New Valley Journal of Agricultural Science
Published by Faculty of Agriculture, New Valley University, Egypt
DOI: 10.21608/NVJAS.2022.177488.1134
Research Article Open Access

Effect of Antioxidant supplementation on Some Hematological Parameters and Thermoregulatory Responses of Aberdeen Angus Cows During Hot Season in Arid Subtropical Regions

Soliman A.S.H. [1], A.Y. Kassab [1], H. A. Hamdon [1], W. Senosy[2] and H. A. Daghash[3]

[1] Animal Production Department, Faculty of Agriculture, New Valley University, Egypt
[2] Department of Theriogenology, Faculty of Veterinary Medicine, New Valley University, Egypt
[3] Animal Production Department Faculty of Agriculture, Assiut University, Egypt

*** Corresponding author**
Soliman A.S.H

Received: 14/12/2022
Revised: 21/12/2022
Accepted: 21/12/2022
Published: 21/12/2022

Abstract

This work aims to investigate the impact of some antioxidants, i.e., zinc sulfate (ZnS) administration, vitamin E and selenium (E-Sel) injection on hematological parameters and thermoregulatory responses of Aberdeen Angus cows. Sixteen cows were randomly divided into 4 equal groups (4 cows each), First group served as a control (G1); second group was received E-Sel injection at rate of 15 ml/ head / 15day) (G2); third group was fed on ZnS with an average rate of 200 mg/head/ daily (G3) and the fourth one was fed on ZnS in combination with E-Sel injection (G4). All experimental cows were fed 60% of their requirements as CFM and the rest of other requirements was covered from wheat strew ad libitum. In addition, the AT and RH% were recorded during the experimental days to calculate the current THI. Blood samples were collected during experimental period from jugular vein. Physiological parameter measurements were recorded during the experimental days. The obtained results showed that the average values of THI were between 69.04 and 85.46 during the experimental period. Treated cows with E-Sel recorded the highest values of hematological parameters in terms of WBC, RBC, HB, HCT and PLT compared with other groups. Using antioxidant agents had significant decrease in RR, PR, and HT. While, slightly decrease in RT, ST and ET was recorded of experimental animal. It is concluded that some antioxidants could improve hematological parameters and thermoregulatory responses of Aberdeen Angus cows under hot climatic conditions.

Keywords: Antioxidant; hematological parameters; Thermoregulation; Aberdeen Angus.

Introduction

Climate change is altering the planet's ecosystems, that threatening the well-being of current and future generations. Governments strive to keep the increases in global temperature below 2^{O} C and avoid climate change. After a long tracking of the global average temperature (from 1901 to 2001), it was noted that the earth is warming. The global average AT has increased by about 0.8 °C along 100 years. The temperature increase began in 1910, and then highly increased in the 2000s **(IPCC 2013).** Systems of Animal production will be challenged by the Expected global temperature increase of 1.5 °C between 2030 and 2050 (**Lima et al., 2022**). The main cause of the global average AT is the increase for GHG i.e., carbon dioxide, methane, and nitrous oxide **(Al-Ghussain, 2019).**

The changes in the weather during different seasons of a year will negatively influences the productivity, reproduction, lactation, and immunity. With increase in average productivity of livestock, the metabolic heat out-put increases increasing the animal susceptibility to heat stress and altering the cooling and housing requirement of the livestock **(Kalmath and Swamy, 2019).** New Valley governorate is in western desert between 25º; 42& 30º; 47 E longitude, 22º 30& 29º 30N latitude and lies 77.8 m altitude above the sea level. The climatic condition of this area is dry and arid. Rainfall is almost negligible and the AT ranges from 46°C during summer days to 8 °C during winter nights (**Nasreldin et al., 2020; Kassab et al., 2021**).

Recently, antioxidants, i.e., vitamin E, and C and some micronutrients i.e., selenium and zinc have been evaluated as nutrients to potentially reduce the negative effects of heat stress in farm animals **(Butt et al., 2019; Bordignon et al., 2019; Kassab et al., 2020; Janampet et al., 2021; Sultana et al., 2022).** Vitamin E (Vit-E) is one of the most important antioxidants that protects against lipid peroxidation caused by free radicals and promotes oxidative stability of organisms due to its ability to protect polyunsaturated fatty acids from oxidation and scavenge free radicals **(Evstigneeva et al. 1998; Halliwell and Gutteridge 1999).** Selenium (Se) is an essential part of some antioxidant enzymes i.e., glutathione peroxidase. These enzymes can destroy lipid hydroperoxides and hydrogen peroxide **(Mustacich and Powis 2000).** Zinc (Zn) is one of the most important components of the antioxidant enzymes, a component of superoxide dismutase (SOD). It also induces synthesis of metallothionein, a metal binding protein that may scavenge hydroxide radicals **(Prasad et al., 2004).**

Materials and Methods

This trial was carried out at the department of animal production farm, Faculty of Agriculture, New Valley University, during summer season.

