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Araştırma Makalesi / Research Article

Investigation of Dynamic Thiol Disulfide Homeostasis in Young Cattle With Pneumonia

Fatma ERTAŞ[1*], Şemistan KIZILTEPE[1], Oğuz MERHAN[2]
[1]Iğdır University, Tuzluca Vocational School, Department of Medical Services and Techniques Iğdır
[2]Kafkas University, Faculty of Veterinary Medicine, Department of Veterinary Medicine Basic Sciences,Kars
*Corresponding author: fatma.ertas@igdir.edu.tr

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Abstract
The aim of this study was to investigate blood levels of thiol and disulfide, a new oxidative stress marker of oxidant and antioxidant balance, or thiol/disulfide ratios in cattle diagnosed with pneumonia and to determine its usefulness as a new prognostic inflammatory marker. The animal material of the study consisted of 20 cattle diagnosed with pneumonia as a result of clinical examinations, aged between 01-02 years, male and female were not important. Total thiol, native thiol, disulfide levels and dynamic thiol disulfide balance were measured chlorometrically with a spectrophotometer. As a result, no significant difference was found between pre-treatment and post-treatment levels. ($p<0.05$). It is thought that an oxidative stress occurs in diseased animals according to the values measured before and after treatment. It is also anticipated that the application of a real treatment for the causative agent will reduce the oxidative stress.

Keywords: Antioxidants, cattle, dynamic thiol disulfide, oxidative stress, pneumonia

1.Introduction

Bovine Respiratory Disease (BRD) is one of the most economically important health problems in cattle breeding. The financial losses in this sense have exceeded the cost of other diseases in cattle. These damages, which cause serious financial losses to the national economy, are shaped by treatment costs, loss of production and death of cattle (Durgut and Köse, 2017; Tuzcu et al., 2020). Several factors are involved in the etiology of BRD. These factors, stress factors such as transplantation, weakening of the host immune system, and the large amount of viral, bacterial and parasitic agents in the environment allow them to invade the lung. (Cusack et al., 2003; Erdoğan et al., 2018; Tuzcu et al., 2020). In order to minimize this negative situation in cattle farms, a reliable prognosis and rational treatment practices are required (Erdoğan et al., 2018). Pneumonia is an important lung disease with high mortality and morbidity in cattle (Tuzcu et al., 2020). Pneumonia is clinically characterized by loss of appetite, high fever, respiratory distress, increased respiratory rate, cough and runny nose (Lopez et al., 2017). Lesions in pneumonia vary according to the type of agent, the route of entry into the lung, the age and resistance of the animal (Tuzcu et al., 2020). Special systems are involved in maintaining the structural integrity and normal functioning of cells and tissues. Oxidants and antioxidants are in balance between these systems. It is of great importance that this balance remains at a certain titer. If this balance shifts in the oxidant direction, oxidative stress occurs (Ertaş and Kırmızıgül 202; Değer et al., 2008). When these mechanisms are inadequate, oxidative stress leads to oxidative damage and, if it progresses, to cell disfunction and even cell loss. This tremendous balance is disrupted when intracellular defense mechanisms are inadequate. Pathological damage has been reported to occur in the case of excessive oxidative stress. This pathological injury is caused by deficiencies in the function, activity and immunity of skeletal muscle, heart, liver and blood cells, especially those requiring high exertion (Akkuş, 2021). Although the lungs can be easily affected by oxidative injury, airway epithelia possess antioxidants to minimize the effect of endogenous and exogenous free oxygen radicals (Özçelik et al., 2014; Al-Qudah, 2009). Antioxidants are substances that can reduce the total number of oxidants in a system by reacting with oxidants, thus stopping oxidation. With the protective effect of antioxidants, the damaging effect of oxidant molecules on tissues is reduced (Özçelik et al., 2014). The thiol or sulfhydryl parameters (SH) constitute the functional and most active model of the sulfur atom. In addition to antioxidant defense, SH is important in enzyme function, protein folding and functionality, detoxification, regulation of transcription factors, signal transduction, apoptosis and cellular stimulation systems by acting on the active parts of enzymes (Oliveira and Laurindo 2018; Akkuş, 2021). Thiol-Disulfite Homeostasis occupies a vital place. Thiol and disulfide levels are known to increase in inflammatory diseases as a marker of total oxidant status (Erel et al., 2014; Üstüner et al., 2018; Georgescu et al., 2022). Thiols, also known as mercaptans, are a class of organic compounds containing a sulfhydryl group (-SH) consisting of a sulfur atom and a hydrogen atom bonded to a carbon atom (Erel, 2014). Thiol metabolism and its role in oxidative stress have also started to be investigated. Thiols are among the key molecules of protein metabolism in the organism and are the first antioxidants consumed in oxidative stress. There is a balance known as dynamic thiol/disulfide homeostasis (Şener et al. 2014). On 09.10.2023, according to the data on the Scopus research site, 505,301 data on "pneumonia" were accessed. But when searching for "pneumonia and thiol", it was found that there were only 446 documents and these data were revealed in 2019-2023. This result shows that the number of publications in which pneumonia and thiol

