

ORIGINAL ARTICLE

Dietary Boron Supplementation and its Impact on Growth, Immunity and some Minerals in the Blood of Male Goats

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Received: 26 August 2022 | Accepted: 15 October 2022

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Abstract

Boron (B) has been linked to a variety of physiological activities, and the World Health Organization considers it essential for both animal and human health. Therefore, this study was implemented to judge the safe use of B at the current dose on the growth, immunity, and blood calcium and magnesium in male goats. Two groups of male goats were used in the current study. The animals in the control group (CNT group) were offered free access to the standard diet. The animals in the B group received the control diet plus 70mg of B/kg diet for 6 months. The findings showed that there were no significant differences ($P > 0.05$) between the two groups in terms of growth indicators (Heart girth, body length, fore, and hind limb lengths, and testicular circumferences). Except after the 18th week, body length was longer in the CNT group, while hind limb length increased with B at the twelfth week. Moreover, serum levels of calcium and magnesium were similar in both groups. However, on the 24th week, serum magnesium level showed a marked increment with B compared to the CNT group ($P < 0.05$). Furthermore, the adjusted densities of serum gamma globulin were equivalent in both groups ($P = 0.814$). In conclusion, adding B to the diet, at the studied dose, to male goats had no negative effects on their ability to grow, immunity, or serum calcium and magnesium levels; therefore, it may be added to the diet without risk.

Keywords

Boron, Calcium, Heart girth, Immunity, Male goat

1. Introduction

By 2050, the human population will have risen dramatically to nine billion (Council, 2015). As a result, the demand for animal protein sources rises (Henchion et al., 2014). Therefore, improving animal product production becomes a critical issue in order to face demand. Goats are an important source of animal protein because of their ability to thrive in arid harsh environments (Aziz, 2010) and consume a variety of diets, making them an important source of animal protein to humans (Monteiro et al., 2017). Therefore, scientists must research new methods to maximize male goat activity in order to raise revenue productivity.

Numerous researchers have studied the impact of certain substances known as nutraceuticals on reproductive performance (Falsig et al., 2019). Therefore, to safeguard against a variety of health challenges, these nutraceuticals are

added to the diet of both humans and animals. However, the European Food Safety Agency (EFSA) believes that these nutraceuticals are only used to carry out specific biological actions and not to relieve diseases (Garolla et al., 2020). At present, dietary supplements are frequently prescribed to enhance male reproductive activity.

In the environment, including soils and waters, boron (B) is a naturally occurring compound with a widespread distribution. The World Health Organization views B as crucial for both animal and human health because it has been linked to some physiological processes, including immunity, reproduction, and antioxidant defense (Hu et al., 2014).

Little information about how dietary boron affects various physiological processes in farm animals, particularly in goats

are present. So, the goal of the current study was to find out how male goats' growth traits, blood mineral levels, and immunity were affected by dietary boron supplementation.

2. Materials and Methods

2.1. Animals

The present study was conducted on twelve healthy male goats (4 months old and 11.72 ± 0.6 kg average body weight). The animals were fed a commercially available diet that included bran (42%), corn (42%), and soybeans (16%), along with probiotics (0.03%), minerals (0.03%), and 0.5% sodium chloride. This blend has 2446 kcal per kilogram and 16% crude proteins. In addition to roughage and unlimited berseem.

2.2. Experimental Design

In the present study, two groups (6 animals each) of male goats were established; 1) the control group (CNT group), whereas the animals were fed the boron-free diet and 2) Boron group (B group), whereas animals were fed the same control diet in addition to the 400mg boric acid (BA)/kg diet (Nasr Company for Chemicals, Egypt), whereas 400mg of BA/kg of food is equivalent to 70mg of B/kg diet (Ibrahim et al., 2019). Males in both groups were fed their corresponding diets *ad libitum* for 6 successive months. The current study followed the rules established by the Institutional Animal Care and Use Committee of Beni-Suef University, Egypt (BSU-IACUC) and the approval number is (022-293).

2.3. Blood Sampling

In this study, four distinct-time points were decided to get blood samples from the animals. These time points included the zero-day, 12th, 18th, and 24th weeks of the experiment. Blood samples were collected via jugular vein and then centrifuged at 3000rpm for 20min then the obtained serum samples were stored in deep freeze (-20°C) till analysis.

2.4. Biochemical Analysis

2.4.1. Determination of Serum Calcium and Magnesium

In the current study, the serum levels of calcium and magnesium were evaluated by anatomic absorption spectrophotometer (Perkin-Elmer. Corporation, USA) via direct sample dilution as previously outlined (Suzuki et al., 1965).

2.4.2. Determination of Serum Gamma Globulin

The serum gamma globulins were determined using Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) according to Martinez et al., (2003).

