

Serum biochemistry and oxidative stress indicators in West African dwarf goats under semi intensive management system

Ihejirika, U. G. D.¹, Adenekan, O. O.¹, Jimoh, O. A.^{1,2}, Jack, A. A.¹ and Uwaeziozi, U. C.¹

¹Animal physiology and Bioclimatology unit, Department of Animal Science, University of Ibadan, Oyo State



²Department of Animal Production Technology, Federal Polytechnic Ado- Ekiti, Ekiti State.

*Corresponding Author: abubakarjimoh2011@gmail.com; +2348066058134

Abstract

This study aims to evaluate variations in serum biochemistry and oxidative status between male and female West African dwarf goats under semi intensive management system. Twenty, each of bucks and does (12 months old) were randomly selected from a herd purchased from Oyo livestock market, in Oyo State. The average body weights of the goats were 12.08±3.26 and 12.15 ±1.51 kg does and bucks, respectively. Blood samples were collected from fastened goats and assayed for serum biochemicals, lipid peroxidation, total antioxidant activity, catalase and superoxide dismutase using standard procedures. Data obtained were subjected to T-test. The result showed serum glucose, albumin, cholesterol, total protein, globulin, triglyceride, creatinine, alanine amino transferase (ALT), aspartate amino transferase (AST) and urea were not significantly ($P>0.05$) different among the sexes. Serum high density lipoprotein was significantly ($P<0.05$) higher in does (13.96 mmol/l) than in bucks (5.91mmol/l) and alkaline phosphatase was significantly ($P<0.05$) higher in bucks (2580.55 IU/L) than in does (1594.58 IU/L). Serum lipid peroxidation, total antioxidant activity and superoxide dismutase were statistically similar ($P>0.05$) in both sexes. Serum catalase was significantly ($P<0.05$) higher in bucks than in does. From this study, it can be deduced that serum biochemical indices in does and bucks are similar except for alkaline phosphatase and high density lipoprotein. Bucks recorded higher catalase than does. It could be concluded that during physiological and environmental stress conditions, antioxidant supplementation should be adopted to boost the antioxidant capacity of the does.

Keywords: Antioxidant enzymes, peroxides, West African dwarf goats, serum Lipid

Introduction

West African dwarf (WAD) goats are extremely important in the rural village economy of West Africa, but still faced with the challenges of climate change and inevitability of exposure to extreme hot and cold environmental weather conditions. This makes oxidative stress associated with extreme environmental conditions an appropriate field of investigation to explore adaptive physiological mechanism of the body (Maan and Kataria, 2012). Seasonal changes can often cause deficit in nutritional composition of pasture plants which could lead to a number of health

problems. The health status of farm animals is of primary concern to livestock producers. Infections and diseases on livestock can cause negative impact on productivity of farm animals, so it becomes necessary to frequently assess the health status of farm animals. In doing this, the blood is a vital component that could predict the health status of the animal, since it could be influenced by factors like nutrition, management, age, sex, disease and stress (Schalm *et al.*, 1975). Serum biochemical and oxidative stress indicators are important parameters for the health status assessment of individual animals. Normal values can be

Serum biochemistry and oxidative stress indicators in West African dwarf goats

altered by an animal's exposure to abnormal conditions including environmental hazards, e.g. crude oil pollution (Ngodiyha, 2009), season (Abdelatif *et al.*, 2009), bacterial infections such as mastitis (Ajuwape *et al.*, 2005), Mycoplasma (Mondal *et al.*, 2004) or parasitic infestation (Mohammed *et al.*, 2010). They can also vary due to physiological status, breed and sex, or with age (Azab and Abdel-Maksoud, 1999; Simsek *et al.*, 2015). Oxidative stress is a term that was introduced by Sies in 1985 and refers to any situation where there is a serious imbalance between the productions of free radicals or reactive oxygen species (ROS) called the oxidative load and the antioxidant defence system. It is a major threat to homeostasis and therefore to the integrity of aerobic organisms. This arises from chemical species possessing one or more unpaired electrons in their outer orbital called free radicals (Halliwell and Gutteridge, 1997). However, low levels of ROS are essential in many biochemical processes; accumulation of ROS may damage biological macro molecules that are lipids, proteins, carbohydrates and DNA (Kumar *et al.*, 2011). External factors such as trauma, ultrasound, infections, radiations, toxins etc. can lead to increased free radicals and other ROS and may lead to oxidative stress (Halliwell *et al.*, 1992). Animals have developed sophisticated mechanisms in order to maintain redox homeostasis (Masella *et al.*, 2005). These protective mechanisms can either scavenge or detoxify ROS, block their production or sequester transition metals that are the source of free radicals and include enzymatic and non-enzymatic antioxidant defences produced in the body namely, endogenous (Hayes and McLellan, 1999; Sies, 1999) and others supplied with the diet namely exogenous (Benzie, 1999).

