International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 9, Issue 51, 2017, pp.-4866-4868.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EVALUATION OF ANTIOXIDANT STATUS OF SURTI GOATS DURING SUMMER AND WINTER UNDER AN INTENSIVE PRODUCTION SYSTEM

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Received: November 07, 2017; Revised: November 12, 2017; Accepted: November 13, 2017; Published: November 18, 2017

Abstract- The present research work was conducted to study possible seasonal variations in the antioxidant status of Surti goats during summer and winter under an intensive production system. Eight adults clinical healthy female Surti goats were used. The meteorological variables like temperature and relative humidity were recorded on daily basis at 7.30 a.m. and 2.30 p.m. during the experimental period. At the same time, meteorological data for a decade (2004 – 2014) were collected for the estimation of temperature humidity index (THI). Blood samples were collected from the Surti goats at a weekly basis for the estimation of antioxidant status. The levels of Superoxide dismutase (SOD), Lipid peroxidase (LPO) and Glutathione peroxidase (GPx) significantly higher during summer than winter season and a positive correlation of these values with THI was found. However, antioxidants remained one fold higher in summer season as compared in winter. Antioxidant status of animal was more vulnerable in summer than in winter season. Levels of SOD, LPO and GPx were higher during summer than winter season, possibly indicating that animals were under stress during summer, although a well ventilated barn was provided.

Keywords- Antioxidants, Seasonal variation, Surti goats, Temperature humidity index.

Citation: Vasava A.A., et al., (2017) Evaluation of Antioxidant Status of Surti Goats during Summer and Winter under an Intensive Production System. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 9, Issue 51, pp.-4866-4868.

Academic Editor / Reviewer: Sharma Ravindra Nath, Dr Ajaykumar Sureshbhai Patel

Introduction

Climate change is a fact [1] and poses serious threats to animal husbandry in some areas of the world. Environment plays an important role in health status and production rates of animals. The variation in climatic variables like temperature, humidity and solar radiation could impair the development and the growth performance of all domestic livestock species.

Major effects on goat production have been greater nowadays due to the global warming and goat species are increasingly exposed to stressful thermal conditions worldwide. Hence, it is necessary to estimate goat production parameters under the present scenario of climate change, which adversely affects health, reproduction and production status of animals by altering the homeostasis. Goat is a short-day breeder ruminant [2] which is generally extensively reared and as a result experiences a variety of ecological challenges like wide variation in temperature, humidity and pathogenic invasions [3].

All the altered body responses *viz*., Physiological, haematological, biochemical and hormonal responses as a result of the increased environmental stress conditions but also due to common metabolic processes cause an increase in the levels of free radicals that are responsible for the poor condition of the immune system. Due to elevated level of apoptosis [4], mortality rates and production parameters could be negatively affected but reports are inadequate to describe the role of free radicals in the regulation of immunity.

Various stress conditions, like heat and cold, could lead to the production of reactive oxygen species (ROS) such as superoxide, peroxide, hydroxyl radical and singlet oxygen species. Reactive oxygen species damage biomolecules such as DNA/RNA and proteins, but also contribute in lipid peroxidation of membranes and disruption of normal cell metabolism [5]. Superoxide dismutase (SOD), Lipid peroxidase (LPO) and glutathione peroxidase (GPX) are important antioxidant enzymes. Antioxidants are the agents that significantly delay or inhibit oxidation of a substrate. The production of free radicals and their neutralization by antioxidants is a normal process of the organism. Ambient stress can reduce the antioxidant capacity of blood [6] resulting in oxidative stress. Antioxidant enzymes protect the cell against cellular oxidants and prevent their accumulation. Excessive production of reactive oxygen species inhibits the action of antioxidants and induces oxidative stress which suppresses the immune system and reduces productivity of animal [7].

There has been no study on the seasonal variation in the antioxidant status of adult Surti goats. Experiment was design to know how much impact occur because of oxidative stress to Surti goats during summer and winter at the Department of Veterinary Physiology & Biochemistry, College of Veterinary Science & Animal Husbandry, AAU, Anand, India.

Material and Method:

Ethical Committee Approval: The research was approved by the Institutional Animal Ethics Committee (IAEC, Project No.:200/VBC/2015).

The experiment was conducted during the seasons of summer (15/04/2015 to 14/06/2015) and winter (01/12/1015 to 31/01/2016) on eight adult clinical healthy female Surti goats reared at Instructional Livestock Farm complex, Department of Livestock Production Management, College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand, Gujarat 388001.

