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Effect of Dietary Zinc or Selenium Supplementation on Some Reproductive Hormone Levels in Male Baladi Goats

[1]G.A. El-Sisy, [1]A.M.A. Abdel-Razek, [1]A.A. Younis, [2]A.M. Ghallab and [2]M.S.S. Abdou

[1]Deparment of Animal Reproduction and AI,
Veterinary Division, National Research Center, Dokki, Ciza, Egypt
[2]Department of Theriogenology, Faculty of Veterinary Medicine, Cairo University, Giza, Egypt

Abstract: Twelve, Male Baladi goats were used to investigate the effect of organic zinc or selenium supplementation on some hormones (Testosterone, triiodothyronine; T_3 and thyroxine; T_4). Following an adaptation period for three months on a basal diet, bucks were randomly assigned into three groups; each of four bucks. Group A served as control, group B was given the basal diet supplemented with 40-ppm zinc methionine and Group C was fed a basal diet supplemented wih 0.15 ppm selenium enriched yeast. Blood samples were collected once weekly and the total testosterone, T3 and T4 levels in blood serum were assayed by a solid-phase I^{125} radioimmuno-assay. Results revealed that zinc and selenium supplementation resulted in a significant increase in testosterone concentration. Zinc supplementation significantly increase T_3 concentration, while selenium supplmentation resulted in a significant decrease in T_4 concenetration concomitant with increase in T_3 concentration.

Key words: Zinc-selenium-trace elements · reproduction-male · goat-testosterone-T3-T4

INTRODUCTION

Much attention has been given to the impact of zinc on male reproductive function. In farm animals, zinc plays an essential role in testicular growth and development of seminiferous tubules, spermatogenesis, testicular steriodogensis, androgen metabolism and interaction with steroid receptors [1-3].

Zinc has also an important role in thyroid metabolism [4]. In addition to its participation in protein synthesis, it is involved in T_3 binding to its nuclear receptor [5]. However, [6] concluded that zinc supplementation had no significant effect on thyroid function. Research conducted over the last decades had clearly shown that selenium is essential for male fertility and testosterone biosynthesis [7, 8]. Also, selenium is a component of deiodinase enzyme, which transform T_4 into T3 [9] and it plays a role in oxidative stress control at the thyroid gland as a component of glutathione peroxidase.

Male goats seem to be sensitive to marginal dietary levels of zinc [10]. Consequently, sufficient zinc must be supplied continuously because little is stored in the body of goats and young males need more zinc than females, with 10 ppm being a minimum requirement and 1,000 ppm may be toxic [11]. Moreover, a comprehensive study in goats showed that this species is as susceptible as others to selenium deficiency with 0.1 mg Se/kg dry matter is adequate for goats[12].

Zinc, manganese, iron and copper are deficient in most growing plants in Egypt [13]. Although, soil selenium level in Egypt was found to be adequate, field studies indicated that buffalo calves suffered from nutritional muscular dystrophy due to selenium deficiency [14].

Thus, the main objectives of the current contrived work, were to investigate the effect of organic zinc or selenium supplementation in ration of male Baladi goats on testosterone and thyroid hormone levels.

MATERIALS AND METHODS

Twelve, 13-months old male Baladi goats with average body weight of 25-32 kg were used in the current work. The animals were housed in three separate pens with expanded concrete floors in the National Research Center Experimental Farm at Abou-Rawash, Giza. The

Corresponding Author: Dr. Ahmad Younis, Deparment of Animal Reproduction and AI, Veterinary Division, National Research Center, Dokki, P.O. Box: 12622, Ciza, Egypt

Table 1: Ingredients and chemical composition of the basal diet

Ingredients	%
Yellow corn, grain	40.00
Soya bean meal (44% CP)	22.70
Wheat straw	35.00
Dicalcium phosphate	1.50
Salt	0.50
Minerals and vitamins premix*	0.30
Chemical composition	
Dry matter (%)	87.81
Crude protein (%)	14.51
Total digesTable nutrients (TDN) (%)	63.46
Zinc (ppm)	24.53
Selenium (ppm)	0.161

*Zinc and selenium free mineral mixture each 3kg contained: vitamin A 10,000,000 IU, vitamin D_3 2,000,000 IU, vitamin E 20, 000 mg, cobalt 500 mg, iodine 1000 mg, iron 45,000mg, manganese 120,000mg and copper 75 mg

ration used was formulated to be adequate in protein, energy, vitamins and minerals to meet the nutrient requirements of goats according to [15]. The basal diet contained 24.53 ppm (mg/kg) zinc and 0.161 ppm selenium (Table 1).

