

Effect of Taurine and Sex on oxidative status of West African dwarf Sheep

Atte, P.O., Zahraddeen, D., Abdulrashid, M and Daudu, O.M

Department of Animal Science, Faculty of Agriculture. Ahmadu Bello University, Zaria

*Corresponding author: olaiyanikemi@yahoo.com 07033718565



Abstract

Several studies have been carried out on the oxidative status of West African Dwarf (WAD) sheep as influenced by series of antioxidants. However, not much is documented on the use of taurine as an antioxidant. Thirty two WAD sheep involving both sexes (16 ewes and 16 rams) with an average weight of 12kg were fed taurine supplemented diets and evaluated in a Completely Randomized Design involving four dietary treatments with four replicates of two animals each containing 0, 0.5, 1 and 1.5% levels of inclusion of taurine. The study was carried out during the wet (July-October) and dry (January-April) seasons. Blood sample was collected and the following oxidative parameters were analyzed; catalase (CAT), superoxide dismutase (SOD), glutathione-S-transferase (GST) and glutathione peroxidase (GPX). The result shows CAT activity increases significantly ($P<0.05$) with 1.5% inclusion level having the highest activity (107.08U) while the control had the least (100.81U/mL). The least value of SOD (5.14U/mL) was recorded in animals fed the 0% dietary taurine while animals fed 1.5% had the highest activity (9.87U/mL). GST activity increases significantly ($P<0.05$) from 1.03 U/mL (0%) to 4.68U/mL (1.5%). The GPX varied from 1.14U/mL (0%) to 2.89U/mL (1.5%). CAT (108.61U/mL) is significantly ($P<0.05$) higher in ram compared to ewe (99.59U/mL). SOD (7.87U/mL) activity was higher in the ewe compared to ram (6.51U/mL). In addition, GST activity was higher in ram (3.06U/mL) compared to ram (1.95U/mL). GPX activity was not influenced by sex. It was concluded from this study that taurine supplemented diet had better antioxidant defense mechanism and significant effect on the sex of investigated WAD sheep. It was recommended that diet of WAD sheep could be supplemented with taurine for higher oxidative stability and protection against tissue damage.

Keywords: Taurine, sex, oxidative status, antioxidant and supplementation



Effet De La Taurine Et Du Sexe Sur Le Statut Oxydatif Des Moutons West African Dwarf

Résumé

Plusieurs études ont été menées sur le statut oxydatif des moutons West African Dwarf (WAD) tel qu'il est influencé par une série d'antioxydants. Cependant, peu de choses sont documentées sur l'utilisation de la taurine comme antioxydant. Trente-deux moutons WAD impliquant les deux sexes (16 brebis et 16 béliers) d'un poids moyen de 12 kg ont été nourris avec des régimes enrichis en taurine et évalués dans un plan complètement randomisé impliquant quatre traitements alimentaires avec quatre répétitions de deux animaux contenant chacun 0, 0,5, 1 et 1,5% niveaux d'inclusion de taurine. L'étude a été réalisée pendant les saisons humides (juillet-octobre) et sèches (janvier-avril). Un échantillon de sang a été prélevé et les paramètres oxydatifs suivants ont été analysés ; catalase (CAT), superoxyde dismutase (SOD), glutathion-S-transférase (GST) et glutathion peroxydase (GPX). Le résultat montre que l'activité CAT augmente de manière significative ($P<0,05$) avec un niveau d'inclusion de 1,5 % ayant l'activité la plus élevée (107,08 U) alors que le contrôle en avait le moins (100,81 U/mL). La plus faible valeur de SOD (5,14U/mL) a été enregistrée chez les animaux nourris avec la taurine alimentaire à 0 %, tandis que les animaux nourris avec 1,5 % avaient l'activité la plus élevée (9,87U/mL). L'activité GST augmente significativement ($P<0,05$) de 1,03 U/mL (0 %) à 4,68 U/mL (1,5 %). Le GPX variait de 1,14U/mL (0 %) à 2,89U/mL (1,5 %). Le CAT (108,61U/mL) est significativement ($P<0,05$) plus élevé chez le bélier que chez la brebis (99,59U/mL). L'activité de SOD (7,87U/mL) était plus élevée chez la brebis que chez le bélier (6,51U/mL). De plus, l'activité de la GST était plus élevée chez le bélier (3,06 U/mL) que chez le bélier (1,95 U/mL). L'activité de la GPX n'était pas influencée par le sexe. Il a été conclu de cette étude que l'alimentation enrichie en taurine avait un meilleur mécanisme de défense antioxydant et un effet significatif. Il a été recommandé que le régime alimentaire des moutons WAD soit complété par de la taurine pour une meilleure stabilité oxydative et une protection contre les lésions tissulaires.