Antioxidant enzymes act to scavenge free radicals by converting them to less harmful molecules (Sies, 1993). Among the most known enzymatic antioxidants, are superoxide dismutase (SOD), glutathione reductase (GR), glutathione peroxidase (GPx) and catalase (CAT). Oxygen free radicals can develop during several steps of normal metabolic events. Although free radicals have the potential to damage the organs their generation is inevitable for some metabolic processes.

There is scanty information on oxidative stress markers in Nigerian indigenous goat. Thus, the study was carried to investigate the sexual dimorphism in oxidative stress markers and serum biochemical indices of West African dwarf goat under semi intensive management system and to provide reference values which is necessary for health assessment of goats in Nigeria.

Materials and methods

West African dwarf goats consisting of 20 does and bucks each with an average weight of 12.50 ± 3.26 and 12.15 ± 1.51 Kg respectively were selected from a herd in a livestock market, Oyo in Oyo State, Nigeria. The goats were quarantined and acclimatized for 4 weeks. The does were dry and all animals were of good conformation. The animals were managed in a semi intensive system, offered concentrate in the morning and allowed for free choice grazing in the afternoon till evening. The concentrate had 12.60% crude protein, 10.00% crude fibre and 3202 kcal/kg of digestible energy. Fresh water was provided regularly. Blood sample were collected through the jugular vein from all animals and serum obtained using standard procedures. Serum biochemical; glucose, total protein, albumin, cholesterol, triglyceride, high density lipoprotein, alkaline phosphatase, alanine amino transferase, aspartate amino

transferase, urea and creatinine were carried out using Randox kits and its procedures. Serum was assayed for lipid peroxidation, antioxidant activity, catalase and superoxide dismutase. Serum total antioxidant capacity activities was carried out as adopted by Jimoh *et al.* (2017). Data obtained in this study were subjected to student's T-test using statistical analysis software (SAS, 2011).

Result and discussion

Serum biochemistry of West African dwarf goats is shown in Table 1. The serum biochemical parameters such as total protein, alanine amino transferase, alkaline amino transferase etc. can reflect physical changes occurring in an animal's body. These changes could be due to diseases or normal physiological changes. The serum biochemistry of WAD goats was not significantly affected by sex except for high

density lipoprotein and alkaline phosphatase. High density lipoprotein was significantly ($P<0.05$) higher in does (13.96 ± 1.42 mmol/L) compared to that of bucks (5.91 ± 1.42 mmol/L). Serum alkaline phosphatase was significantly ($P<0.05$) lower in does (1594.58 ± 197.57 U/l) compared to bucks (2580.55 ± 197.57 U/l) while Serum glucose and urea level were apparently lower in does compared to bucks. Lower glucose level might be due to differences in energy expenditure because of the semi intensive system of management under which the study was carried out. The apparently high glucose level in the bucks may be reflected in high physical activity levels in WAD bucks compared to does. Glucose level of 5.52 ± 0.52 mmol/L in does recorded in this study was lower than the results reported for WAD does (25.1 ± 4.6 mg/dl) by Opara and Okoli (2010).