After a preliminary period of three months on the basal diet, animals were offered zinc or selenium supplementation 7 months. Bucks were fed once daily at 08.00 am and had free access to water. Following 3 months adaptation period, bucks were randomly assigned into three groups; each of four bucks.

Group A: Served as a control and was fed the basal diet only without any feed supplementation.

Group B: (zinc-supplemented group). Animals were fed a basal diet supplemented with 40-ppm zinc methionine (biomet zn-10%, Norel S.A., Madrid, Spain)

Group C: (selenium-supplemented group) bucks were fed a basal diet supplemented with 0.15 ppm selenium enriched yeast (Sel-Plex 50, Altech, inc, USA

Blood samples were collected once weekly at a fixed time in the morning (9.00-9.300 am), blood samples were allowed to coagulate for 30 minutes at room temperature and then centrifuged at 3000 rpm for 30 minutes. Serum was harvested and stored at –20°C. Total testosterone, total T3 and T4 levels in blood serum were assayed by a solid-phase I^{125} radioimmuno-assay using available commercial kits (Coat-a-Count, diagnostic product corporation, Los Angles, USA). Assay has sensitivity of 0.4 ng/ml with inter and intra-assay c.v both being <13% for testosterone,0.25 μg/dl, 3.15% and 8.18% for T4 and 0. 09ng/ml, 4.87 and 5.80% for T3, respectively.

Statistical analyses: Data were analyzed statistically for testosterone, T3 and T4 hormones levels by 2-way analysis of variance using statistical analysis program-user guide, 6.04 [16]. In the statistical model the effects of supplementation and period of treatment as well as interaction between them were the main source of variance. In addition differences between means were compared with LSD procedure.

RESULTS

The effect of dietary zinc or selenium supplementation on serum testosterone, T4 and T3 levels, as well as T3/T4 ratio were illustrated in Table 2-5, respectively.

Table 2: Serum testosterone level (ng/ml) of Baladi bucks in zinc and selenium-supplemented groups after different supplementation periods (Mean±SEM)

		Supplementation periods	
Group	Pre-supplementation period	3 month	6 month
Control	1.57 ± 0.69^{a}	1.52 ± 0.31^{a}	1.02 ± 0.35^{a}
Zinc	1.54 ± 0.48^{a}	$4.00\pm0.70^{b*}$	$2.76\pm0.60^{ab*}$
Selenium	1.51 ± 0.63^{a}	$3.76\pm0.43^{b*}$	$2.96\pm0.53^{ab*}$

Within rows, means with different alphabetical superscripts are significantly different at least at P<0.05. Within columns, a (*) indicates significant difference (at least at P<0.05) of a given element from control

Table 3: Total serum thyroxine (T4) level(ng/ml) of Baladi bucks in zinc and selenium-supplemented groups after different supplementation periods (Mean±SEM)

		Supplementation periods	
Group	Pre-supplementation period	3 month	6 month
Control	41.90 ± 2.20^{a}	40.86 ± 1.60^{a}	40.92 ± 1.60^{a}
Zinc	38.75 ± 5.07^{a}	38.60 ± 2.29^{a}	40.20 ± 2.13^{a}
Selenium	35.78 ± 4.47^{a}	$27.53\pm0.45^{ab*}$	$25.99\pm3.86^{b*}$

Within rows, means with different alphabetical superscripts are significantly different at least at P<0.05. Within columns, a (*) indicates significant difference (at least at P<0.05) of a given element from control

Table 4: Serum triiodothyronine (T_3) level (ng/ml) of Baladi bucks in zinc and selenium supplemented groups after different supplementation periods (Mean±SEM)

		Supplementation periods	
Group	Pre-supplementation period	3 month	6 month
Control	0.59 ± 0.20^{a}	0.78 ± 0.18^{b}	0.67 ± 0.22^{ab}
Zinc	$0.34\pm0.31^{a*}$	0.86 ± 0.10^{b}	$0.77\pm0.15^{b*}$
Selenium	0.66 ± 0.29^{a}	$0.93\pm0.03^{b*}$	$0.93\pm0.05^{b*}$

