Animal Feed Science and Technology 238 (2018) 57–65

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Effects of organic selenium (Se-enriched yeast) supplementation in gestation diet on antioxidant status, hormone profile and haemato-biochemical parameters in Taihang Black Goats

Lei Shi[a,b], Youshe Ren[a,b,*], Chunxiang Zhang[a,b], Wenbin Yue[a,b], Fulin Lei[c]

[a] College of Animal Science and Veterinary Medicine, Shanxi Agricultural University, Taigu 030801, PR China
[b] Lab of Animal Reproductive Biotechnology, Shanxi Agricultural University, Taigu 030801, PR China
[c] Licheng Breeding Goat Center, Lichen 047600, PR China

ARTICLE INFO

Keywords:
Antioxidant status
Goats
Haemato-biochemical parameters
Hormone
Selenium

ABSTRACT

The objective of this study was to investigate the effects of different levels of selenium (Se-enriched yeast) supplementation in gestation diet on blood antioxidant status, hormone profile and haemato-biochemical parameters in goats. Selected pregnant Taihang Black Goats (n = 119) were randomly allotted to four treatment groups. They were fed the basal diet supplemented with 0 (control), 0.5, 2.0 and 4.0 mg Se/kg DM during gestation period. Blood samples were collected on the 140th day of gestation to evaluate blood antioxidant status, hormone levels and haemato-biochemical parameters. The results showed that dietary Se improved ($P < 0.05$) the activity of GSH-Px and SOD, T-AOC of does. No significant difference ($P > 0.05$) was found in the MDA content, GSH-Px and SOD activities between the $Se_{0.5}$ and $Se_{2.0}$ group. Dietary Se did not affect the FSH and LH level, but increased ($P < 0.05$) the estradiol, progesterone and T_4 level of does. RBC count, haematocrit value and haemoglobin concentration were not influenced ($P > 0.05$) by the Se supplemented in diet. The does in the $Se_{4.0}$ group had the highest blood WBC, lymphocytes and monocytes counts. Dietary Se did not affect the ALT and CK activity, as well as the HDL and albumin concentration, but improved ($P < 0.05$) the AST, LDH, glucose, total cholesterol and protein in serum of does. These data suggest that Se-enriched yeast is a kind of safe Se source for the pregnant animals. Se supplementation in gestation diet can not only improve the antioxidant status and stimulate the estradiol, progesterone and T_4 production of does, but also enhance the metabolism of major nutrients in goats.

1. Introduction

Selenium (Se) is an essential trace element for animals and humans. In female mammals, Se deficiency has been associated with various disorders, such as impaired fertility, abortion, retained placenta, repression of immunity (Mistry et al., 2012; Ahsan et al., 2014; Pieczynska and Grajeta, 2015), etc. Se is also a key component of numerous functional selenoproteins including glutathione peroxidases (GSH-Px), iodothyronine deiodinases and thioredoxin reductases. Activity level of these enzymes in liver or plasma is indicative of Se status and antioxidant level of the organism. Furthermore, Se is not only associated with the activity of thyroid

Abbreviations: GSH-Px, glutathione peroxidase; SOD, superoxide dismutase; MDA, malondialdehyde; T-AOC, total antioxidative capability; FSH, follicle-stimulating hormone; LH, luteinizing hormone; T_3, triiodothyronine; T_4, thyroxine; RBC, red blood cells; WBC, white blood cells; ALT, alanine aminotransferase; AST, aspartate aminotransferase; LDH, L-lactate dehydrogenase; GGT, γ-glutamyltransferase; CK, creatine kinase; LDL, low density lipoprotein; HDL, high density lipoprotein

* Corresponding author at: College of Animal Science and Veterinary Medicine, Shanxi Agricultural University, Taigu 030801, PR China.
E-mail address: sxndrys@gmail.com (Y. Ren).

https://doi.org/10.1016/j.anifeedsci.2018.02.004
Received 12 October 2017; Received in revised form 25 January 2018; Accepted 6 February 2018

peroxidase (a selenoenzyme) in the process of iodization of thyroglobulin, but also with the activity of thyroid deiodinases, selenoenzymes which catalyze the activation of triiodothyronine (T_3) from thyroxine (Beckett et al., 1987; Beckett et al., 1993; Gartner et al., 2007; Schomburg et al., 2007). However, Se is only beneficial within an appropriate dose range for all species. The ruminant animals have a general requirement of 0.1–0.3 mg/kg Se in the diet (NRC, 2007) and the estimated maximum tolerable level of Se is 5.0 mg/kg (NRC, 2005). Se excess can lead to impaired physiological functions, and Se toxicity occurs in livestock is related to several factors including diet, gender, animal species and chemical form (Koller and Exon, 1986; Schrauzer, 2000; Arthur et al., 2003).

