} ±1.9	35.02^{C} ±2.4	19.87^{B} ±2.5
Cr	25.26^{B} ±1.7	22.18^{B} ±1.5	44.11^{B} ±2.3	23.63^{B} ±1.5
Se-E	31.25^{A} ± 1.0	46.07^{A} ±4.0	62.49^{A} ±4.2	35.53^{A} ±3.2
***P*- value**	0.0001	0.0001	0.0001	0.0001
Interaction (S*T) Item				
Mild				
Control	17.95^{c} ± 1.6	14.01^{c} ±1.2	27.22^{d} ±1.9	12.89^{c} ±1.9
Cr	17.36^{c} ±0.01	17.57^{c} ±0.8	36.23^{cd} ±3.3	17.39^{c} ±0.5
Se-E	33.27^{a} ±1.8	59.77^{a} ±4.5	74.46^{a} ±6.1	46.16^{a} ±4.2
Hot				
Control	25.28^{c} ±1.2	29.96^{b} ±1.3	42.82^{bc} ±3.2	26.84^{b} ±3.8
Cr	33.16^{a} ±0.83	26.79^{b} ±2.2	51.98^{b} ±0.5	29.87^{b} ±1.5
Se-E	29.24^{b} ±0.32	32.36^{b} ±1.8	50.53^{b} ±3.0	24.91^{b} ±1.9
***P*- value**	0.0001	0.0001	0.0001	0.0001

Means with different letters (A, B and C or a, b, c,…) in the same column are significantly different.

IV. Discussion

The effects of hot summer conditions and (Cr and/ or Se-E) supplementations during estrus cycle in female goats on:

1- Proteins

In harmony with our results plasma albumin in blood of buffaloes were significantly higher during summer, while plasma total protein and globulin were significantly lower when compared with values of winter season showed by **Chaudhry et al., (1995)**. And, **Kamal, [14]** reported that during summer an extension in plasma volume occurred beside an increase in plasma total protein to match colloid osmotic pressure. The increase in plasma globulin noticed in summer is thus a trail to increase the plasma TP in order to maintain the osmotic pressure.

In disagreement of our results **El-Gaafarawy et al., [15]** found that high ambient temperature during summer, accompanied with a decrease in plasma total protein, albumin and globulin. And also, **Dangi *et al.*, [16]** showed a significant decrease in total protein concentration in goats during heat stress**.** While, plasma total protein decreased from 6.56 to 5.88 g/dl in Baladi goats exposed to short-term heat stress. This may be due to increase in plasma volume as a result of heat shock which causes decreases in plasma protein concentration **[17]**.

Previous studies found insignificant changes in globulin concentrations due to season of the year **[18].** In this respect, the current results disagreed with the later authors since the present results revealed an increase in globulin under hot than mild season during estrus cycle. The present results of Cr supplementation are in harmony with the findings of **El-Masry *et al.*, [19]** who recorded a significantly increased in serum total proteins in calves received 0.6 mg Cr/kg DM under heat stress conditions when compared with non-Cr treated calves. The increase of TP in response to Cr supplementation may be attributed to nitrogen absorption improvement **[20],** increased amino acid synthesis in the liver in which Cr may enhance amino acid synthesis possibly via insulin and incorporation of several amino acids into protein **[21].** In the same trend, **Wang *et al.*, [22]** revealed that supplementation of pigs with Cr resulted in significant increase in serum TP. In disagreement of our results **El-Masry *et al.*, [19]** stated that supplementation calves with Cr under heat stress conditions insignificantly increased Alb concentration as compared to untreated animals.

Our results about Cr treatment are in harmony with the findings of **El-Masry *et al.*, [19]** in calves exposed to heat stress, while, there was significant increase in globulin concentrations in Cr treated animals more than untreated. This increase may be attributed to an improvement in immune response in treated calves, since Cr may have an effect on certain enzymes that increase immunoglobulin synthesis **[21].** Also, **Soltan *et al.*, [23]** found that supplementation of heat stressed calves with 3 mg Cr/head/day significantly increased blood globulin concentration as compared with control group.

On contrary, the current results about globulin concentration disagreed with the finding of **Al-Saiady *et al.*, [24]** who reported that treating heat stressed Holstein cows with Cr resulted in significant decrease in globulin concentration during lactation period as compared to control group.

Results in the current study of Se-E treatment in accordance with **Krajnicakova *et al.*, [25]** who found a significant increase in TP on day 40 postpartum in goats. Also, treatment Baladi goats with Se-E caused a remarkable increased in TP concentration in all treated animals in early, mid- and late-pregnant and lactating goats when compared to control group under southern Sinai conditions **[26]**. **Soliman *et al.*, [27]** reported that ewes injected with Se-E at late-gestation and during suckling period significantly increased plasma total protein comparing with control ewes. Our results disagreement with **Kumar *et al.*, [28]** who stated that supplementation of sheep with Se (0.15mg Se/kg of diet) through sodium selenite had no effect on serum TP.