Anand town is situated in Middle Gujarat at 22°: 33' North latitude and 72°: 57' East longitude at an elevation of 39 m above the mean sea level with subtropical climate. On the basis of last 50 years (1956-2011) observation, the climatic

condition of Anand is cold and dry (Av. Temp is 27.81°C-32.40°C) during winter (mid-October to mid-February) and hot and dry (Av. Temp is 34.64°C-40.08°C) during summer season (mid-February to mid-June).

About 8 adult (age: 4 – 7 year) Surti goat were selected from the flock maintained at Instructional Livestock Farm Complex, Department of Livestock Production Management, College of Veterinary Science and AH, Anand Agricultural University, Anand. The experimental animals were separated from the flock only at the time of blood collection.

The meteorological variables like dry bulb temperature and relative humidity were recorded inside the experimental facility with the help of a Sling Psychrometer. It was recorded on daily basis at 7.30 a.m. and 2.30 p.m. during the experimental period. Meteorological data for a decade (2004-2014) were collected from the Department of Agricultural Meteorology, B. A. College of Agriculture, AAU, Anand. On the basis of dry bulb temperature and relative humidity, THI was calculated using following formula [8] :

$$THI = (0.8 \times T_{db}) + [(RH/100) \times (T_{db} - 14.4)] + 46.4$$

Where, T_{db}= Dry bulb Temperature; RH = Relative Humidity

Blood samples were collected in the morning at a weekly basis during summer and winter. Seven to eight ml of whole blood from each animal was collected aseptically from jugular vein and divided into three vacutainers i.e. K_3EDTA, heparinized and clot activator (for serum separation). Serum was separated by centrifugation at 3000 rpm for 15 minutes and stored at -20ºC until analyzed. Heparinized blood samples were used for the determination of the levels of the antioxidant enzymes superoxide dismutase and lipid peroxidase and the remaining blood sample was centrifuged at 3000 rpm for 15 min for separation of plasma and stored at -20ºC until analyzed for glutathione peroxidase.Superoxide dismutase was estimated according to the method described by Madesh and Balasubramanian [9],lipid peroxidase was determined in terms of malondialdehyde (MDA) production by the method of Rahman[5] and glutathione peroxidase was estimated using a Calbiochem (Merck, Germany) Glutathione Peroxidase assay kit.

Statistical analysis:

Statistical analysis was performed using completely randomized design through SPSS Software. The model used for analysis was Yij= µ+Si+Eijwhere, Yijwas observation of dependent variable; µ was the population mean for the variable; Si was effect of season and Eijwas the random error associated with observation [10].

Results & Discussion:

Temperature humidity index is an important factor for measuring the environmental stress of animals during different seasons. The values of THI during last decade are presented in [Table-I] and during experimental period presented in [Table-II]. THI values during summer and winter for the last decade were 82.09±0.48 and 66.14±0.38, respectively, while the respective values during the experimental period were 82.55±1.22 and 59.36±2.24.

Table-I *Effect of season (summer or winter) on THI values during 2004 -2014 (means±s.e.m.)*

	Summer			Winter		
Year	7.30 am	2.30 pm	Average	7.30 am	2.30 pm	Average
2004	78.15	84.68	81.42	55.17	73.22	64.20
2005	77.69	85.20	81.45	54.02	73.37	63.70
2006	78.34	84.32	81.33	59.60	75.20	67.40
2007	79.17	84.91	82.04	59.93	75.06	67.09
2008	77.48	82.66	80.07	58.66	74.92	66.79
2009	78.21	84.04	81.13	57.72	74.65	66.19
2010	79.85	84.91	82.38	57.52	74.41	65.96
2011	78.98	85.28	82.13	57.20	75.65	66.42
2012	78.92	84.80	81.86	56.88	76.90	66.89
2013	79.30	93.51	86.41	57.95	77.47	67.71
2014	79.86	85.68	82.77	56.45	73.86	65.16
Mean±SE			82.09±0.48 *			66.13±0.38

Value having ' * ' as superscript is defer significantly (P <0.05) between seasons (summer and winter)

Table-II *Effect of season (summer or winter) on THI values during the experimental period (means±s.e.m.)*

Week	Summer			Winter		
	7.30 am	2.30 pm	Average	7.30 am	2.30 pm	Average
1	76.17	84.31	80.24	57.64	67.81	62.72
2	75.90	83.74	79.82	55.15	64.55	59.85
3	79.16	87.54	83.35	50.24	61.52	55.88
4	78.04	84.75	81.40	50.92	61.70	56.31
5	79.60	86.08	82.84	55.69	68.70	62.20
6	81.44	87.09	84.27	54.81	66.47	60.64
7	82.09	87.63	84.86	55.99	65.89	60.94
8	82.11	87.54	84.82	47.17	61.33	54.25
9	80.44	82.34	81.39	54.75	68.08	61.42
Mean ±SE			**82.55±1.52***			**59.36±2.24**

Value having ' * ' as superscript is defer significantly (P <0.05) between seasons (summer and winter)

Temperature humidity index of 65 or less is considered within the comfort zone of animals; up to 72 as a critical and 74 to 83 is associated with a severe stress zone [11]. During the present study, the temperature humidity index was between 74 and 83 during summer, values that correspond to the severe stress zone. Thus, the obtained climatic data revealed that Surti goats experienced severe heat stress during summer.

