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Original article

RELATIONSHIP BETWEEN BLOOD ANTIOXIDANT PARAOXONASE-1 AND THE OFFSPRING YIELD IN HAIR GOATS

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Summary

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Small ruminants bring unproductive pastures to the economy with products such as meat and milk. Although the management of Hair goats is difficult compared to that of sheep, they make better use of unproductive pastures than sheep. The birth rate of Hair goats is high, but the multiple birth rate is quite low. This study aimed to determine the relationship between the antioxidant paraoxonase-1 (PON-1), and the offspring yield in Hair goats. In the second week of September, 100 females were randomly selected and blood samples were taken 15 days before the introduction of male goats to the herd from both males and females. Blood was taken from the same animals again before starting milking in May. Paraoxonase-1 values were found to be low and significantly different in both sexes in October compared to May. There was a statistical difference ($P \leq 0.05$) in PON-1 level in terms of gender and birth type. The PON-1 level of Hair goats that gave birth to twins was like that of male goats and goats with single birth, while it was insignificant between single-birth and infertile goats. It was found that a low PON-1 value was associated with low fertility whereas twin births were closely related to high value of PON-1. PON-1 was found to be important for multiple births ($P \leq 0.05$). As a result, it was concluded that the PON-1 level increased the birth rate and offspring yield in Hair goats.

Key words: Hair goats, paraoxonase-1, pregnancy, relationship

INTRODUCTION

During the metabolism in the body, some harmful free radicals emerge. Formation of these free radicals that damage the body is evaluated through the so-called total oxidant status (TOS), and the damage they cause to tissues is called oxidative stress. The substances that prevent tissue damage by binding these free radicals are called antioxidants (Karabulut & Gülay, 2016). Vitamins (A, C, E), minerals (Se, Zn, Mn, Cu, Fe), and enzymes (glutathione peroxidase, catalase, PON-1) are considered antioxidants (Dimri *et al.*, 2010; Arslan *et al.*, 2011; Aslankoç *et al.*, 2019). Of these, PON-1 is an enzyme associated with high-density lipoprotein (HDL) that shows esterase and lactonase activity. The enzyme is with the structure of glycoprotein, which is mostly synthesised in the liver and to little extent

in the kidneys and is released into the blood in small amounts (Ceron *et al.*, 2014). It is stated that serum PON-1 activity can vary at least 40-fold in the human population, and that the increase in esterified fatty acids during lipolysis causes immunosuppression and thus, oxidative stress (Arslan *et al.*, 2011; Ceron *et al.*, 2014; Kuhla, 2020). One of the physiological tasks of paraoxinase-1 is lipid oxidation (Ahmed *et al.*, 2001; Koç & Kaçar, 2012). Being a antioxidant enzyme mainly associated with HDL (Tarçın, 2011), PON-1 protects lipoproteins. Fragmented phospholipids formed during reactive oxygen species (ROS) oxidation and hydroperoxides occurring during lipid hydrolysis exert a protective effect against oxidative stress by blocking or delaying the oxidation of low-density lipoproteins (LDL) and HDL (Turk *et al.*, 2008; Özgün *et al.*, 2019). PON-1 proteins were found to be increased in parasite infestations such as *Fasciola hepatica*, which cause liver damage (Haçarız & Baykal, 2014; Romero *et al.*, 2020). PON-1, which acts as an important antioxidant against oxidative stress, is associated with the pathogenesis of many diseases, especially cancer and cardiovascular diseases. A better understanding of the molecular mechanism of the enzyme, along with regulatory mechanisms, especially transcription and translation, can help utilising agonists to potentiate the antioxidant effects of the enzyme (Karakurt *et al.*, 2010; Uysal, 2011; Ceron *et al.*, 2014; Selek *et al.*, 2015).

Oxidative stress has been reported to impair the comfort of farm animals and affect reproductive performance (Lorraine, 2009; Ceron *et al.*, 2014). Paraoxonase-1 is stated to influence follicular development, ovulation, fertility, uterine health, embryo development, pregnancy formation and progress in cows (Castro *et al*., 2018; Isola *et al.,* 2019). Although it has been demonstrated that PON-1 activity affects fertility parameters (Lorraine, 2009; Ceron *et al*., 2014), there are no studies reporting the relationship of PON-1 level in Hair goats with pregnancy. Zamuner *et al.* (2020) affirm that in terms of oxidative stress, the reproductive performance of dairy goats is like that of dairy cows. Although the infertility rate in Hair goats is low, the twin rate (1%) is also very low (Gökdal *et al*.,2013; Boztepe *et al*., 2014). Pradieé *et al*. (2017) has reported that the PON-1 level in follicular fluid in sheep is lower than that in blood serum and that the follicular fluid PON-1 level is important for most pregnancies, but in general the PON-1 levels in blood and follicle fluid are proportional.

