Assessment of oxidative stress indicators of West African Dwarf sheep under semi intensive management system

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Abstract

Oxidative stress results from increased production of free radicals and reactive oxygen species, and a decrease in antioxidant defense. This study was conducted to assess sexual dimorphism in serum biochemistry and oxidative status of West African dwarf lambs. Sixteen each of rams and ewes 8 months old were randomly selected from a herd purchased from livestock market, Oyo. The average body weights of the lambs were 12.08±3.26 and 12.76 kg for ewes and rams, respectively. Fastened blood samples were collected from the sheep and assayed for serum biochemical, lipid peroxidation, total antioxidant activity, catalase and superoxide dismutase using standard procedures, data obtained were subjected to T-test. The result indicated that both sex had similar serum biochemical indices except total protein. Ewes had significantly higher serum protein than rams. Rams had apparently higher total antioxidant activity and significantly higher serum catalase activity than ewes, while serum lipid peroxidation and superoxide dismutase were statistically similar in both sexes. This indicates that rams have better antioxidant activity than ewes. During oxidative stress prone conditions and environment, measures to boost antioxidant activity of ewes should be emphasized.

Keywords: Antioxidant enzymes, Free radicals, WAD sheep, Stress

Introduction

Base feeding of sheep in Nigeria is pasture with very little or no concentrate supplements. During the dry season, animals are often in deficit due to scarce pastures which could lead to a variety of production and health problems. The inevitability of exposure of sheep to extreme hot and cold environmental weather conditions, makes oxidative stress associated with extreme environmental conditions and appropriate field of investigation to explore adaptive physiological measures of the body (Maan and Kataria, 2012). Oxidative stress results from increased production of free radicals and reactive oxygen species, and a decrease in antioxidant defense (Trevisan et al., 2001; Williams et al., 2002). Ganaie et al. (2013) reported that oxidation is essential to nearly all cells in the body to provide energy for vital functions. Approximately 95 to 98% of the oxygen consumed is reduced to water during aerobic metabolism, but the remaining fraction may be converted to oxidative by-products--reactive oxygen species, that may damage the DNA of genes and contribute to degenerative changes (Ganaie et al., 2013). Studies have shown that antioxidants are uniquely different from each other and each have a specific function in the body. Levels of ROS are determined by production and by the rate of ROS degradation and/or inactivation, an appropriate balance is important for maintaining cellular homeostasis (Covarrubias et al., 2008). Although low levels of ROS are essential in many biochemical processes, accumulation of ROS may damage...
biological macromolecules i.e. lipids, proteins, carbohydrates and DNA (Kumar et al., 2011). External factors such as oxygen exposure (resuscitation; Kumar et al., 2010) heat, 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).

The ROS are produced in all cells, depending on the intensity of aerobic metabolism, especially in activated neutrophils, monocytes, smooth muscle cells and in endothelial cells (Nanda et al., 2007). Disequilibrium between ROS production and inactivation leads to oxidative stress. The organism has enzymatic (e.g. superoxide dismutase, catalase, glutathione peroxidase) and non-enzymatic (e.g. vitamin E) antioxidant mechanisms that work as scavenger for this harmful ROS.

Altan et al. (2003) have demonstrated that heat stress increased lipid peroxidation which is associated with production of large number of free radicals and are capable of initiating peroxidation of polyunsaturated fatty acids. Ralhan et al. (2004) also reported that lipid peroxidation is significantly increased during reticulo-ruminal impaction in buffaloes.

A major threat to homeostasis and therefore to the integrity of aerobic organisms arises from chemical species possessing one or more unpaired electrons in their outer orbital, called free radicals (Halliwell and Gutteridge, 1997). Oxygen free radicals can develop during several steps of normal metabolic events. Although free radicals have the potential to damage the organism, their generation is inevitable for some metabolic processes. There is limited documentation on oxidative stress markers in Nigerian sheep population. Thus, investigation was carried out on influence of sexual dimorphism in oxidative status and serum biochemistry of West African dwarf sheep.