were evaluated together is low. In addition, the fact that these publications are in the last 5 years indicates that this issue is current. Our hypothesis in this study was; Are thiol and disulfide blood levels at a level to indicate an inflammatory process in young cattle with pneumonia using clinical symptoms and can this be used as a prognostic marker? Our aim is to investigate the answers to these questions.

2. Materials and Methods

2.1. Collection of Samples in the Study

This study was ethically approved by Kafkas University Animal Experiments Local Ethics Committee at its meeting on 27. 04. 2021 with the approval number KAÜ-HADYEK/2021-075. The animal material was carried out in 20 cattle evaluated before and after treatment after obtaining the consent of the breeder from cattle holdings in Igdir region. Regardless of whether male or female, 10 ml of blood was collected from the vena jugularis of the cattle in the study. The blood brought to the laboratory in the cold chain was centrifuged at 3000 rpm for 10 min and then separated into sera and the sera were stored in ependorf tubes at (-20ºC) until the count was completed. The age, breed, sex, temperature, pulse rate and respiratory rate of the animals from which blood samples were collected were recorded.

2.2. Biochemical Analyzes

Serum samples were measured by using Total Thiol Assay and Native Thiol Test kits in the Biochemistry Laboratory of the Faculty of Veterinary Medicine, Kafkas University using the method described by Erel et al. The results obtained were statistically calculated.

2.3. Statistical Analysis

The data were statistically analyzed with SPSS (Statistical Package for Social Scieneces) version 20.0. "Shapiro Wilk Test" was used to determine the conformity of the data to normal distribution. Since all data fit the normal distribution, parametric tests were applied in the analysis. In all analyses, $p<0.05$ values were considered statistically significant.

3. Results and Discussion

3.1. Biochemical Results

Total Thiol and Native Thiol, Disulfite, Disulfite/native thiol, Disulfite/total thiol, Native thiol/total thiol values are given in Table 1.

Table 1. Total Thiol and Native Thiol, Disulfite, Disulfite/native thiol, Disulfite/total thiol, Native thiol/total thiol values before and after treatment in Cattle with Pneumonia

Parametreler	**Groups**		
	Pre-Treatment Ort±SS	**Post-treatment Ort±SS**	P-value
Total thiol	387,36±73,15	488,17±170,36	0,066
Natif thiol	273,53±77,39	337,73±91,91	0,067
Disulfide	56,91±26,98	75,21±57,35	0,164
Disulfide/native thiol	24,03±16,87	21,95±15,34	0,504
Disulfide/total thiol	14,86±6,6	13,99±6,48	0,586
Native thiol/total thiol	70,27±13,20	72,01±12,97	0,586

Total thiol, native thiol, disulfide, disulfide/native thiol ratio, disulfide to total thiol ratio and native thiol to total thiol ratio values before and after treatment were evaluated by 'One Way ANOVA' statistical method. No significant difference was found between pre-treatment and post-treatment values ($p<0.05$).