Mot-clé : Taurine, sexe, statut oxydatif, antioxydant et supplémentation

Introduction

The thermal conditions of the environment in the tropics is traumatic leading to production of many reactive oxygen species (ROS) which can lead to oxidative stress (Natasha *et al.*, 2017) and subsequently, to cell damage and obliteration (Rathwa *et al.*, 2017). Tightly controlled ROS generation appears to be one of the vital components in the mechanisms involved in cell function, growth, differentiation and death (Valko *et al.*, 2007). Maintaining physiological equilibrium between intracellular antioxidants levels and production of reactive oxygen species (ROS) is crucial for the survival of the organisms (Hayajneh *et al.*, 2016). Sex effect in various physiological responses has been established (Mondal and Reddy, 2017), Mondal and colleague reported that the average female has a larger surface to mass ratio, a smaller blood volume and comparatively more peripheral tissue compared to male equivalent, this may be responsible for variations in various physiological responses of the animal (Mondal and Reddy, 2017).

Antioxidant supplementation provides valuable effects against oxidative stress. Taurine, an example of antioxidant reduces the production of ROS which leads to improved mitochondrial function through increased mitochondrial electron transport chain; it also neutralizes any physiological challenges imposed on the animal as a result of season, sex or other related stresses (Schaffer *et al.*, 2014). The potent antioxidant properties of taurine is also associated with increased antioxidant enzyme activity; Superoxide dismutase (SOD), Catalase Glutathione S-transferases (GSTs) and Glutathione peroxidase (GSH-Px) are the key cellular antioxidant enzymes that defend against oxidative stress. This study is aimed at evaluating the effect of taurine and sex on oxidative status of West African dwarf sheep.

Materials and Methods

Experimental Site

The experiment was carried out at the Small Ruminant Unit of Kogi State Ministry of Agriculture, Kabba. Kabba is located within the Southern Guinea Savannah Zone on latitude 7°5'N, longitude 6°4'E and altitude of 640m above sea level. It has an annual rainfall of

1500mm and rain starts between late April and early May to October. The dry season begins around the middle of November, with cool weather that ends in February. This is followed by relatively hot-dry weather between March and April just before the rain begins. The minimum daily temperature is from 14°C to 20°C during the cool season while the maximum daily temperature is from 19°C to 40 °C during the hot season. The mean relative humidity during dry and wet seasons is 21% and 72%, respectively (Kabba College of Agriculture Metrological Section, 2018).

Experimental Diets

Diets were formulated to meet the nutrient requirements for sheep (Table 1). Taurine was supplemented at 0, 0.5, 1.0 and 1.5 levels respectively. Experimental animals were fed at 3% of their body weight and drinking water was provided daily *ad libitum*.