Oxidative stress significantly affects reproductive performance and negatively affects embryo productivity as well as offspring productivity (Rizzo *et al*., 2012; Abuelo *et al.,* 2015). It is stated that PON-1 affects sperm quality in male animals and increases motility and influences fecundation rate (Dedeoğlu *et al*., 2014; Barranco *et al*., 2015).

PON-1 has a very important effect for the protection against genital infections (Deveci *et al*., 2017; Büyükleblebici, 2019). Antioxidants decrease the incidence of uterine infection and increase the rate of pregnancy, which leads to a shorter time to the next pregnancy with less insemination (Lopez-Gatius *et al*., 2006). Abuelo *et al*. (2016) reports a significant correlation between reproductive performance and oxidative stress. It is stated that higher lamb productivity is realised in sheep treated with exogenous antioxidants (Köse *et al*., 2013).

This study aimed to determine the effect of antioxidant PON-1 enzyme on reproductive performance of Hair goats, with emphasis on on pregnancy and multiple pregnancies.

MATERIALS AND METHODS

Ethics approval

Study was carried out after the decision of the Selcuk University Faculty of Veterinary Medicine Experimental Animal Production and Research Ethics Committee (09.12.2020 and 2020/116).

Experimental animals

The study was conducted with 100 females, 2–6 years of age with a live weight of 45–50 kg and 20 male goats aged 2–4 years with a live weight 60–70 kg in a family business located in Aksaray province. The water needs of the animals were met in the pasture 3-4 times/day.

Blood sample collection and analysis

In the second week of September, 100 females were randomly selected from the herd. In October, 15 days before the male introduction, blood samples were taken from previously marked goats and from all males present at the facility. Blood was taken from the same animals again before starting milking in May. Blood samples were taken from *vena jugularis* into plain tubes. The samples were transported to the laboratory in accordance with the cold chain rule. Blood samples were centrifuged at +4 °C, 3000 rpm for 10 minutes and serum were removed. Each resulting serum was transferred to two Eppendorf tubes and stored at –20 °C. Paraoxfnase-1 levels were determined by ELISA kit (Elabscience, Catalog No: E-EL-H2298, Rel Assay Diagnostics, Türkiye).

Statistical analysis

Descriptive statistics for continuous variables were mean is expressed as standard deviation, minimum and maximum values. One-way analysis of variance was performed to compare group averages in terms of continuous variables. Following the analysis of variance, Duncan multiple comparison test was used to identify different groups. The statistical significance level was taken as 5%. SPSS (ver. 21) statistical package software was used for the calculations.

RESULTS

Paraoxonase-1 values varied depending on gender and season. The value of PON-1 was statistically significantly higher ($P<0.05$) in both sexes in May than in October (Table 1).

There was a statistical difference in the PON-1 level in terms of gender and birth type (Table 2). Infertile goats had low PON-1 values, whereas goats with twin births had significantly high paraoxonase-1 concentrations. PON-1 value was found to be important for multiple births. The blood PON-1 level in single-birth Hair goats was like that of twin-birth Hair goats, but the difference between twin-birth Hair goats and infertile goats was significant ($P<0.05$).

DISCUSSION

Small ruminants are the animals that make the best use of unproductive lands with poor vegetation and bring these lands to the economy with products such as meat, milk, and mohair. Hair goats on the other hand, although difficult to manage compared to sheep, make better use of unproductive pastures. Low birth rate in Hair

Table 1. Blood paraoxonase-1 concentrations in Hair goats by season and gender. Data are presented as mean ± standard deviation (SD)

Gender	October	May
Male (n=20)	21.00 ± 8.89 #◊	528.50 ± 122.68◊
Female (n=100)	345.71 ± 183.90 #	748.32 ± 160.68

Statistically different from May; ◊ Statistically different from females.