Experimental Design

Sixteen healthy Aberdeen Angus cows (460-520 kg body weigh) were used in this study. The animals were divided randomly in to four equal groups (4 animals each). Animal groups were control (G1), E-Sel (G2), ZnS (G3), and E-Sel plus ZnS (G4). All cows were fed on basal diet to meet their nutrient requirements according to NRC (2000) recommendations for Beef cattle. The basal diet consists of 60% CFM and 40% wheat straw and the chemical composition are shown in Tables 1 and 2. Cows in first group (G1) were fed a basal diet without any supplementation while, cows in second group (G2) were intramuscular injected every week for 90 days with 15 ml viteselen. Each 1 ml of viteselen contains vitamin E, 150 ml acetate and 1.67mg sodium selenite. The third group (G3) fed daily with ZnS 200 mg/heed/day. While the fourth group (G4) was fed daily with ZnS 200mg/head/day and injected every week with E-Sel.

Meteorological Measures

Air temperature and RH% were recorded during experimental days using **(**Temperature /Humidity Temperature thermometer**)** at 2 p.m. and 10 p.m. THI was calculated according to **Mader et al. (2006)** as following THI = (0.8 × Ta) + [(RH/100) × (Ta–14.4)] + 46.4 Where; Ta °C is the ambient temperature (°C), and RH is the relative humidity (RH %) /100.

Blood Hematological Parameters

About 2 ml blood was collected from each cow in anticoagulant tube (EDTA) for the hematological parameters through jugular venipuncture at 8:00 a.m. at day 0, 30, 60, and 90 of the experimental periods. Anti-coagulated blood was analyzed for the number of white blood cell (WBC) count, lymphocytes (LYM), granulocytes (GRAN), monocytes (MID), red blood cell (RBC) count, hemoglobin concentrations (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and PLT, were calculated by an automatic hematology cell counter (Dirui Bcc-3600).

Thermoregulatory Responses

Respiration rate (RR) was determined per 15 day (about 2 weeks) by counting the flank movements for a minute (breath / min). Pulse rate (PR) was determined per 15 days. PR and RR were counted before measuring the body temperature. Rectal temperature (RT, °C) was measured using a clinical thermometer inserted gently into the rectum for one minute. Skin temperature (ST, °C), hair temperature (HT, °C) and ear temperature (ET, °C) were measured using portable infrared thermometer produced by RadioShack Company designed for temperature measurements.

Statistical Analysis

The data were analyzed using a completely randomized design with the GLM procedure of the statistical program SAS/STAT 9.1 (SAS, 2004). The differences among treatments were tested using Duncan's Multiple Range Test (Duncan, 1955).

The model used was $Yij = U + A_j + E_{ij}$

Y_{ij} = Observation traits, U = Overall mean, A_j = Experimental treatment and E_{ij} = Random error

Results

Meteorological Measures

In the current study the THI values were between 79.43 to 85.46 at 02:00 p.m. and 69.04 to 74.14 at 10:00 p.m. during the experimental period (Figure 1).

Blood Hematological Parameters

The results of hematological parameters are shown in Table (3). The number of WBC, LYM HGB concentration, HCT, MCV and MCH in the E-Sel group cows were statistically higher than the other group ($P<0.05$). There was no difference between treatments on, MID, GRAN, MCHC and RBC ($P<0.05$). Dietary zinc had no statistically significant differences on hematological parameters vs control group.

Thermoregulatory Responses

Data in Table (4) showed that using antioxidants led to decrease rectal temperature, skin temperature, and ear temperature, but the differences were not significant. While caused a significant decrease ($P<0.05$) in hair temperature, pulse rate, and respiration rate in the treated animal. These results showed that using antioxidant alleviated the thermoregulatory responses to heat stress in Aberdeen Angus cows.