2.5. Assessment of Body Linear Measurements

To assess the body linear measurements, heart girth, body length, forelimb length, hind limb length, and testicular

circumferences were all evaluated and compared between the two groups as described previously (Abd-Allah et al., 2019).

Concerning heart girth, a circumferential measure was applied across the chest at the area behind the forelimbs and withers, whereas the body lengths were recorded as the length in centimeters from the base of the ears to the base of the tail. Regarding the lengths of both the forelimb and hind limb, the distance was taken from the point of the shoulder or hip joint till reaching the ground.

2.6. Statistical Analysis

Collected data for the two groups were statistically analyzed in comparison for the mean and standard error mean using a statistical software program (SPSS for windows, version 16, USA) according to Coakes and Steed (2009). One-way analysis of variance (ANOVA), followed by Tukey's post hoc test for multiple comparisons was used to record the statistical differences within rows (Between the B and CNT groups at a certain time point) and within columns (Comparison of the different time- points for each group).

3. Results

3.1. Effect of Boron on Body Linear Measurements

Data in Fig (1) showed that, in comparison to the CNT group, there was no significant difference either in the heart girth or body length following B supplementation along the different time intervals of the experiment ($P > 0.05$). However, at the 18th week, the body length revealed higher values in the CNT group. Similarly, the lengths of both fore and hind limbs were comparable in both groups. At the 12th week, the length of the hind limb significantly increased with B in comparison to the CNT group. Furthermore, testicular circumferences were similar in both groups.

3.2. Effect of Boron on Serum Levels of Calcium and Magnesium

As represented in Fig (2), the serum levels of calcium and magnesium in both CNT and B groups didn't differ significantly at zero-day, 12th and 18th weeks experimental period ($P > 0.05$). However, at the 24th week, the serum magnesium level showed a noticeable increment following B supplementation in comparison to the CNT group ($P < 0.05$).

3.3. Effect of Boron on the Serum Levels of Gamma Globulin as an Indicator of Immunity

Figs (3 and 4) clarified how B affected serum gamma globulin. According to the findings, there was no significant difference between the two groups' adjusted serum gamma globulin densities ($P = 0.814$).

