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Effects of maternal dietary selenium (Se-enriched yeast) on growth performance, antioxidant status and haemato-biochemical parameters of their male kids in Taihang Black Goats

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ABSTRACT

To investigate the effects of maternal dietary selenium (Se-enriched yeast) on growth performance, antioxidant status and haemato-biochemical parameters of their male kids, selected pregnant Taihang Black Goats (n = 119) were randomly allotted to four treatment groups. They were fed the basal gestation and lactation diets supplemented with 0 (control), 0.5, 2.0 and 4.0 mg of Se/kg DM. Before weaning, the male kids were weighted at 30-d intervals and the growth performance was evaluated. Blood samples collected during the last month of the experiment were analyzed for antioxidant status, Se concentration and haemato-biochemical parameters. The results show that the kids in the $Se_{0.5}$ and $Se_{4.0}$ group had the highest ($P < 0.05$) birth weight and weaning weight, respectively. No significant difference was found in the birth weight between the control and the $Se_{4.0}$ group. Dietary Se levels of dams did not affect ($P > 0.05$) the body weight from 60 days of age, weaning weight, ADG and feed efficiency of kids. ADFI was not influenced ($P > 0.05$) by maternal Se. The GSH-Px and SOD activities, T-AOC and Se concentration of the kids were significantly ($P < 0.05$) improved with the increasing Se level in the diet of dams. Maternal Se increased ($P < 0.05$) the RBC count, haemoglobin content and haematocrit value of kids. The decreased WBC count, lymphocytes and monocytes percentage were also found in the Se treatment groups. Serum AST, LDH, GGT and CK activities, as well as LDL and albumin content were not affected by maternal dietary Se. The highest ALT activity, total protein and HDL content were observed in $Se_{4.0}$ group. The kids of mother fed Se had increased ($P < 0.05$) serum globulin, total cholesterol and glucose concentration. Dietary Se levels of dams had no effect ($P > 0.05$) on serum ALT, ALB, total cholesterol and protein concentration of their kids. These data indicate that appropriate maternal dietary Se can improve the birth weight and growth performance of their male kids by enhancing the antioxidant status and nutritional metabolism in Taihang black goats. It is suggested that Se-enriched yeast is a kind of relatively safe Se source for the pregnant animals, and can be supplemented to the gestation and/or lactation diets to promote growth performance of their offspring when various feeding methods and basic Se status of animals were considered.

Abbreviations: DM, dry matter; ADFI, average daily feed intake; ADG, average daily gain; GSH-Px, glutathione peroxidase; SOD, superoxide dismutase; MDA, malondialdehyde; T-AOC, total antioxidative capability; RBC, red blood cells; WBC, white blood cells; ALT, alanine aminotransferase; AST, aspartate aminotransferase; LDH, L-lactat dehydrogenase; GGT, γ-glutamyltransferase; CK, creatine kinase; LDL, low density lipoprotein; HDL, high density lipoprotein

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1. Introduction

Selenium (Se) is an essential trace element for animals and humans. Se deficiency or low Se status may lead to various disorders, such as nutritional myopathy (Zervas et al., 1988; Hamliri et al., 1993), postnatal maladjustment syndrome (Guyot et al., 2007), impaired fertility and immunity (Mistry et al., 2012; Ahsan et al., 2014). Dietary administration of Se has been reported to enhance growth performance by influencing the nutritional and metabolic functions in various species (Abbas, 2002; Kumar et al., 2009; Salles et al., 2014; Song et al., 2015). Se is also a key component of numerous functional selenoproteins, such as glutathione peroxidases (GSH-Px), iodothyronine deiodinases and thioredoxin reductases, which protect cell membrane from lipid peroxidative damage. These enzymes in liver or plasma are the important indicators of Se status and antioxidant level in the animal organism.

However, Se is only beneficial within a narrow dose range for all species. The excessive amounts of Se can be very toxic to organisms (Lemly, 2002). Se toxicity in farm animals is usually related to several factors, including diet, gender, animal species and chemical form (Koller and Exon, 1986; Schrauzer, 2000; Arthur et al., 2003). Se is supplemented mainly in two forms, inorganic mineral salts (e.g. sodium selenite: Na_2SeO_3 or selenate: Na_2SeO_4) and organic forms such Se-enriched yeast (SY) and selenomethionine (SeMet). Se-enriched yeast, a highly available organic 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).

In the past two decades, the effect of dietary Se on the growth performance of growing animals has been extensively investigated and dietary Se requirements for most livestock species have already been established (about 0.1–0.3 mg/kg). Therefore, the potential of direct Se application in improving the growth performance of animals is relatively limited. It should be considered to further improve the birth weight and growth performance of animals through the transmission of Se from dams to their offspring. Gestation and lactation are critical for the development of offspring. During gestation, the fetus relies entirely on the maternal nutrients for normal development. Lactation is also a key stage during which nutrients including Se are transmitted via colostrum and milk transfer to the newborn. Se can be efficiently transmitted from dams to their offspring even in cases of low maternal concentration of Se (Zachara et al., 1993; Hawkes et al., 2004). Due to the lack of data on Se requirement of the fetus and newborn, direct Se supplementation could easily lead to metabolic disorders in terms of deficiency or toxicity.

In recent years, studies have focused more on the influence of maternal nutrition on the growth and development of their offspring (Kumar et al., 2009; Pieczynska and Grajeta, 2015; Surai and Fisinin, 2016). However, research work on the effects of maternal Se on the growth performance of their offspring is rather limited, especially in gazing goat of Se deficient areas. Therefore, the current study was performed to determine whether Se supplementation to gestation and/or lactation diets could affect the growth performance, antioxidant status and haemato-biochemical parameters of their male kids in Taihang Black Goats.

2. Material and methods

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

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. After kidding, the lactation diet was continuously supplied to the does which produce male kids until weaning at four months of age. Daily feed allocations to each pen were adjusted according to the minimal feed refusals (< 5%) in the feed bunk. The amounts of feed offered and feed refused were weighed daily. The basal diets (Table 1) were formulated to meet or exceed the nutrient requirements of goats except for Se (NRC, 2007).

The male kids were fed green hay (0.039 mg Se/kg DM) from 10 days of age and offered a common basal diet (without Se supplementation, Yue et al., 2009) from 20 days of age until the end of the experiment. The kids were weighted at birth and every 30 d thereafter until the end of the experiment before they were fed in the morning on two consecutive days. Feed was offered daily at 07:00 and 18:00 in equal allotments. Feed refusals in the feed bunk were weighed daily to determine the net feed intake. Drinking water was freely available all the time.