Materials and methods
Thirty-two West African dwarf sheep consisting of 16 ewes and rams each with an average weight of 12.08±3.26 and 12.76Kg respectively were selected from a herd in a livestock market, Oyo, Nigeria. The sheep 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 for 2-3 hours in the morning and 6-7 hours for free choice grazing. Blood sample were collected through 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 peroxidation, antioxidant activity, catalase and superoxide dismutase. Serum total antioxidant capacity activities was carried out according to Korecevic, (2001), superoxide dismutase (SOD) was estimated by the method of Marklund and Marklund (1974) adopted by Soon and Tan (2002) and catalase was estimated by Beers and Sizer (1952) method, serum lipid peroxidation was determined using thiobarbituric acid assay according to Ohkawa et al. (1979).

Data obtained in this study were subjected to student's T-test using statistical analysis software SAS 2002.

Result and discussion
Serum biochemistry of West African dwarf
sheep is shown in Table 1. The serum biochemistry of WAD sheep was not significantly affected by sex except for total protein. This showed that both sex have similar physiological status. The differences in serum total protein of WAD sheep is contrary to report of Onasanya et al. (2015) that no significant difference in serum total protein in Uda, Yankassa and Balami sheep.

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

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Ram</th>
<th>Ewe</th>
<th>±SEM</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose mmol/l</td>
<td>1.76</td>
<td>1.81</td>
<td>0.13</td>
<td>Not sig</td>
</tr>
<tr>
<td>Total protein g/l</td>
<td>21.31</td>
<td>58.48</td>
<td>5.20</td>
<td>Sig</td>
</tr>
<tr>
<td>Albumin g/dl</td>
<td>2.60</td>
<td>3.11</td>
<td>0.27</td>
<td>Not sig</td>
</tr>
<tr>
<td>Cholesterol mmol/l</td>
<td>1.13</td>
<td>1.46</td>
<td>0.13</td>
<td>Not sig</td>
</tr>
<tr>
<td>Triglycerides mmol/l</td>
<td>0.56</td>
<td>0.54</td>
<td>0.03</td>
<td>Not sig</td>
</tr>
<tr>
<td>High density lipoprotein mmol/l</td>
<td>2.72</td>
<td>3.22</td>
<td>0.58</td>
<td>Not sig</td>
</tr>
<tr>
<td>Alanine amino transferase</td>
<td>5.05</td>
<td>6.98</td>
<td>1.32</td>
<td>Not sig</td>
</tr>
<tr>
<td>Aspartate amino transferase</td>
<td>14.88</td>
<td>18.40</td>
<td>1.80</td>
<td>Not sig</td>
</tr>
<tr>
<td>Alkaline phosphatase u/L</td>
<td>1495.87</td>
<td>1245.02</td>
<td>111.71</td>
<td>Not sig</td>
</tr>
<tr>
<td>Creatinine µmol/L</td>
<td>119.43</td>
<td>149.99</td>
<td>35.71</td>
<td>Not sig</td>
</tr>
<tr>
<td>Urea mg/dl</td>
<td>161.97</td>
<td>195.84</td>
<td>15.93</td>
<td>Not sig</td>
</tr>
</tbody>
</table>

SEM- standard error of mean; Sig- Significant difference; Not sig- No significantly different

The result of oxidative status of West African dwarf sheep as influenced by sex difference is shown in Table 2. It showed that all oxidative indicator parameters were not affected by sex differences, except catalase activity. Serum catalase of rams was significantly higher than ewes. Though, rams had apparently higher total antioxidant activity than ewes, serum lipid peroxidation was apparently lower in does. This indicates that the significantly higher serum catalase was responsible for the numerical high total antioxidant activity value of ram.