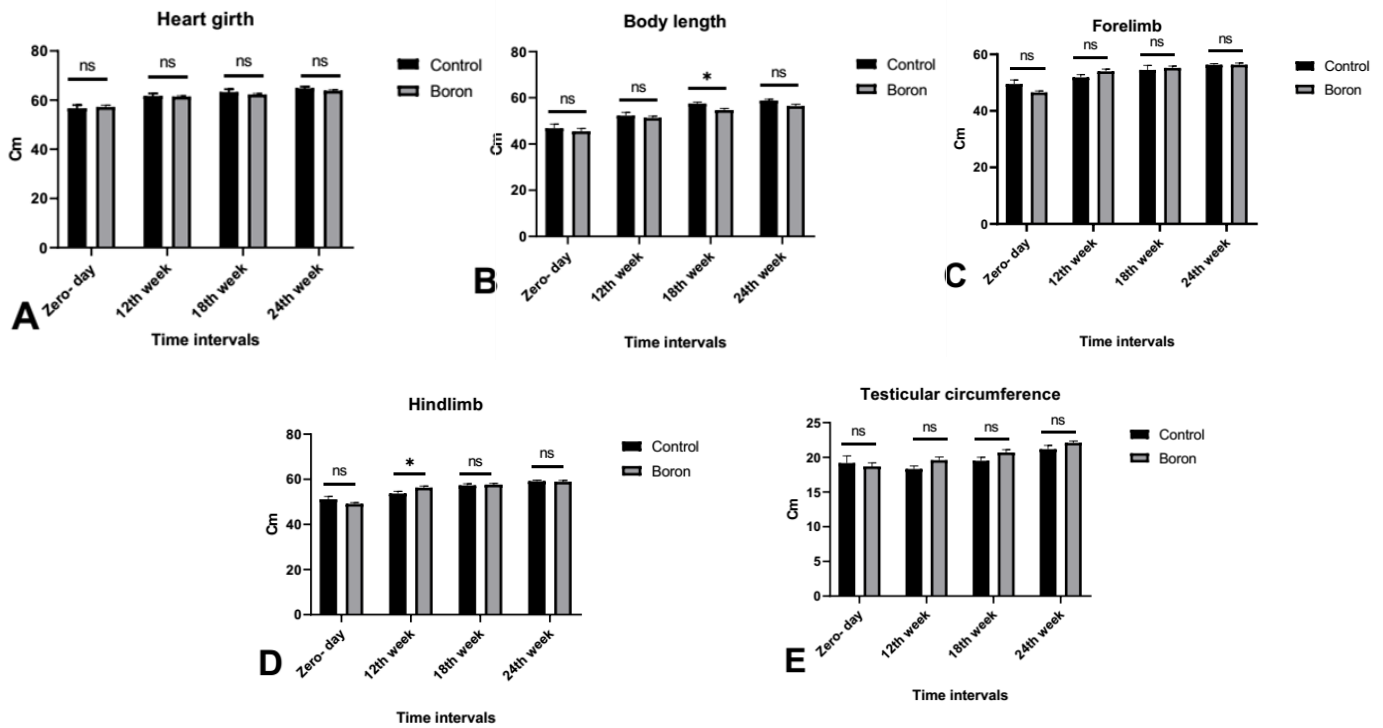


Fig 1. Effect of boron on body linear measurements including heart girth (A), body length (B), forelimb length (C), hind limb (D) and testicular circumference (E). Values were expressed as mean ± standard error of the mean. ns: none significant from each other (P > 0.05). * P<0.05.

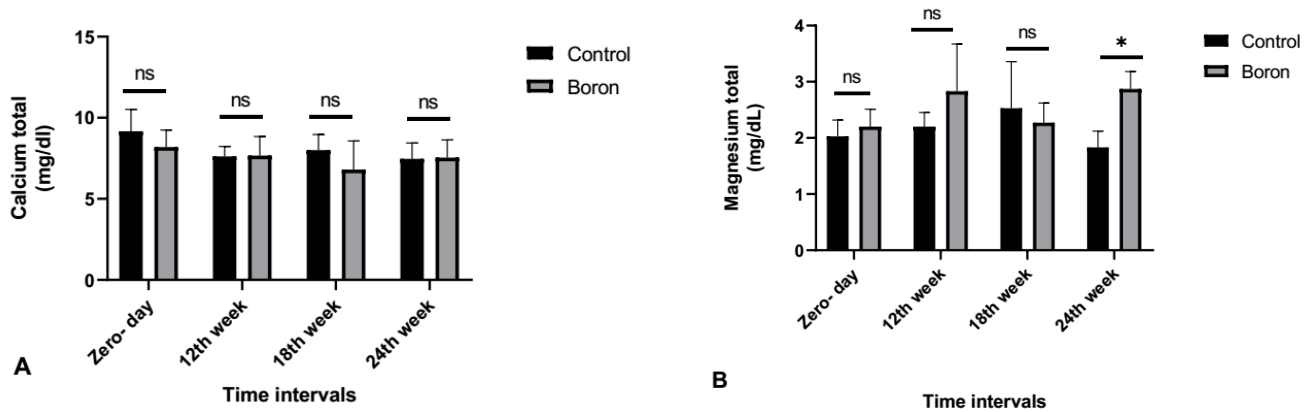


Fig 2. Effect of boron on serum levels of calcium and magnesium. Values were expressed as mean ± standard error of the mean. ns: none significant from each other (P > 0.05). * P<0.05.

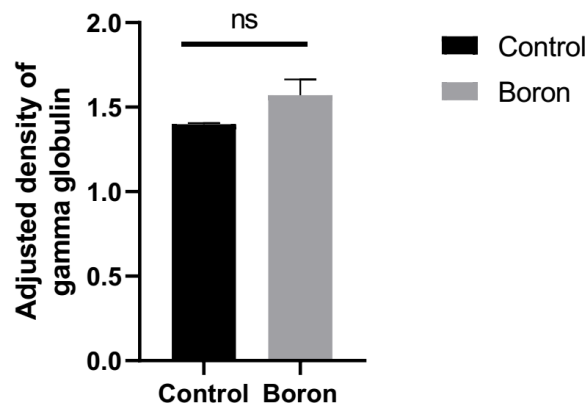


Fig 3. Effect of boron on serum levels of gamma globulin. Values were expressed as mean ± standard error of the mean. ns: none significant from each other (P > 0.05). Adjusted densities were measured using SDS-PAGE (sodium dodecyl sulfate-polyacrylamide gel electrophoresis) analysis of gamma globulin in control and treated groups.