Table 1: Sexual dimorphism in serum biochemistry of WAD goats under semi-intensive management system

Parameters	Doe	Buck	SEM	Significance
Glucose (mmol/L)	5.52	6.68	0.52	NS
Totalprotein (g/L)	102.69	92.49	3.53	NS
Albumin (g/dL)	9.79	13.41	2.03	NS
Globulin (g/dL)	7.81	6.86	0.42	NS
Highdensity lipoprotein (mmol/l)	13.96	5.91	1.42	*
Cholesterol(mmol/l)	1.24	1.32	0.18	NS
Triglyceride (mmol/l)	0.75	0.62	0.12	NS
Alkaline phosphatase (U/L)	1594.58	2580.55	197.57	*
Creatinine(μ mol/L)	189.24	193.14	15.80	NS
Alanineamino transferase	6.55	2.34	1.67	NS
Aspartateamino transferase	30.18	14.63	12.09	NS
Urea (mg/dL)	131.64	157.08	16.95	NS

NS: Not significant,

*Significantly different

This could be as a result of environmental conditions, age and activity level of the animals. This report was in line with the findings of Ewuola *et al.* (2017) on higher glucose level in bucks compared to bulls which was linked to differences in energy

expenditure in animals on semi intensive management. Alanine amino transferase was 6.55 ± 1.67 iu/L in doe and 2.34 ± 1.67 iu/L in buck. This was lower than what was reported by Kaneko and Cornelius (1972) for buck (22.1 ± 11.2 IU/L) and in doe (24.5 ± 9.60

Serum biochemistry and oxidative stress indicators in West African dwarf goats

IU/L). Aspartate aminotransferase was higher in female (doe) 30.18 ± 12.09 IU/L than in male (buck) 14.63 ± 12.09 IU/L. The value was lower than 67.5 ± 26.8 IU/L and 66.5 ± 26.7 IU/L reported by Kaneko and Cornelius (1972) in bucks and in females (doe). An increase in serum AST and ALT concentrations are directly related to damage to tissue which include liver, heart and kidney. Total protein was higher in does than in bucks showing that the does have higher protein utilization than bucks. Total protein is an indicator of protein digestion, absorption and metabolism. It is an estimation of the nutritive state of the animals and helps to monitor how the diet is being utilized, reflecting alterations in metabolism. More *et al.* (1980) reported a significant increase in the serum protein of sheep exposed to heat stress. The increase in serum protein could be a physiological attempt to maintain extended plasma volume. High environmental temperature caused increase in total plasma protein in lactating cattle (Podar and Oroian, 2003). However, Rasooli *et al.* (2004) found a significant increase in plasma total protein from 63.88 ± 0.77 g/l in winter to 69.26 ± 0.70 g/l in hot summer in non-pregnant Holstein heifers. In cattle, heat exposure and dehydration during heat stress resulted in sharp increase in ADH level which was

associated with a significant decrease in urine output and a significant increase in plasma protein (El-Nouty *et al.*, 1980). Bucks recorded apparently higher value (13.41 ± 3.03 g/dl) for albumin than the does (9.79 ± 2.03 g/dl). A significant increase in plasma albumin levels was reported in cows (El-Masery and Marai, 1991) and buffalo calves (Koubkova *et al.*, 2002) during heat stress. This finding is quite relevant considering that albumin is the major extracellular source of thiols, which are scavengers of free radicals allowing albumin to function as an antioxidant. Haliwell, 1998 and Rasooou *et al.* (2004) reported an increase in plasma albumin concentrations in summer (40.23 ± 0.38 g/l) compared to winter (35.09 ± 0.42 g/l) in non-pregnant Holstein heifers and suggested that the increase in plasma protein concentrations might be due to the loss of extracellular fluid due to heat exposure.

The result of oxidative status of West African dwarf goats as influenced by sex difference is shown in Table 2. It showed that all oxidative stress markers were not affected by sex differences, except catalase activity. Serum catalase of bucks was significantly higher than in does. Though, total antioxidant capacity in buck serum was numerically higher than does, serum lipid peroxidation was apparently lower in buck.