Respiratory system diseases have an important place in the veterinary field. It is known that respiratory diseases cause economic damage on a country basis (Erdoğan et al., 2018). Pneumonia can be defined as acute inflammation of the lung

parenchyma. Pneumonia causes high morbidity and mortality globally (Mandell 2015; Shaukat et al., 2021). Lung inflammation causes large-scale financial losses associated with low productivity, high treatment costs and preventive measures (Shaukat et al., 2021). The problem of pneumonia is of great importance in cattle breeding. In cattle with pneumonia, lagging behind the herd, moving the forelegs away from the chest, extending the neck of the animals to facilitate breathing, breathing through the mouth, frequent and superficial respiration, coughing although not very frequent, excessive salivation and nasal discharge are observed (Durgut and Köse 2017). It also causes hypoxia, respiratory failure leading to respiratory distress and microscopically involves alveoli congestion, hemorrhages, edema and emphysema (Shaukat et al., 2021). The clinical symptoms mentioned in the present study are present and parallel to those mentioned. Oxidative stress is defined as the imbalance of oxidant and antioxidant mechanisms (Ertaş and Kırmızıgül 2021). Oxidative stress is a popular area of research in the veterinary field and is associated with many diseases (Tufarelli et al., 2023). Some of these diseases include bacterial/viral agents such as smallpox in sheep, traumatic reticuloperitonitis in cattle, osteoarthritis and tuberculosis. It has been reported that oxidant antioxidant regulation is impaired in these diseases (Ertaş and Kırmızıgül 2021). Oxidative stress is thought to play an important role in the pathogenesis of a number of lung diseases, not only through its direct damaging effects, but also through its involvement in molecular mechanisms that control lung inflammation (Al-qudah, 2009). Pneumonia is an important lung disease that causes great economic damage, especially in cattle enterprises (Tuzcu et al. 2020). An imbalance between lipid peroxides and antioxidants has been suggested in patients with pneumonia. It has been recorded by various studies that this imbalance may contribute to pulmonary endothelial damage. Poor perfusion in pulmonary tissues can induce the onset of free radical processes and free radical peroxidation. Oxidizing agents are reported to be produced in many infections of cattle (Al-qudah, 2009). Thiols, which are antioxidant molecules, constitute one of the important links in the extracellular defense system chain (Sener et al., 2019; Değirmençay et al., 2021). Under oxidative stress, thiols release hydrogen into the environment and disulfide bonds are formed (R-S-S-R). Thus, the released hydrogen binds excess oxygen, leading to deactivation of ROS and thus protecting the tissue from oxidative damage (Sener et al., 2019). However, it is known that they cannot resist the injury in plasma and tissue levels (Değirmençay et al., 2019). The sum of natural thiols and disulfides constitutes total thiol. Currently, there is a balance between thiols and disulfides, so they play a protective role in cellular redox homeostasis. Dynamic thiol/disulfide homeostasis is known to have basic functions such as antioxidant defense, apoptosis, detoxification, stabilization of protein structure and cellular signal transduction (Sener et al., 2019). Proteins in the cell wall and extracellular fluid are oxidized by the cysteine residue of thiols in the presence of oxidant molecules. Thiols are metabolized to disulfide bonds in this reversible reaction (Değirmençay et al., 2019). It is suggested that a decrease in -SH groups and functional disorders occur when proteins are exposed to oxidative stress. In studies conducted in different structures and patients, a decrease in -SH groups is generally expected with oxidative stress (Yazıcı et al., 2002). Çetinkaya et al., (2022) reported that total thiol parameter was significantly lower in rat models of Alzheimer's disease compared to the control group. Similarly, Çamkerten et al., (2019) reported that total sulfhydryl group was significantly lower in pigs with sarcoptyx mange compared to healthy pigs. Değirmençay et al., (2021) revealed that thiol levels were low in dogs with canine distemper. In another study, Tarhan et al.,