The decrease in albumin concentrations during diestrus and proestrus phases due to Se-E treatment of the current study agreed with the findings of **Esa, [26]** who indicated that albumin decreased in Se-E treated female goats at premating stage than control group under Southern Sinai conditions. Moreover, **El-Shahat and Abd El-Monem, [29]** reported that Baladi ewes supplemented with Se-E, 2 weeks before mating and extended through pregnancy till lambing showed a significant increase in TP. They also noticed that higher concentration of Alb was found in vitamin E alone supplemented-ewes compared to vitamin E plus Se or Se alone supplemented ewes, however, ewes received Se alone had significantly lower serum TP, Alb and globulin.

On the other hand, the significant increases in globulin of Se-E treated goats were conformed to the findings of **Mahmoud *et al.*, [30]** who reported an improvement in blood metabolites in sheep administrated with selenium. This result may be due to improvement of protein anabolism, decrease of protein catabolism. In addition, the increase in the other blood metabolites could be ascribed to the improvement of feed efficiency by vitamin E and Se injection that improve by the way the overall animal health and/or reproductive performance.

Se-E supplemented Baladi ewes group had significantly higher total globulins than control group and the major changes in total globulins fractions was in the γ-globulins. The γ-globulins concentrations were significantly higher in Se-E supplemented group compared with Se group control. The authors attributed this behavior to the fact that animals exposed to various antigenic agents, resulting in an increase in the IgG production **[31]**.

2- Glucose

In the current study, results of Cr are in harmony with those of **[32]** on stressed calves; **[33]** in early lactation cows and **[19]** in solar radiation exposed calves. These authors stated that animals treated with Cr had serum glucose concentration less than untreated animals. The decrease in glucose concentration may be attributed to the depression in cortisol level which has been found to be associated with reducing gluconeogenesis process and increasing glucose utilization as a response to an increase in insulin concentrations, since Cr seems to be an integral component of glucose tolerance factor to potentiate the action of insulin**, [34].**

On the contrary**, Nikkhah *et al.*, [35]** in heat-stressed dairy cows found that serum concentrations of glucose did not affected by treatment with Cr. In addition, **Malik *et al.*, [36]** in a study of Cr on blood glucose and liver enzymes in rabbits, stated an increase in blood glucose level at dose 200 µg chromium chloride and further increase in blood glucose observed at dose 400 µg.

The current results of glucose decrement due to Se-E injection are disagreement with the findings of **Mahmoud *et al.*, [30]** who reported that rams injected with a combination of Se-E showed significant increase in serum glucose as compared with the control group**.** In the same line results obtained by **Tahmasbi *et al.*, [37]** in heat stressed lactating cows showed that glucose for selenium-vitamin E group was higher than untreated group. **Mahmoud *et al.*, [30]** attributed the increase in serum glucose may be due to improvement of protein anabolism and decreased protein catabolism.

3- Liver function

Concerning the levels of liver enzymes, some studies showed that serum AST activity was higher in summer, while serum ALT was insignificantly affected by season in Barki and Rahmani ewes **[38],** Also, the significant increase in AST and ALT activities in cows under hot condition was recorded by **El- Masry et al., [39].**

The current results showed an increase in ALT due to hot season in a harmony with results of **Sharma and Kataria, [40]** who recorded an increase in serum ALT activity during heat stress period in goats. The increase in activities of serum AST and ALT in the heat stressed animals may be due to the increase in stimulation of gluconeogenesis corticoids under hot conditions. However, the increase in AST and ALT may be due to the impaired function of the liver under heat stress **[41]**.

The current results are in agreement with **Malik *et al.*, [36]** who reported that serum ALT activity significantly increased in rabbits groups which received either 200 or 400 µg $CrCl_3$ for 60 days when compared with control group. On the other side, the increase in serum ALT activity during estrous cycle in goats supplemented with Cr was disagreed with the findings of **Paul *et al.*, [42]** who revealed significant decrease in ALT activity in the Cr supplemented bucks as compared with control group in Black Bengal bucks. Furthermore, **Wang *et al.*, [22]** indicated insignificantly decreased in ALT activity in supplementation pigs with different forms of Cr.