Table 2: Oxidative stress indicators of WAD goat under semi intensive management system

Parameters	Doe	Buck	SEM	Significance
Total antioxidant activity (mmol/litre)	97.75	127.35	18.22	NS
Catalase (nmoles of H ₂ O ₂ consumed/min/mg protein)	73.32	199.77	61.12	*
Superoxide dismutase (U/min/mg protein)	1.25	0.65	0.39	NS
Lipid peroxidation (x10 ⁻³ MDA/mg protein)	3.76	3.53	0.55	NS

NS: Not significant * significantly different

This indicated that the significantly higher serum catalase was responsible for the numerical high total antioxidant activity and lower lipid peroxidation value of bucks, thus implying that the bucks might be less susceptible to lipid peroxidation than the does. Lipid peroxidation and superoxide dismutase were apparently higher in the does compared to the bucks; the higher lipid peroxidation is an indication of oxidative stress which led to the increase in superoxide dismutase to counter toxic super oxides which may be produced as a result. During metabolism, ROS are unstable and highly reactive, becoming stable by acquiring electrons from nucleic acids, lipids, proteins, carbohydrates or any nearby molecule causing a cascade of chain reactions resulting in cellular damage and disease (Agarwal *et al.*, 2005). Lipids are polyunsaturated and are prone to oxidation and are one of the most susceptible substrates to free radicals' damage as biomarkers of lipid peroxidation are considered the best indicators of oxidative stress (Georgieva, 2005). Over production of reactive species results in oxidative stress (Halliwell and Chirico, 1993). Under normal conditions, scavenging molecules known as antioxidants convert ROS to safe by-products to prevent damage caused by ROS. However, when the balance between ROS production and detoxification is disrupted, ROS accumulation elicits oxidative stress (Ford, 2004) thus adversely affect DNA integrity (Baumber *et al.*, 2003) and block oxidative metabolism (Makker *et al.*, 2009). The apparently higher antioxidant activity in bucks could be attributed to its higher catalase activity which might lead to higher scavenging of hydrogen peroxides into water and oxygen. Also, this could be attributed to report that catalase is a heme-containing enzyme that catalyses the dismutation of hydrogen

peroxide into water and oxygen. In peroxisomes, catalase takes care of the cytosolic and mitochondrial peroxides formed during urate oxidation (Oshino and Chance, 1977). Mitochondrial SOD readily converts the bulk of mitochondrial superoxide ions to H_2O_2 . They are known to neutralize excess reactive oxygen species and prevent it from damaging cell structure. Catalase also detoxifies both intracellular and extra cellular hydrogen peroxide by reducing it to water and oxygen by eliminating the potential reactive oxygen species. Thus, SOD and catalase protects the cell from the damage due to the secondary generation of highly reactive hydroxyl group from superoxide ion to H_2O_2 (Miyazaki *et al.*, 1991). The differences in antioxidant enzyme activity may be caused by various mechanisms. The reactive oxygen species contribute to an intensified synthesis of antioxidant enzymes in tissues and hence their elevated activity may be a manifestation of adaptation mechanisms in response to oxidative stress. A decreased activity of antioxidant enzymes or a decreased non-enzymatic antioxidant concentration may be caused by their intensified utilization in protection against oxidative tissue damage (Seven *et al.*, 2001). There are a number of factors that may influence antioxidant system activity: the physiological state of the thyroid gland, the dose and the duration of treatment.

Conclusion and recommendation

This study has revealed that West African dwarf does and bucks possessed similar serum biochemical and that the West African dwarf bucks have better antioxidant activity and are less susceptible to lipid peroxidation than does. During physiological and environmental stress conditions, antioxidant supplementation should be adopted to boost the antioxidant capacity of the does in

different physiological stages so as to improve productivity which is the target of the farmer. The values obtained in this study can serve as references for oxidative markers of West African dwarf male and female goat in Nigeria. These differences further underline the need to establish appropriate physiological baseline values for various breeds, which could be helpful for diagnosis purposes and in the realistic evaluation of management practices, nutrition and health status.

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Serum biochemistry and oxidative stress indicators in West African dwarf goats

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