Most of the lands in China (approximately 72%) are Se-deficient regions, in which the soil generally contains less than 0.2 mg/kg Se (Tan et al., 2002). Dietary Se supplementation is the most common approach to improve Se status of animals. Se supplements are mainly in two forms: inorganic mineral salts, typically sodium selenite (Na_2SeO_3) or selenate (Na_2SeO_4), and organic forms such as Se-enriched yeast (SY) and selenomethionine (SeMet). Se-enriched yeast, a highly available form of Se for domestic animals, is an ideal additive because it can be absorbed and retained more than inorganic Se (Juniper et al., 2006; Behne et al., 2009; Sevcikova et al., 2011).

Gestation is one of the important physiological stages in which nutritional needs are enhanced for supporting the growth and development of fetus. Nutrients including Se are transmitted via maternal circulation and placental transfer to the fetus during pregnancy. Se can be efficiently transmitted from does to their offspring even in cases of low maternal concentration of Se (Zachara et al., 1993; Hawkes et al., 2004). During pregnancy, females are also more prone to oxidative stress caused by the imbalance between the prooxidant-antioxidant levels (Toescu et al., 2002). Thus, it is most likely that maternal Se deficiency during pregnancy can lead to abnormal physiological function and poor health condition. Blood is an important and reliable medium for indicating the health status of individual animals. The blood parameters of animals can be greatly altered by numerous factors, such as nutrition, disease, stress, parturition and climate. So the hematological tests served as the basic information for animal health assistance.

Previous studies have suggested that Se supplementation in diet can improve the immune function, reproductive and growth performance in goats (Wichtel et al., 1996; Shi et al., 2010; Song et al., 2015; Aghwan et al., 2016). Blood antioxidant enzyme activities, hematological and biochemical parameters of goats can also be influenced by the Se supplemented in diet (Aghwan et al., 2013; Shokrollahi et al., 2013). However, research work about the influence of dietary Se on the antioxidant status, hormone profile and haemato-biochemical parameters of pregnant animals is rather limited, especially in gazing goat of Se deficient areas. Therefore, the current study was performed to determine whether long-term Se supplementation in gestation diet could affect the antioxidant status, hormone levels and haemato-biochemical parameters of Taihang black goats.

2. Material and methods

This study was approved by the Shanxi Agricultural University Animal Care and Ethics Committee. All experimental procedures involving animals and their care were conducted in conformity with the guidelines for the care and use of laboratory animals (the Ministry of Science and Technology of the People's Republic of China, Beijing, China, 2006).

2.1. Study site

The feeding experiment was conducted at the Lichen Breeding Goat Center in Shanxi province of China, located at longitude 36.56°E and latitude 113.4°N (Se deficiency region in China) and at an altitude of 840 m. This region has a typical north temperate continental monsoon climate with an average annual precipitation of 540 mm and an average temperature 10.4 °C.

2.2. Animals, management, and treatments

Before the trial, animals were kept in the same shed and grazed as one flock on the mountain pasture (containing 0.03–0.06 mg Se/kg DM). One hundred and sixty 3-year-old Taihang Black Goat does (with an average body weight of 38.6 ± 0.8 kg) were selected to synchronize estrus with progesterone-based protocols. They were bred using artificial insemination with diluted fresh semen after being observed in estrus. The does that did not exhibit estrus (n = 119) were randomly allocated to four treatment groups. They were individually housed in 1.0 m × 1.2 m wooded pens with concrete floors and offered the basal diet for early gestation. After a 20-days adaption period, the basal diet was gradually switched to the experimental diet (the basal diet supplemented with 0, 0.5, 2.0 and 4.0 mg Se/kg DM) for early gestation. The does received the late gestation diet from the 90th day of gestation to kidding. Daily feed allocations to each pen were adjusted according to the minimal feed refusals (< 5%) in the feed bunk. The basal diets (Table 1) were formulated to meet or exceed the nutrient requirements of goats except for Se (NRC, 2007). Feed was offered daily at 07:00 and 18:00 in equal allotments. Drinking water was freely available all the time. Se-enriched yeast (1000 mg/kg) was purchased from Angel Yeast Co., Ltd. (Yichang, China).

2.3. Sample collection

Blood sampling was performed in the morning on the 140th day of gestation. Briefly, 10-mL blood samples were taken via jugular venipuncture using an 18-gauge needle into a vacutainer tube without anticoagulants. Blood samples were allowed to stand for 20 min and centrifuged at 700*g* for 15 min. Serum was separated into 2-mL Eppendorf tubes and frozen at −20 °C until analysis. Secondly, an additional 5 mL of blood was collected into a heparinized vacutainer tube and transferred to the laboratory within 3 h for analysis.