Within rows, means with different alphabetical superscripts are significantly different at least at P<0.05. Within columns, a (*) indicates significant difference (at least at P<0.05) of a given element from control

Table 5: Serum T_3/T_4 ratio of Baladi bucks in zinc and selenium-supplemented groups after different supplementation periods (Mean±SEM)

Group	Pre-supplementation period	Supplementation periods 3 month	6 month
Control	0.010±0.001[a]	0.021±0.001[b]	0.016±0.001[ab]
Zinc	0.009±0.002[a]	0.023±0.001[b]	0.021±0.001[b]
Selenium	0.019±0.003[a]	0.048±0.010[b*]	0.047±0.010[b*]

Within rows, means with different alphabetical superscripts are significantly different at least at P<0.05. Within columns, a (*) indicates significant difference (at least at P<0.05) of a given element from control

DISCUSSION

The current study investigate the effect of zinc or selenium supplementation on blood serum testosterone levels in bucks. It was evident that testosterone levels increased significantly in sera of zinc supplemented bucks. These changes are in close agreement with previously published results in ram [17]. Zinc deficiency caused reduction in testosterone secretion in rams and impair the responsiveness of Leydig cell to gonadotrophins [18]. This effect could be due to a malfunction in LH receptors mechanism controlling storage and release of testosterone [19], lesion in the biochemical systems controlling steroid synthesis [20], or damage to smooth endoplasmic reticulum of the Leydig cells where testosterone is synthesized [21].

The current study provided clear evidence that selenium supplementation caused a significant increase of testosterone level in blood serum of goat bucks. Similar observations were recorded in bucks [22].With respect to the effect of selenium deficiency on testosterone level, serum level of testosterone in selenium-depleted rats was significantly lower than that in the selenium adequate-rats [23]. In the Leydig cells, glutathione peroxidase (Se-dependant) has been localized immunocytochemically in the cytoplasm in close relationship to the smooth endoplasmic reticulum [24] and it is possible that the metabolic pathway of testosterone biosynthesis requires protection against peroxidation and is thus affected by a decrease in the activity of this enzyme [23]. It can, therefore be suggested that the increase of testosterone in serum of selenium supplemented goat bucks might have been due to the concomitant increase in glutathione peroxidase activity that protects the testes from the unfavorable effect of reactive oxygen species or through its effect on Leydig cells and steriodogenic functions. In the light of the current study, supplementation of bucks with selenium yeast enriched diets increased the basal plasma level of triiodothyronine (T_3) and reduced the basal plasma concentration of thyroxine (T_4) and increased T_3/T_4 ratio. Our results are in full agreement with those of [25] in goats and [26] in sheep.It has long been shown that selenium is a second essential trace element, next to iodine, required for appropriate thyroid hormones synthesis, activation and metabolism; and that the thyroid has the highest selenium content per gram of tissue among all body organs [27]. Eventually, membrane-bound seleno-proteins were identified as a type 1 iodothyronine deiodinase (IDI), capable of transforming T_4 to the physiologically active form, T_3 [28]. In addition, selenium plays an important role in oxidative stress control at the thyroid hormone level as a component of the enzyme glutathione peroxidase.

In the present study, the mean concentration of total T_3 was significantly increased in bucks fed diets supplemented with zinc yeast as compared with the control ones. However, the mean concentration of total T_4 kept constant through the course of the study. This result is in agreement with previous studies denoting that zinc supplementation increase the total T_3 [29]. It has been reported that zinc in addition to its participation in protein synthesis, is involved in T_3 binding to its nuclear receptor [5]. Also, zinc participates in the formation and action of thyrotropin-releasing hormone (TRH). [30] reported that the processing of prepro-TRH to form TRH is zinc dependent via posttranslational processing enzymes such as carboxypeptidase H. In addition to its direct effect on thyroid function, zinc deficiency can indirectly affect thyroid hormone status by decreasing energy intake [31].

In conclusion, zinc or selenium supplementation is essential for improving the reproductive efficiency of male goats specially those raised on areas deficient in one of them.

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