Table 1: Experimental Diets

Ingredients	Levels of inclusion (%)
Maize offal	78.0
Soya bean cake	6.5
Groundnut cake	8.6
Oil	5.0
Limestone	1.5
Salt	0.4
Metabolizable Energy (Kcal/kg)	2800

Experimental Design and Management of Animals

A total of 32 WAD sheep (16 rams and 16 ewes) were purchased from the open market within Kabba and used for this experiment. The sheep were 6 to 8 months old with an average body weight of 12kg. On arrival they were given prophylactic treatment and quarantined for two weeks during which they were treated against ecto-parasite using Diasentol® and dewormed with Albendazole® (2.5% oral suspension) per kg body weight. Experimental diets were fed immediately after acclimatization and were divided into four treatments groups with four replicates, consisting of a ram and an ewe per replicate in a 4×2 factorial arrangement, in a Complete Randomized Design. The trial was conducted during the rainy season from July to October, and during the dry season from January to April.

Determination of Oxidative Stress Marker

Blood samples were collected via the jugular vein puncture (Frandsen, 1986). Blood samples were collected into anticoagulant free bottles from which serum was harvested for oxidative stress marker analysis. The Superoxide dismutase (SOD) was estimated by the method of Marklund and Marklund (1974) adopted by Soon and Tan (2002). Catalase (CAT) was estimated by the method of Beers and Sizer (1952). Glutathione peroxidase (GPX) activity was determined by the method of Rotruck *et al.* (1973) and Glutathione S-transferases (GSTs) was estimated by the method of Habig *et al.* (1974)

Statistical Analysis

All data obtained were statistically analyzed using the Analysis of Variance (ANOVA) procedure of SAS (2002) while the significant differences in means were separated using pair wise difference of the same software.

Results and Discussion

Oxidative Stress Marker of WAD Sheep Fed Graded Levels of Dietary Taurine

The results of the oxidative stress marker of WAD sheep fed graded levels of dietary taurine are shown in Table 2. The results show that dietary treatments had significant ($P < 0.05$) effect on all the antioxidants parameters considered. The supplemented diets were generally better than that of the control diet. The CAT activity increases significantly ($P < 0.05$) as supplementation increases with the 1.5% inclusion level having the highest activity (107.08U/mL) while the control had the least activity (100.11U/mL). In agreement with the present finding, Liu *et al.* (2016) observed that taurine supplementation significantly increased

CAT activity as level of taurine application increases. There was significant ($P < 0.05$) increase in SOD activity as supplementation increases. The least value (5.09U/mL) was recorded in animals fed the control diet while animals fed 1.5% dietary taurine had the highest value (9.87U/mL) of SOD. Similar finding was observed in damaged brain cells (Liu, 2016) where SOD activity improves as the rate of taurine dosage increases. It also corroborates other studies; Yin *et al.* (2015) and Yusuf *et al.* (2019) also reported significant increased in SOD activities of goats supplemented with an antioxidant (selenium). Schaffer *et al.* (2014) observed that taurine increases antioxidant activity by reducing superoxide production, which leads to improved mitochondrial function through increased mitochondrial electron transport chain.

There was a tremendous increase in activity of GST in sheep fed taurine supplemented diets as the level of taurine increases, its concentration increases significantly ($P < 0.05$) from 1.03 U/mL (0%) to 4.68U/mL (1.5%). This observation agrees with the result obtained by Liu *et al.* (2016) who reported an increase in GST activity as taurine doses increase in damaged brain cells. Yusuf *et al.* (2019) reported that elevated GST levels have been associated with increased resistance to oxidative damage. The activity of GPX increases significantly ($P < 0.05$) as the level of taurine increases from control to 1.5% inclusion (1.13, 1.49, 2.59 and 2.83U/mL). This agreed with the findings of Zejuzhang (2014) that taurine supplementation significantly increased GPX activity as supplementation increases in an iron loaded mice.

Table 2: Oxidative Stress Marker of WAD Sheep Fed Graded Levels of Dietary Taurine

Parameters	Levels of taurine (%)				SEM	P - value
	0	0.5	1.0	1.5		
Catalase (U/mL)	1.1	104.75 ^b	105.89 ^b	109.00 ^a	7.89	0.04
Superoxide dismutase (U/mL)	5.09 ^c	6.51 ^b	7.10 ^b	9.87 ^a	4.83	0.03
Glutathione-S-transferase (U/mL)	1.03 ^c	1.60 ^b	2.79 ^b	4.68 ^a	1.84	0.03
Glutathione peroxidase	1.13 ^b	1.49 ^b	2.59 ^a	2.83 ^a	1.36	0.04

^{abc}: means with different superscript in the same row are significantly ($P < 0.05$) different, SEM - standard error of mean.