Discussion

Meteorological Measures:

Temperature humidity index (THI) values of less than 72 is normal, while the THI value of 72 to 78 is mild heat stress, a THI values of 79 to 88 is considered as moderate heat stress, THI values of 89-98 is severe heat stress and the above of 98 is considered as emergency **(Armstrong, 1994)**. The THI values in current study agree with **Kassab et al. (2017)** who reported that the values of THI during summer season in New Valley recorded between 75.39 to 82.12, these results indicating that animals were between mild and moderate heat stress. Likewise, The THI values were between 70.08 to 74.78 at 08:00 a.m. and 75.33 to 83.01 at 02:00 p.m. in the New Valley governorate during summer season indicating that animals in mild stress at 08:00

a.m. moderate stress at 2:00 p.m. **(Kassab et al., 2021).** The present data showed that animals were under moderate stress zone at 2:00 p.m. and mild heat stress at 10:00 p.m. according to **Armstrong (1994)**.

Blood Hematological Parameters:

The results in the present study showed that the average values of white blood cell and lymphocytes of cows injected with E-Sel was significant ($P<0.05$) higher than other treatments, while granulocytes and monocytes did not exhibit any significant differences. It has been explained that the higher leucocytes and lymphocyte cell counts due to E-Sel administration could be related to the protection of cell membrane and intracellular organelles by the effects of E-Sel and thus increase their lifespan **(Moeini and Jalilian, 2014).** Similar response of leukocytes counts to E-Sel was also found in adult buffaloes **(Qureshi et al., 2001),** Friesian heifers **(Suwanpanya et al., 2007);** and dairy calves **(Mohri et al., 2005).** The increase in blood lymphocyte populations may be a good indicator of an immunomodulatory response **(Qureshi et al., 2001).** Moreover, cows in E-Sel group had higher ($P<0.05$) concentration of HGB than other treatments, these results supported the positive effect of E-Sel supplementation on blood hematology as reported in earlier studies in sheep (**Makkawi et al., 2012**), cows (**Mohri et al., 2005**) and buffaloes (**Qureshi et al., 2001**).

In the present study, some hematological parameters were positively changed up because of E-Sel treatment, which may point out the active metabolism and biological oxidation effects on the cellular base that might lead to availability of metabolites needed for tissue growth. The significant increase in blood HGB due to injection of E-Sel agree with the results reported in dairy cows (**Mohri et al., 2005**), and Ossimi lambs (**Soliman et al., 2001**).

Thermoregulatory Responses:

The positive effect of antioxidants, i.e., ZnS and E-Sel to heat-stressed cows was clear when the temperature was increased as compared with control group, which lowering the values of RT, RR, and PR. Hence, we accepted the hypothesis that antioxidant can reverse some of the adverse effects of heat stress on productive performance and physiological responses to stressed animal.

General homeostatic responses to heat stress in animals included elevated heart rate and respiratory rate, decreased feed intake, sweating, panting, and drooling **(Silanikove, 1992).** Our study's results indicate there was no significant difference in RT among the experimental groups. In addition, animals in the control group were unable to dissipate heat efficiently due to the high THI, result an increase in RT. Although the mechanism by which E-Sel and ZnS lowered RT in the treated animals was not investigated in this study, it may be through antioxidant mechanism involving the enhancement of synthesis of glutathione (**Newsholme et al., 2003 and Hsu et al., 2012**), a very potent endogenous antioxidant molecule.

Interestingly, the RR and PR were significantly reduced by the antioxidant, which may be explained by the beneficial effects of antioxidant on the cardiac autonomic nervous system. Moreover, our results indicate no significant variation in skin temperature in any of the experimental groups.

Conclusions

In conclusion, the present results declare that supplementation with antioxidant (Vitamin E & Se and zinc sulfate) had beneficial effect on some hematological parameters and thermoregulatory responses especially hair temperature, pulse rate, and respiration rate of Aberdeen Angus cows under New Valley hot climatic conditions. In addition, antioxidant supplementation was effective to ameliorate the harmful effects of thermal stress.

Acknowledgments

We would like to express our hearty - appreciation, sincere thanks for the staff of animal production department, faculty of agriculture, New Valley University for all the offered facilities, significant help, and encouragement.

Conflicts of Interest/ Competing Interest

The authors declare that they have no competing interests.