The trend of result showed that superoxide dismutase activities of ewes were slightly higher than rams and this could account for the slightly lower serum lipid peroxidation in ewes. SOD is the first line of defense against free radical accumulation, superoxide isdismutated by SOD to hydrogen peroxide which is further converted to water and other lesser oxygen species by catalase. The role of superoxide dismutase is to accelerate the dismutation of the toxic superoxide produced during oxidative energy processes to hydrogen peroxide and molecular oxygen (Hajimohamadi et al., 2015). Mitochondrial SOD readily converts the bulk of mitochondrial superoxide ions to H₂O₂ (Ganaie et al., 2013). The apparently higher antioxidant activity in rams could be attributed to its higher catalase activity which indicates higher scavenging of hydrogen peroxides. Because peroxisome catalase takes care of the cytosolic and mitochondrial peroxides formed during urate oxidation (Oshino and Chance, 1977).

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

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Ewe</th>
<th>Ram</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Antioxidant activity (mmol/litre)</td>
<td>7.07±6.19</td>
<td>12.34±10.33</td>
<td>0.18NS</td>
</tr>
<tr>
<td>Lipid peroxidation (x10⁴TBARSmgprotein)</td>
<td>1.79±1.37</td>
<td>1.97±1.79</td>
<td>0.87NS</td>
</tr>
<tr>
<td>Catalase (mmoles of H₂O₂ consumed/min/mgprotein)</td>
<td>24.00±6.94</td>
<td>49.08±41.10</td>
<td>0.011**</td>
</tr>
<tr>
<td>Superoxide dismutase (U/mg)</td>
<td>0.50±0.09</td>
<td>0.48±0.08</td>
<td>0.31NS</td>
</tr>
</tbody>
</table>

** Significant difference is observed, NS- No significantly different
One of the molecules contributing to oxidative stress is a large decrease in the reducing capacity of cellular redox couples (antioxidants). The importance of oxidative stress indicators in lambs has been elicited by works of Kumar et al. (2010) in which he described the excitation of antioxidant enzymes to newborn lambs in response to hyperoxia due to resuscitation and within 24 hrs exposure, suggested that oxygen resuscitated lambs had evidence of systemic oxidative stress over time and cell membrane damage at 24 hrs compared with the room air resuscitated lambs. He indicated that fetal lung antioxidant enzymes; specifically SOD, catalase and gluthatione peroxidase increases during the final 15 to 20% of intrauterine life (Frank and Sosenko, 1987), and lambs can induce antioxidant activity at 24hrs in the presence of maximal hyperoxia, suggesting the maturation of its pathways. Kumar et al. (2010) reported that newborn lambs exposed to maximal oxygen had systemic oxidative stress, damage to cell membranes and higher activities of antioxidant enzymes in response to a pro oxidant situation. Kataria et al. (2010) reported that increase activity of serum catalase during hot environmental condition suggested the ability of the animals to provide defense against free radicals and oxidative stress. Environmental conditions associated variations in the catalase activities have been reported by researchers (Martí et al., 2007). Kataria and Kataria (2012) reported effect of PPR on oxidative stress in sheep, the findings suggested the relevance of periodic assessment of oxidative status in taminants for healthier management through supplementation of proper antioxidants as supportive treatment in PPR and in healthy in-contact animals. Rezapour and Taghinejad-Roudbaneh (2011) reported that late gestation imposed lots of stress of anti-oxidative system of ewes.

Conclusion
This study has revealed that WAD rams have better antioxidant activity than ewes. During oxidative stress prone conditions and environment, measures to boost antioxidant activity of ewes should be emphasized.

It is recommended that reference values of oxidative stress indicators should be developed in sheep populations. There should be awareness for protection against oxidative stress in different physiological states, production, feeding and management systems for Nigeria livestock species.

References


Oshino, N. and Chance, B. 1977. Properties of glutathione release observed reduction of organic hydroperoxide, demethylation of...


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