Effect of Sex on Oxidative Stress Marker of WAD Sheep Fed Graded Levels of Dietary Taurine

Effect of sex on oxidative stress marker of WAD sheep fed graded levels of dietary taurine is presented in Table 3. The CAT was significantly higher ($P < 0.05$) in ram compared to ewe. This was contrary to the report of Luo *et al.* (2016) who reported catalase activity levels were found to be higher in the female mice compared to male. However, Marin *et al.* (2017) findings showed no difference in catalase activity levels between male and female rats. The SOD was statistically ($P < 0.05$) higher in rams compared to ewe, and this report corroborate the findings of (Luo *et al.*, 2016) who reported that brain and lung SOD activity levels were higher in male mice than female. However, in another study, female rats were found to have higher SOD activity levels in the pancreas than the male rats (Enciso *et al.*, 2018).

There was significant ($P < 0.05$) increase in concentration of GSTs in the rams compared to the ewe. This agreed with the report of Yusuf *et al.* (2019) that free radicals are in lower amount in mitochondria of females than males due to higher antioxidant enzymes. The GPX activity was significantly higher ($P < 0.05$) in ram compared to ewe. Several studies also reported that GPx activities were lower in females compared to males (Luo *et al.*, 2016, Marin. *et al.*, 2017 and Yusuf *et al.*, 2019).

Table 3: Effect of Sex on Oxidative Stress Marker of WAD Sheep Fed Graded Levels of Dietary Taurine

Parameters	Sex		SEM	P.- value
	Ram	Ewe		
Catalase (U/mL)	108.61 ^a	99.59 ^b	1.65	0.02
Superoxide dismutase (U/mL)	7.87 ^a	6.51 ^b	1.20	0.03
Glutathione-S-transferase (U/mL)	3.06 ^a	1.95 ^b	0.70	0.03
Glutathione peroxidase (U/mL)	1.76	1.66	0.68	0.04

^{ab}- means with different superscript in the same row are significantly ($P < 0.05$) different, SEM - standard error of mean.

Conclusion

It was concluded from this study that WAD sheep fed taurine supplemented diet had better antioxidant defense mechanism. Also, taurine

had significant effect on the sex of investigated WAD sheep.

Recommendation

It is recommended that, for higher oxidative stability and protection against tissue damage, diets of WAD sheep could be supplemented with taurine

References

- Beers, R. F. and Sizer, I. W. 1952. A spectrophotometric method for measuring the breakdown of hydrogen peroxide by catalase. *Journal of Biological Chemistry*, 195(1): 133 – 140
- Enciso, J. M., de Cerain, A. L., Pastor, L., Azqueta, A. and Vettorazzi. 2018. A. Is oxidative stress involved in the sex-dependent response to ochratoxin A renal toxicity? *Journal of Food and Chemical Toxicology*. 116:379–387.
- Fradson, R. D. 1986. Anatomy and Physiology of Farm Animals. Lea and Fabiger, Philadelphia, USA. Pp 174 – 189.
- Habig, W. H., Pabst, M. J. and Jakoby, W. B. 1974. Glutathione S-transferases. The first enzymatic step in mercapturic acid formation. *Journal of Biological Chemistry*. 249 (22):7130–7139.
- Hayajneh, F. M. F., Abdelqader, A. and Irshaid, R. A. H. 2016. Effects of pregnancy and disease stress on the antioxidative capacity of sheep and goat. *Journal of Experimental Biology and Agricultural Sciences*. 4(5): 605 – 609.
- Liu, F., Cottrell, J. J., Furness, J. B., Rivera, L. R., Kelly, F. W., Wijesiriwardana, U., Pustovit, R.V., Fothergill, L. J., Bravo, D. M. and Celi, P. 2016. Selenium and vitamin E together improve intestinal epithelial barrier function and alleviate oxidative stress in heat-stressed pigs. *Journal of Experimental Physiology*. 101:801–810.
- Luo, Z., Zhu, W., Guo, Q., Luo, W., Zhang, J., Xu, W. and Xu, J. 2016. Weaning Induced Hepatic Oxidative Stress, Apoptosis, and Aminotransferases through MAPK Signaling Pathways in Piglets. *Journal of Oxidative Medicine and Cellular Longevity*, 16:1–10.