In agreement of our results serum AST activity was incre ased significantly under the effect of Cr supplementation in compared to control group **[36].** Nevertheless, these results agreed with the findings of **Yazaki *et al.*, [43] ; Al-Bandr *et al.*, [44]** who reported increase in serum AST activity due to Cr supplementation. On the other hand, the increase in AST activity disagreement with **Wang *et al.*, [22]** who reported that supplementation of pigs with different forms of Cr insignificantly decreased AST activity.

The present increase in serum ALT activity due to Se-E treatment are in accordance with **Shashidhar and Prasad, [45]** who found an increase in ALT activity in adult goats supplemented with Se. and also, **Singh *et al.*, [46]** reported ALT activity increased in buffalo calves supplemented with Se. On the contrary, our results disagreed with **Saleh, [47]** in pregnant ewes and **Esa, [26]** in pregnant and early lactating goats under southern Sinai conditions, who reported a decrease in serum ALT activity in animals treated with Se-E during the previously mentioned reproductive periods compared to untreated group.

The current Results of Se-E supplementation are disagreement with **Esa, [26]** who reported a significant decrease in serum AST activity in female goats after treatment with Se-E comparing with untreated goats. Also, **Saleh, [47]** reported that injection with Se-E decreased AST at parturition and early lactation in ewes. Many authors stated that protective dose of vitamin-E of pregnant ewes prevent hepatic damage and decrease AST activity **[48, 49] [50].** Furthermore, **Kumar *et al.*, *[28]*** reported that the activity of AST was not affected due to supplementation of Se either through inorganic or organic source in the diet of lambs.

4- Total cholesterol

Our results about total cholesterol increase during estrus and metestrus under hot conditions agreement with **Alameen and Abdelatif, [51]** who found that serum levels of cholesterol and triglycerides were higher during summer compared to respective winter values. This is probably related to the role of the compound in ovary steroidogenesis, so that the total cholesterol concentrations are under control of the complex of factors **[52].**

Otherwise, the decrease in total cholesterol concentration with the increase in environmental temperature during diestrus and proestrus in our results are in harmony with **Marai *et al.*, [53]** who attributed the marked decrease in cholesterol concentration under heat stress to dilution as a result to the increase in total body water or to the decrease in acetate concentration, which is the primary precursor for the synthesis of cholesterol. Furthermore, the marked increase in glucorticoid hormone level in heat stressed animals may be another factor causing the decline in blood cholesterol.

And also, **Watson et al., [54]** explained the significantly lower serum cholesterol levels in summer compared to winter values is probably related to metabolic disorder associated with exposure of cows to hot environment which may accelerate body fat catabolism**.** Furthermore, **Ocak and Okan, [55]; Pandey *et al.*, [56]** found significant decline in the cholesterol during the summer season in goats and Marwari goats, respectively. While**,** the decreased cholesterol concentration during the heat stress may attributed to lowered thyroid activity **[56]** or decreased feed intake during hot summer and consequent reduction in intake of dietary cholesterol **[57].**

Concerning results of chromium treatment that revealed significant decrease in serum total cholesterol during estrus cycle, which clearly showed during hot season are in agreement with the findings of **Wang *et al.*, [22]** who suggested that supplementation with different forms of Cr significantly decreased total cholesterol in pigs. In addition, **El-Masry *et al.*, [19]** found that serum cholesterol decreased significantly in calves received 0.6 mg Cr/kg DM under heat stress conditions when compared with non-Cr treated calves.

The present results of mild season which recorded an increase in serum total cholesterol during most of estrous cycle phases disagreed with the findings of **Bunting *et al.*, [58]** who showed that Cr supplementation decreased total cholesterol under moderate environmental conditions. The previous studies of **Depew *et al.*, [59]** revealed that Cr supplementation has no effect on concentration of serum total cholesterol and triglycerides.

The decrease of serum total cholesterol due to Se-E treatment especially at hot season condition during estrus cycle are in harmony with results of **Brzoska and Brzoska, [60]** who found that cows received Se in the form of sodium selenite showed significant decrease in plasma total cholesterol. On the other side, the current Se-E results disagreed with those of **Kalmath *et al.*, [61]** who revealed significant increase in serum total cholesterol during summer compared to winter season in both control and Se-E supplemented Hallikar cattle groups. The authors claimed that the higher concentrations of cholesterol during summer season might support the enhanced cortisol synthesis that occurs during summer stress as the cholesterol acts as a precursor for the synthesis of steroid hormones in the body.

Also, obtained results disagreed with **Kumar *et al.*, [62]** in Beetal goats, **Sejian *et al.*, [63]** in Malpura ewes and **Das *et al.*, [64]** in buffaloes and his increase in circulating cholesterol may be to support hepatic gluconeogenesis during adaptive mechanisms **[63].** From another view, the variation in cholesterol level may be accompanied with the changes in cortisol concentration, since the change in cholesterol concentration is controlled by adrenocorticotropic hormone, which has an effect on some steps that related to the conversion of cholesterol to pregnanolone and subsequently to cortisol **[65]**.