Ethical Statement

All the experimental procedures and the study protocol have been approved by the National Animal Care and Use Committee, and the experiments were performed in accordance with the internationally accepted standard ethical guidelines for animal use and care according to **National Research Council (2010).**

Abbreviations

ET	Ear temperature
HT	Hair temperature
MCH	Mean corpuscular hemoglobin
MCHC	Mean corpuscular hemoglobin concentration
MCV	Mean corpuscular volume
PR	Pulse rate
RBC	Red blood cell
RH	Relative humidity
RR	Respiration rate
RT	Rectal temperature
THI	Temperature humidity index
WBC	White blood cell

Table (1): Ingredients of concentrate feed mixture (CFM)

Items	%
Yellow Corn%	55.0
Wheat bran%	21.5
Soyabean meal%	20.0
Limestone %	1.50
Dicalcium phosphate%	0.50
Yeast %	0.20
Bicarbonate %	0.30
Sodium chloride %	1.00

Table (2): Chemical composition of concentrate mixture and wheat straw (on DM basis).

Item	DM	OM	CP	CF	Fat	Ash	NFE
Concentrate mixture	88.76	93.79	15.76	14.12	2.39	6.21	61.52
Wheat straw	90.35	89.05	1.79	38.71	1.12	10.95	47.43

DM: Dry Matter, CP: Crude Protein, CF: Crude Fiber, NFE: Nitrogen Free Extract

Table (3): Effects of antioxidants supplementation on hematological parameters.

Parameter	Control Means+ *SEM*	E-Sel group Means+ *SEM*	ZnS group Means+ *SEM*	E-Sel &ZnS group Means+ *SEM*	Sign
WBC (10^3/µl)	8.18±1.35^{b}	11.13±1.44^{a}	8±1.15^{b}	8.88±1.89^{ab}	*
LYM (10^3/µl)	2.78±0.24 ^{b}	4.01±0.43^{a}	3.1±0.34 ^{ab}	2.88±0.33^{b}	*
MID (10^3/µl)	1.07±0.15	1.57±0.24	1.14±0.13	1.18±0.22	NS
GRAN (10^3/µl)	4.33±1.15	5.55±1.27	3.76±0.89	4.83±1.48	NS
RBC (10^6/µl)	6.59±0.24	6.94±0.38	6.44±0.26	6.84±0.19	NS
HGB (g/dl)	10.73±0.36^{b}	12.84±0.81^{a}	10.65±0.37^{b}	11.63±0.39 ^{ab}	**
HCT %	30.38±1.04^{b}	34.99±1.95^{a}	28.53±1.06^{b}	31.67±1.08 ^{b}	**
MCV (fl)	43.09±1.68^{b}	50.37±0.29^{a}	42.76±1.63^{b}	48.21±0.97 ^{a}	**
MCH (pg)	16.58±0.4^{bc}	18.52±0.43^{a}	15.92±0.45^{c}	17.78±0.64 ^{ab}	**
MCHC (g/dl)	36.73±0.8	37.33±0.27	35.44±0.57	36.79±0.66	NS

a-b-c the means placed at the rows with different superscript letters are significantly different (P > 0.05).

Table (4): Effects of antioxidant supplementation on thermoregulatory responses.

Parameter	Control Means+ *SEM*	E-Sel group Means+ *SEM*	ZnS group Means+ *SEM*	E-Sel &ZnS group Means+ *SEM*	Sign
RT (ºC)	38.79 ± 0.07	38.73 ± 0.35	38.73 ± 0.05	38.59 ± 0.04	NS
RR *(breath/min)*	37.67 ± 0.96 ^{a}	34.80 ± 1.01 ^{b}	37.30 ± 1.26 ^{ab}	34.67 ± 1.03 ^{b}	*
PR *(beat/min.)*	54.90 ± 1.18 ^{a}	53.13 ±.016 ^{ab}	54.10 ± 1.12 ^{ab}	52.23 ± 1.25 ^{b}	*
ST (ºC)	33.66 ± 0.26	33.53 ± 0.26	33.47 ± 0.27	33.34 ± 0.24	NS
HT (ºC)	32.92 ± 0.26 ^{a}	32.46 ± 0.31 ^{b}	32.73 ± 0.28 ^{ab}	32.45 ± 0.3 ^{b}	*
ET (ºC)	35.48±0.14	35.38 ± 0.19	35.27±0.14	35.21±0.13	NS

a-b the means placed at the rows with different superscript letters are significantly different (P > 0.05); SEM, standard error of the means.