Levels of antioxidant enzymes such as SOD, LPO and GPx were significantly (P<0.05) increased during summer (6.04±0.05, 4.27±0.02 and 97.15±0.11, respectively) compared to winter (5.00±0.05, 3.47±0.02 and 74.25±0.13, respectively) [Table-III]. A positive correlation of antioxidant enzymes levels with THI was found (r = 0.88, 0.86 and 0.97, respectively; P<0.01).

Table-III *Effect of season (summer or winter) on the concentration of SOD, LPO and GPxantioxidant enzymes during the experimental period (means±s.e.m.)*

Parameters	Season		SEm	CD (0.05)	CV %	P Level
	Summer	Winter				
Superoxide dismutase (SOD) (U)	6.04±0.05*	5.00±0.05	0.06	0.17	9.30	P<0.05
Lipid peroxidase (LPO) (nmol of MDA/ml of pack cells	4.27±0.02*	3.47±0.02	0.02	0.07	5.93	P<0.05
Glutathione peroxidase (GPx) (U/ml)	97.15±0.11*	74.25±0.13	0.23	0.64	2.29	P<0.05

Value having ' * ' as superscript is defer significantly (P <0.05) between seasons (summer and winter)

SEm = Standard Error Mean

CD = Critical Difference (P<0.05)

CV % = Coefficient of Variation

A significant increase in SOD, LPO and GPx was observed which indicates increased production of the free radical in summer season in Surti goats. However, the values of the antioxidant parameters in the summer season was significantly higher than the winter season indicating that summer is more stressful to Surti goats.

Superoxide dismutase is responsible for the quenching of superoxide radicals which are released during the chemical reactions of the various metabolic pathways and its higher concentration in the serum is an indicator of oxidative stress [12]. The higher SOD activity in surti goats during summer was probably a response to higher level of superoxide produced by these animals, since superoxide dismutase catalyzes the dismutation of superoxide to oxygen and hydrogen peroxide. Thus, a higher SOD activity leads to increase in hydrogen peroxide level in the cells which is metabolized by GPx[13] that protects the organism against deleterious effects of free radicals.

High ambient temperature increases oxidative stress by increasing lipid peroxidation and decreasing antioxidant defence [14]. LPO in the form of MDA production was found to be higher in the summer season. Thiobarbituric acid reactive substances is also an indicator of LPO which was also found to increase

in summer season in cows[15]. Peroxidase is a hemoprotein catalyzing the oxidation by hydrogen peroxide of a number of substrates. Peroxidase activity is considered as the main indicator of the antioxidant activity.

GPx reacts with peroxides and requires glutathione (GSH) as the reductive substance donating an electron. Glutathione reduces oxygen toxicity by preventing O2-formation. In the present study, increased levels of GPx were also observed, possibly due to the glutathione-associated metabolism that plays an important role for the cellular protection against oxidative stress generating agents.

Extreme ambient temperature causes high levels of stress resulting in increased antioxidant values (SOD, LPO and GPx*etc.*) to scavenge the elevated levels of free radicals [16,17].

Conclusion

It was concluded that environmental stress was able to induce marked changes in the levels of serum biomarkers in an order to evoke physiological defence. Antioxidant status of animal was more vulnerable in summer than in winter season. However, further studies are needed to elucidate the tolerance level exhibited by goats.

Authors' Contributions:

This study was a part of Dr. Vasava original research work during M.V.Sc thesis programed. Dr. Pande has designed the plan of work. Dr. Rathwa helped during sample collection and laboratory analysis. Dr. Pathan and Dr. Madhira helped in statistical analysis and manuscript preparation. Dr. Wadhwani provided animals and farm equipment. All the authors read and approved the final manuscript.

Acknowledgement:

The study was performed as part of the M.V.Sc research work and was funded by the College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, Gujarat 388001. The authors are thankful to Department of Livestock Production Management, Department of Reproductive Biology Research Unit, and Department of Agriculture Statistics, Anand Agricultural University, Anand, Gujarat 388001.

Ethical Committee Approval: The research was approved by the Institutional Animal Ethics Committee (IAEC, Project No.:200/VBC/2015).

Conflict of Interest: None declared

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