5- Urea-N

In the present study, serum urea concentrations during hot season were lower than mild at estrous cycle, and in harmony with our results **Dixon *et al.*, [66]** reported that hot environment reduced nitrogen balance in Merino x Border Leicester sheep, probably due to the decrease of total dry matter intake and increase of panting. The depression in blood urea–N associated with heat stress in animals may be due to more reabsorption of urea–N from the blood to the rumen to compensate the decrease in rumen ammonia– N according to the decrease in feed intake and digestible nitrogen consumption **[67]**. In addition, the increase in urinary nitrogen excretion under severe heat stress conditions as indicated by a negative nitrogen balance may also contribute to the decrease of serum urea level under such conditions **[68]**.

On the contrary, **Shwartz *et al.*, [69]** found that heat stress increased plasma urea–N concentration in lactating Holstein cows. Particularly, **Momtmurro *et al.*, [70]** suggested that the high level of urea was due to the low energy/protein ratio and to gluconeogenesis by protein degradation in conditions of insufficient energy for growth, and indicated that urea is normally higher when protein is in excess in the diet or there is a low energy / protein ratio**.**

Concerning treatment effect, applying Cr to goats showed a decrease of serum urea-N concentrations during most estrus cycle phases as compared with control. In agreement with our results **Wang *et al.*, [22]** found that supplementation of pigs with Cr in different forms decreased serum concentration of urea. Also, **Yanchev *et al.*, [71]** suggested that supplemental Cr may have caused reduced diet consumption, less feed protein intake**,** lower level of released NH3 and better NH3 utilization by rumen microorganisms, thus reducing the level of ammonium that has to be detoxicated as urea-N in the liver.

In accordance of the present results of Se-E supplementation, **Esa, [26]** reported that supplemented premating and pregnant Baladi goats with Se-E showed significant decrease in serum urea as compared to untreated group. Contrarily, **El-Shahat and Abdel Monem, [29]** stated that Se-E treated Egyptian Baladi ewes under subtropical conditions not reveal significant difference in serum urea-N concentration among different groups.

6- Estradiol-17β

Our results about non-significant effects of season on estradiol-17β concentration in female goats are disagreement with **Ozawa et al., [72]** who found that heat stress reduces plasma concentrations of estradiol-17β and lower follicular estradiol concentration, and also, delay ovulation, while, the mechanisms by which heat stress alters the concentrations of circulating reproductive hormones are not known. Some effects of heat stress may involve adrenocorticotropic hormone (ACTH) and increase cortisol secretion. ACTH has been reported to block estradiol-induced sexual behavior **[73]**. Heat stress during follicular recruitment suppresses subsequent growth to ovulation, accompanied by decreased LH receptor level and estradiol synthesis in the follicles **[72] [74]**.

The increase of estradiol-17β throughout estrous cycle due to Crcl3 supplementation in the present study agreed with the findings of **Balicka et al., [75]** in dairy heifers, who found that heifers fed Cr in different doses developed Graffian follicles and estrus incidence, and this increase in E2 concentrations during estrus may reflect its enhancing effect on Graffian follicles growth and maturation and subsequently released amount of estradiol-17β from granulosa cells. Increased corticosteroid secretion has been suggested while, it can be inhibit

GnRH and thus LH secretion **[76]**. Many studies confirmed the decrease of cortisol due to Cr supplementations which in turn may act on alleviate the adverse effects of heat stress on reproductive hormones **[77]**. Furthermore, **Tuormaa, [78]** stated that chromium exerts a significant influence on follicular maturation and luteinizing hormone.

In accordance of the effect of Se-E supplementation on estradiol 17 β **Prasdini, et al., [79]** showed that Se-E supplementation provides a real strong influence in increase concentrations of estradiol 17 β during estrus in dairy cows compared with control group. The supplementation of Se-E to repeat breeder and an oestrous buffaloes relieved the oxidative stress as shown by reduced the levels of lipid peroxidation and superoxide dismutase activity and finally, improved blood biochemical composition in Se-E supplemented animals **[80]**.

V. Conclusion

It can be concluded that Cr and Se-E supplementation can enhanced the blood metabolites and estradiol 17 β hormone concentration of female Baladi goats during estrus cycle under hot summer conditions, In order to achieve improved physiological and reproductive performance for female goats under heat stress conditions in Egypt.

Conflict of Interest

The authors declare that they have no conflict of interest.

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