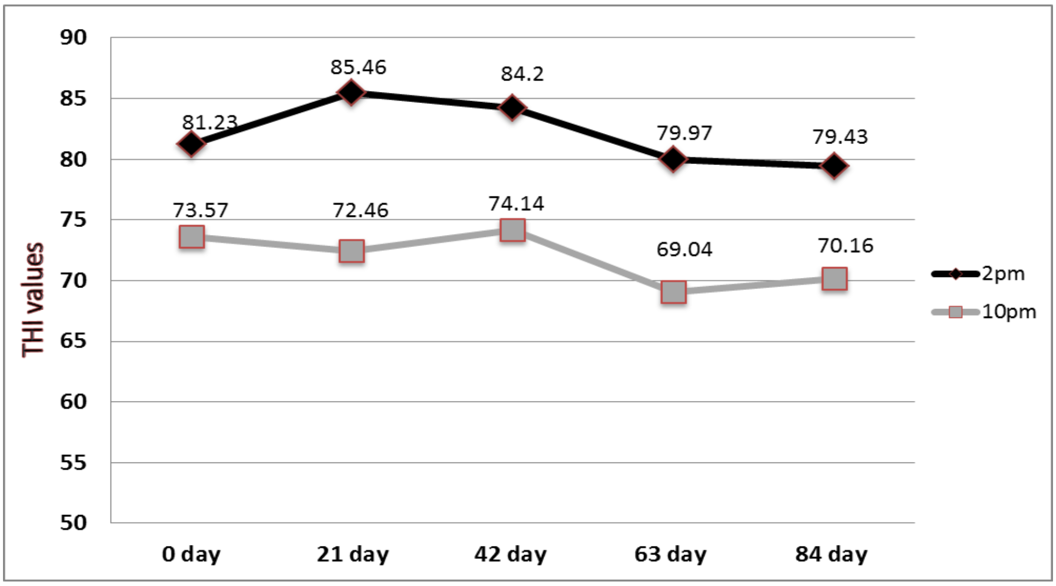

Figure 1: Temperature humidity index (THI) during the experimental period.

References

Al-Ghussain, L. (2019). Global warming: Review on driving forces and mitigation. *Environmental Progress & Sustainable Energy*, *38*(1), 13-21.

Armstrong, D. (1994). Heat stress interaction with shade and cooling. *Journal of dairy science*, *77*(7), 2044-2050.

Bordignon, R., Volpato, A., Glombowsky, P., Souza, C. F., Baldissera, M. D., Secco, R.,... and Da Silva, A. S. (2019). Nutraceutical effect of vitamins and minerals on performance and immune and antioxidant systems in dairy calves during the nutritional transition period in summer. *Journal of thermal biology, 84, 451-459.*

Butt, M. A., Shahid, M. Q., Bhatti, J. A., & Khalique, A. (2019). Effect of dietary vitamin e and selenium supplementation on physiological responses and reproductive performance in holstein Friesian bulls during humid hot summer. *Pak. Vet. J, 39, 593-597.*

Duncan, D. B. (1955). Multiple rang and multiple F test. Biometrics 11: 1- 42.

Evstigneeva RP, I. M. Volkov, V. V. Chudinova (1998) Vitamin E as a universal antioxidant and stabilizer of biological membranes. Membr Cell Biol 12: 151-172.

Halliwell B, and Gutteridge JMC (1999) Free radicals in biology and medicine. 3rd ed., Oxford University Press, New York.

Hsu, C. B., Lee, J. W., Huang, H. J., Wang, C. H., Lee, T. T., Yen, H. T., and Yu, B. (2012). Effects of supplemental glutamine on growth performance, plasma parameters and LPS-induced immune response of weaned barrows after castration. *Asian-Australasian journal of animal sciences, 25(5),* 674–681.

IPCC. (2013). Summary for policymakers. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA.

Janampet, R. S., Amaravadhi, S. C., Ramana, D. B. V., Thirunahari, R., Manthani, G. P., and Malisetty, V. (2021). Effect of Supplemental Chromium, Vitamin E and Selenium on Feed Intake, Production Performance and Cost Economics of Holstein Friesian Cows under Heat Stress. *Animal Nutrition and Feed Technology*, *21*(3), 509-521.

Kalmath, G. P., and M. N. Swamy (2019). Effect of antioxidants supplementation on plasma hormonal profiles in Hallikar cattle during different seasons. *Indian Journal of Animal Research, 53(1), 28-32.*

Kassab, A. Y., Hamdon, H. A., and Mohammed, A. A. (2017). Impact of probiotics supplementation on some productive performance, digestibility coefficient and phsiological responces of beef bulls under heat stress condations. *Egyptian Journal of Nutrition and Feeds*, *20*(1), 29-39.