Table 2. Blood paraoxonase-1 concentrations in Hair goats in October and May in relation to offspring yield

	Mean ± SD	Minimum-maximum
Male (n=20)	613.01 ± 291.69 A	10–1318
Single births (n=73)	323.81 ± 197.70 B	19–1341
Twin births (n=23)	431.83 ± 105.40 AB	276–692
Infertile (n=4)	250.25 ± 125.84 B	67–354
Total (n=120)	501.64 ± 284.49	10–1341

A,B: different uppercase letters in the same column indicate statistically significant difference of mean values.

goats is because the pasture vegetation on which these animals graze is not good, especially when there is no additional balanced feeding (Boztepe *et al*., 2014). In absence of balanced feeding (Özdal *et al*., 2013), the oxidative stress is high, which is reflected in the fertility of the offspring. As a matter of fact, in the study presented, the rate of multiple births is high in Hair goats with high blood concentrations of PON-1 enzyme, which is considered as an oxidative stress factor during the mating season (October).

To the best of our knowledge, there are not enough data available on the effect of the PON-1 level on offspring productivity in dairy goats (Ghavipanje *et al*., 2021). Studies aimed at increasing the yield of offspring in goats have been mostly associated with hormone levels. This study, which determines a situation that it is possible to increase fertility by reducing oxidative stress, revealed a relationship between PON-1 level and fertility. It is seen that the level of PON-1 obtained in Hair goats is especially high compared to that in other ruminants. Similar values are obtained in Hair goats from different regions by Kartal *et al*. (2021): the animals achieve the highest PON–1 value between 1.5 and 2 years and the levels tend to decrease after the age of 6 years. In the present study, the Hair goats were in the range of 2–6 years (most of them were 3–4 years old).

In the literature, no source has been found regarding the correlation between PON-1 and reproductive performance in Hair goats. However, a positive correlation between PON-1 levels and sperm motility in males and reduction of uterine infections in females has been demonstrated in cattle (Lorraine, 2009; Rizzo *et al*. 2012; Abuelo *et al*., 2015; Castro *et al*.

2018; Isola *et al*., 2019), and sheep (Lopez-Gatius *et al*., 2006; Köse *et al*., 2013; Barranco *et al.,* 2015). The results obtained in the present study are in line with the reports in cattle and sheep. During the goat breeding season (October), the pregnancy rates and twin birth rates were higher in Hair goats with high PON-1 levels. These results indicate that more follicles are formed in animals with high PON-1 blood concentrations during the mating period leading to high number of offspring. The present study showed that during the breeding season PON-1 levels of the Hair goats that gave birth to twins were significantly higher than those in single birth and infertile goats.

There was a relationship between PON-1 level and diseases (Kartal *et al*., 2021). However, Kartal *et al*. (2021) did not report the season in which samples were collected, but they reported that diseases were generally less common in groups with high PON-1 levels. Reproduction performance is expected to be higher in healthy animals. This study determined much higher PON-1 levels compared to those of Turkish Saanen goats (Salar *et al*., 2018). However, Salar *et al*. (2018) obtained samples 30 days after birth, while in the present study they were obtained approximately 60 days after birth. This is perhaps an important difference since the Hair goats were in the pasture period and the stress factors are considerably reduced, and that the Turkish Saanen goats were subject to more intensive farming and their milk yield was higher than that of the Hair goats. In addition, differences may be due to the better ability of Hair goats to adapt to care, feeding and stress factors than Turkish Saanen goats (Boztepe *et al*., 2014).

Similar results were reported by Gavipanje *et al*. (2021) and Akgul *et al*. (2019). In both studies, there was an increase in the level of PON-1 after birth. In the presented study, although high PON-1 values were observed in some goats, multiple births were not preset. Although the PON-1 value in blood serum is high, it may not reach sufficient levels in follicular fluid. Pradieé *et al*. (2017) stated that the PON-1 value in the follicular fluid should be close to the value in the blood to get multiple births. Mikuš *et al*. (2021) reported that the level of PON-1 was higher in October than in April in their study of sheep. In the present research, PON-1 level in Hair goats was higher in May compared to October. The probable reason was that the Hair goats stayed on the pasture longer in May until October, feed more evenly with the plants in the pasture and experience less stress.

In conclusion, there was a positive relationship between PON-1 level and offspring yield in Hair goats, so it is suggested that applications that will increase PON-1 level during the breeding period (addition of antioxidants to the ration, elimination of stress factors) will contribute positively to increase multiple births rates.

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