- Marin, D. E., Pistol, G. C., Gras, M. A., Palade, M. L. and Taranu, I. 2017.** Comparative effect of ochratoxin A on inflammation and oxidative stress parameters in gut and kidney of piglets. *Journal of Regulatory Toxicology and Pharmacology*, 89:224–231.
- Marklund, S. and Marklund, G. 1974.** Involvement of the superoxide anion radical in the autoxidation of pyrogallol and a convenient assay for superoxide dismutase. *The FEBS Journal*, 47(3):16 – 17
- Mondal, S., and Reddy, I. J. 2017.** Impact of climate change on livestock production. In *Biotechnology for Sustainable Agriculture: Emerging Approaches and Strategies*, Pp.234–256.
- Natasha, I., Mariapaola, C. Giovanni, P. Federica M., Vincenzo, A., Francesco S. and Domenica, A. 2017.** Selenium: the superoxide anion radical in the autoxidation of pyrogallol and a 3.Oxidative Stress: Harms and Benefits for Human Health. *Journal of Oxidative Medicine and Cellular Longevity*, 17:1
- Rathwa, S. D., Vasava, A. A., Pathan, M. M., Madhira, S. P., Patel, Y. G. and Pande, A. M. 2017.** Effect of season on physiological, biochemical, hormonal and oxidative stress parameters of indigenous sheep. *Veterinary World*, 10:650–654.
- Rotruck, J. T., Pope, A. L., Ganther, H. E., Swanson, A. B., Hafeman, D. C. and Hoekstra, W. G. 1973.** Convenient assay for superoxide dismutase. *The FEBS Journal*, 47(3):469 – 474.
- SAS. 2002.** SAS/STAT. User's Guide: Statistics (Release 6.04 Ed). SAS Institute Inc., Cary, NC, USA.
- Schaffer, S. and Kim, H. W. 2018.** Effects and mechanisms of taurine as a therapeutic agent. In *Biomolecules and Therapeutics*. 26: (3), Pp, 225–241.
- Valko, M., Leibfritz, D., Moncol, J., Cronin, M. T., Mazur, M. and Telser, J. 2007.** Free radicals and antioxidants in normal physiological functions and human disease. *International Journal of Biochemistry and Cell Biology*, 39: 44 – 84.
- Yin, J., Duan, J., Cui, Z., Ren, W., Li, T. and Yin, Y. 2015.** Hydrogen peroxide-induced oxidative stress activates nf_β and nrf2/keap1 signals and triggers autophagy in piglets. *Royal Society of Chemistry Advances*. 5:15479–15486.
- Yusuf, A. O., Mlambo, V., Sowande, O.S. and Solomon, R. 2019.** Oxidative stress biomarkers in West African Dwarf Goats reared under intensive and semi-intensive production systems. *South African Journal of Animal Science*. 47(3): 281 – 289.
- Zajuzhang, D., Gao, Z., Zhao, J., Huang, X. L., Duo, L. and Tian, Y. 2014.** Effects of taurine on growth performance, immune organ development and antioxidative ability of broilers. *Chinese Journal of Veterinary Science*. 29: 774–778.

Date received: 9th March, 2023

Date accepted: 12th March, 2023