Kassab, A. Y., Senosy, W., Hamdon, H., Daghash, H., and Soliman, A. (2020). Impact of antioxidant supplementation on metabolic status and reproductive performance of Aberdeen Angus cows during seasonal thermal stress in arid subtropical regions. *Egyptian J. Anim. Prod, 57(1),* 1-11.

Kassab, A., Hamdon, H., Daghash, H., and Soliman, A. (2021). Impact of Betaine Supplementation as Anti Stress on Some Hematological Parameters and Thermoregulatory Responses of Aberdeen Angus Cows in Arid Subtropical Regions. *New Valley Journal of Agricultural Science*, *1*(2), 89-97.

Lima, A. R. C., Silveira, R. M. F., Castro, M. S. M., de Vecchi, L. B., da Fernandes, M. H. M. R., and Resende, K. T. (2022). Relationship between thermal environment, thermoregulatory responses, and energy metabolism in goats: A comprehensive review. *Journal of Thermal Biology*, 103324.

Mader, T.L., M.S. Davis and T. Brown-Brandl (2006). Environmental factors influencing heat stress in feedlot cattle. *J. Anim. Sci., 84:712-719.*

Makkawi, A.A.; A. Hamra and S. B.El Abdalla (2012). Effects of vitamin E and selenium on leukocytic profile and reproductive performance in Awassi Ewes. *Minia International Conference for Agriculture and Irrigation in the Nile Basin Countries, El-Minia, Egypt.*

Moeini, M. M. and M. T. Jalilian. (2014). Effect of Selenium and Vitamin E Injection during late pregnancy on immune system and productive performances of Sanjabi ewes and their lambs. *Global J. Anim. Sci. Res. 2:210-219.*

Mohri, M., H. A. Seifi and J. Khodadadi. (2005). Effects of preweaning parenteral supplementation of vitamin E and selenium on hematology, serum protein, and weight gain in dairy calves. *Comp. Clin. Pathol., 14: 149-154.*

Mustacich, D and G. Powis (2000) Thioredoxin reductase. Biochem J 346: 1-8.

Nasreldin, N., Ewida, R. M., Hamdon, H., and Elnaker, Y. F. (2020). Molecular diagnosis and biochemical studies of tick-borne diseases (anaplasmosis and babesiosis) in Aberdeen Angus Cattle in New Valley, Egypt. *Veterinary World*, *13*(9), 1884.

Newsholme, P., Procopio, J., Lima, M. M. R., Pithon-Curi, T. C., and Curi, R. (2003). Glutamine and glutamate—their central role in cell metabolism and function. *Cell biochemistry and function*, *21*(1), 1-9.

NRC, (2000). Nutrient requirements of beef cattle. *7th edition, National Academies Press, Washington D. C.*

National Research Council, (2010). Guide for the care and use of laboratory animals.

Prasad A. S, B. Bao, F. W. Beck, O. Kucuk, and F. H. Sarkar (2004) Antioxidant effect of zinc in humans. Free Radic Biol Med 37: 1182-1190.

Qureshi, Z. I.; L. A. Lodhi; H.A. Samad; N.A. Naz and M. Nawaz. (2001). Hematological profile following immunomodulation during late gestation in buffaloes (Bubalis Bubalus). *Pak. Vet. J., 21: 148-151.*

SAS (2004). SAS/STAT 9.1 User's Guide. Statistical Analysis System. Institute, Inc. Cary., NC.

Silanikove, N. (1992). Effects of water scarcity and hot environment on appetite and digestion in ruminants – A review. *Livest. Prod. Sci. 30:175–194*

Soliman, E. B.; M. A. A. El-Barody and S. T. M. Fahmy (2001). Some physiological reactions of male lambs subject to vitamin E and selenium injection during summer conditions. *Assuit Vet. Med. J., 46: 210-225.*

Sultana, J. R., Chandra, A. S., Ramana, D. B. V., Raghunandan, T., Prakash, M. G., and Venkateswarlu, M. (2022). Effect of Supplemental Chromium, Vitamin E and Selenium on Biochemical and Physiological Parameters of Holstein Friesian Calves under Heat Stress. *Indian Journal of Animal Research*, *56*(8), 921-927.

Suwanpanya, N.; W. Wongpratoom, M. Wanapat, S. Aiumlamai, S. Wittayakun and C. Wachirapakorn (2007). The influence of bovine neutrophils on in vitro phagocytosis and killing of staphylococcus aureus in heifers supplemented with selenium and vitamin E. *Songklanakarin J. Sci. Technol., 29: 697-706.*