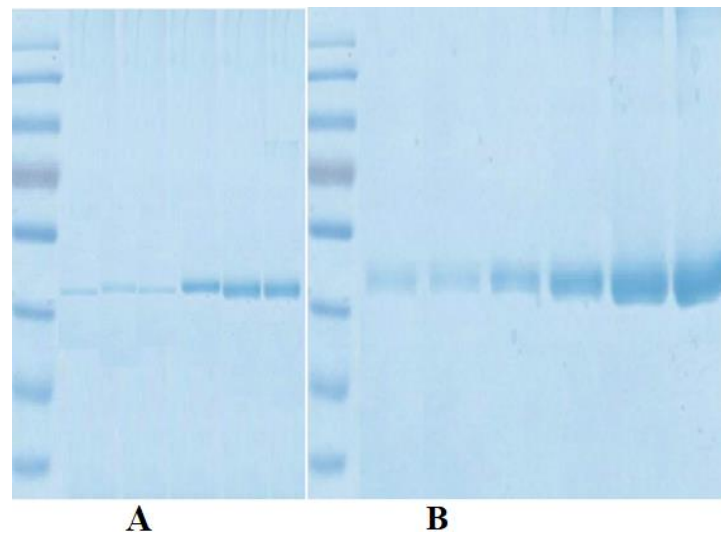


Fig. 4. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) patterns of gamma globulin in CNT (A) and B groups (B).

4. Discussion

Goat industry requires an improvement to face the higher requiring capacity for protein. One technique for this improvement is to supplement the animals' diets with trace elements. Element B has been classified essential by the World Health Organization (WHO, 1998), and it is important to manifest certain biological activities including enhancement of body growth, metabolism, and enriching the body tissues with anti-oxidative power. Therefore, the goal of this study was to explore the safe use of B in the diet of male goats on the growth, blood calcium and magnesium as well as immune status.

The present data clarified that, in comparison to the CNT group, the linear measurements including heart girth, body length, lengths of forelimb and hind limb, and testicular circumference were relatively similar in both CNT and B groups at most time points. In this concern, it has been noted that B is essential for growth because it plays an important role for strengthening the cell membrane (Goldbach et al., 2007). Boron concentration was observed to vary from species to species (Çinar et al., 2015), and low levels caused noticeable growth retardation (Fort, 2002). Therefore, B should be retained at the proper concentration to ensure normal bodily development and growth. The final body characteristics of ostrich chicks fed a diet supplemented with 160mg/LB were markedly improved. (Wang et al., 2014). The body weight of male broilers, but not females, increased after being given various doses of B (Rossi et al., 1993). When B was administered to birds at concentrations of 30, 60, 90, and 120ppm, they developed linearly between the 3rd week and the 6th week of age. Furthermore, B at 30ppm increased feed conversion and decreased mortality (Fassani et al., 2004). Boron was observed to be beneficial to amend the reduced growth rate in pigs after being exposed to a deficient diet (Armstrong et al., 2001). Similarly, B in the swine's diet at low levels (5–10ppm) remarkably succeeded in improving weight gain and feed efficiency (Goihl, 2002). The current findings could therefore imply that B, at such a

dose, could sustain body growth within the range of control while having no negative consequences.

Serum calcium and magnesium levels in the CNT and B groups did not differ significantly. In the 24th week, however, it was shown that B supplementation considerably increased the serum magnesium level ($P < 0.05$). This is supported by a previous study in sheep that reported a beneficial role of B to keep the serum levels of calcium and magnesium within the physiological level (Ibrahim et al., 2019). According to another study, B was observed to be advantageous or necessary for optimal calcium metabolism and the prevention of bone loss, which affects postmenopausal women and older men (Nielsen et al., 1990). Boron was found to be essential for proper blood Ca and Mg homeostasis. According to this criterion, B is given priority in order to mitigate many obstacles in dairy cows including milk fever and hypomagnesaemia (Kabu and Civelek, 2012).

The current study proved that B supplementation didn't induce any adverse effects on the immune status of the male goats by keeping the serum gamma globulins within the control range. B was observed to keep the normal immune and antioxidant status via up regulating the hepatic mRNA expression levels of both SOD isoenzymes (Bhasker et al., 2016). B was involved to keep normal humoral and cellular immunity by boosting splenic IL-2 expression, the CD4+/CD8+ cell ratio, and decreasing the amount of splenic CD8+ cells (Jin et al., 2017). This explains why the immune status in this study was maintained at the control level.

5. Conclusion

Adding B supplements to a male goat's diet did not appear to have any negative impact on linear growth measures, blood calcium and magnesium levels, or immunity. Boron might thus be introduced to the diet of male goats at such a dose without posing any risk.

6. Authors Contributions

All authors contributed equally to the study design methodology, interpretation of results, and preparation of the manuscript.

7. Conflict of Interest

The authors declare no conflict of interest.

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How to cite this article:

Ibrahim TB, Ibrahim SS, El-Anwar AH, Mabrook EA, Abdel-Wahab A. Dietary Boron Supplementation and its Impact on Growth, Immunity and some Minerals in the Blood of Male Goats. *J Vet Med Res.*, 2023; 30(1): 19–23. <https://doi.org/10.21608/jvmr.2022.157254.1067>