(2023) compared babesian dogs with a healthy group and measured total thiol levels. As a result, he stated that the level of this parameter was found to be low, but this was not significant. In this study, thiol values were measured before and after treatment in young cattle with respiratory system problems. As seen in Table 1, total thiol, native thiol and disulfide values increased slightly from the pre-treatment values to the post-treatment values. However, this increase was not significant. Similar to the aforementioned studies, thiol values of young cattle with pneumonia increased according to the table after the treatment. The likely reason for this is that an oxidative stress is said to occur in young cattle with lung disease. In addition, it is thought that the increase in values after treatment reduces the oxidative stress that occurs.

4. Conclusion

As a result, no significant difference was found between the values of total thiol, native thiol, disulfide, disulfide/native thiol ratio before and after treatment in this study ($p<0.05$). Pre- and post-treatment values suggest oxidative damage in animals with pneumonia. It is anticipated that the application of a real treatment for the causative agent will reduce the oxidative stress.

Author Contribution Statement

The authors declare that they have contributed equally to the article. All authors declare that they have seen/read and approved the final version of the manuscript ready for publication.

Conflict of Interest Statement

All authors declare that they have no conflict of interest in relation to this article.

Ethical Committee Approval

This study was ethically approved by Kafkas University Animal Experiments Local Ethics Committee at its meeting on 27. 04. 2021 with the approval number KAÜ-HADYEK/2021-075

Referance

Akkuş, T., 2021. The effect of birth type on total thiol and native thiol in Aleppo goats and kids. *Journal of Agriculture and Veterinary Science,*14(7): 32-36.

Al-Qudah, KM., 2009. Oxidative stress in calves with acute or chronic bronchopneumonia. *Revue de Medecine Veterinaire,* 160: 231-236.

Cusack, P., Mcmenıman, N., Lean I., 2003. The medicine and epidemiology of bovine respiratory disease in feedlots. *Australian Veterinary Journal,* 81: 480-487.

Çamkerten, İ., Çamkerten, G., Erdoğan, H., Ayan, A., Erdoğan, S., Ural, K., 2019. Serum thiol disulphide levels among sheep with sarcoptic mange. *Kafkas University Faculty of Veterinary Medicine Journal,* 25(6): 865-868.

Çetinkaya, A., 2020. Ratlarda Amiloid Beta1-42 İle Oluşturulan Deneysel Alzheimer Modelinde Tiyol Disülfit Homeostazisi. *Düzce Üniversitesi Sağlık Bilimleri Enstitüsü Dergisi*, 10(3): 343-347.

Değer, S., Değer, Y., Ertekin, A., Gül, A., Biçek, K., Özdal, N., 2008. Dictyocaulus viviparus ile Enfekte sığırlarda lipit peroksidasyon ve antioksidan durumunun saptanması. *Türkiye Parazitol Dergisi*, 32(3): 234-237.

Değirmençay, Ş., Çamkerten, G., Çamkerten, İ., Aktaş, MS. 2021. An investigation of thiol/disulfide homeostasis and ischemia-modified albumin levels to assess the oxidative stress in dogs with canine distemper. *The Journal Veterinarski Arhiv*, 91(1): 39-49.

Durgut, R., Köse, Sİ., 2017. Sığırlarda Akut İntersitisyel Pnömoni. *Turkiye Klinikleri Journal of Veterinary Sciences Intern Med-Special Topics*, *3*(2): 143-7.

Erdoğan, H., Erdoğan, S., Özalp, T., Günal, İ., Ural K., 2018. Pnömonili danalarda L-laktat konsantrasyonları. *Journal of Advances in VetBio Science and Techniques*, 3(2):38-42.

Erel, O, Neselioglu, S., 2014. A novel and automated assay for thiol/disulphide homeostasis. *Journal Clinical Biochemistry*. 47(18): 326-32.

Ertaş, F., Kırmızıgül, A.H., 2021. Fasiyolozisli koyunlarda oksidatif stres ve metabolik profilin araştırılması. *Atatürk Üniversitesi Veteriner Bilimleri Dergisi*, 16(2): 204-210.

Georgescu, S.R., Mitran, C.I., Mitran, M.I., Matei, C., Popa, G.L., Erel, O., Tampa, M., 2022. Thiol-disulfide homeostasis in skin diseases. *Journal of Clinical Medicine*, 11(6): 1507.

Lopez, A, Martinson, AS. 2017. Respiratory System. Zachary JF. ed. Pathologc Basis of Veterinay Disease. Sixth edition, Elsevıer, ST Louis.

Mandell, LA., 2015. Community-acquired pneumonia: an overview, PGM (Postgrad. Med.) 127 607–615.

Oliveira, PV., Laurindo, FR., 2018. Implications of plasma thiol redox in disease. *Journal of Clinical Science,* 132(12): 1257-1280.

Özçelik, M., İssi, M., Güler, O., Şimşek, H., Özdemir, N., Kılıç, A., 2014. Bakteriyel pnömonili besi sığırlarında oluşan serbest radikal hasarının antioksidan aktivite ve bazı mineral maddeler üzerine etkisi. *Erciyes Üniversitesi Veteriner Fakültesi Dergisi*, 11(2): 111-116.

Sener, S., Akbas, A., Kilinc, F., Baran, P., Erel, O., Aktas, A., 2019. Thiol/disulfide homeostasis as a marker of oxidative stress in rosacea: a controlled spectrophotometric study. Journal of *Cutaneous and Ocular Toxicology*, 38(1): 55-58.

Shaukat, A., Hanif, S., Shaukat, I., Shukat, R., Rajput, S. A., Jiang, K., Deng, G., 2021. Upregulated-gene expression of pro-inflammatory cytokines, oxidative stress and apoptotic markers through inflammatory, oxidative and apoptosis mediated signaling pathways in Bovine Pneumonia. *Journal of Microbial Pathogenesis*, *155*, 104935.

Tarhan, M., Deger, Y., Oguz, B., Özdek, U., 2023. Investigation of Thiol-Disulphide Homeostasis, Total Oxidant-Antioxidant and Ischaemia-Modified Albumin Levels in Dogs with Babesiosis. *Alexandria Journal for Veterinary Sciences*, 77(1).

Tufarelli, V., Colonna, MA., Losacco, C., Puvača, N., 2023. Biological Health Markers Associated with Oxidative Stress in Dairy Cows during Lactation Period. *Metabolites*, 13(3): 405.

Tuzcu, N., Tuzcu, M., Akçakavak, G., 2020. Sığırlarda farklı pnömoni tiplerinde Tümör Nekroz Faktör Alfa (TNFα), Malondialdehit (MDA), Prokalsitonin ve Neopterin düzeylerinin karşılaştırılması. *Etlik Veteriner Mikrobiyoloji Dergisi*, 31(1): 52-61.

Üstüner, P., Balevi, A., Özdemir, M., Olmuşçelik, O., Ülfer, G., Yiğitbaşı, T. 2018. The role of thiol/disulfide homeostasis in psoriasis: Can it be a new marker for inflammation? *Turkish Archives of Dermatology & Venerology/Turkderm*, 52(4).

Yazıcı AE., Paşaoğlu, H., Yücel, D., Çelebi N., Bakır F., Özkaya M., 2002. Tip II Diabetes Mellituslu Hastalarda Plazma Total Tiyol ve Eritrosit Redükte Glutatyon Düzeyleri. *Türkiye Klinikleri Tıp Bilimleri Dergisi*, 22:487-492.

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