Journal of Animal and Veterinary Advances 11 (21): 3894-3897, 2012
ISSN: 1680-5593

Effects of Dietary Inorganic Iodine and Selenium on Their Concentrations in Serum, Muscle and Organs in Kacang Goats

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Abstract: The objective of this study was to evaluate the impact of supplementing inorganic Selenium (Se), Iodine (I) and combination of both on their concentrations in serum, skeletal muscle and organs of 24 local Kacang crossbred meat goats. Four dietary treatments of six goats each were randomly allotted to basal diet without supplementation (background only) as control (T1), basal diet + 0.6 mg Se kg^{-1} DM (T2), basal diet + 0.6 mg I kg^{-1} DM (T3) or basal diet with combination of 0.6 mg Se + 0.6 mg I kg^{-1} DM (T4) for 100 consecutive days. Serum samples were collected at days 0, 30, 60 and 95 for the determination of Se and I concentrations. Semitendinosus (ST) muscle, liver and kidney were also collected, vacuum packaged and stored frozen until assayed for the Se and I levels. The levels of I and Se in the serum of supplemented groups (T2, T3 and T4) were significantly higher compared to control (T1). In comparison with the control animals (T1) I and Se concentrations in the ST muscle, kidney and liver were also higher ($p<0.05$) in the supplemented groups. The results demonstrated the potential of Se and I dietary supplementation employed in this study to increase the concentrations of both elements in the serum, muscle, liver and kidney of goats.

Key words: Goat meat, iodine, selenium, retention, crossbred, organs

INTRODUCTION

Goats are domesticated globally for the production of meat for human consumption especially in rural areas. Goat meat (chevon) has been universally accepted by different cultures (Boyazoglu *et al*., 2005) and it contains less fat compared to other types of red meat which are also preferable in the western diets (Sen *et al*., 2004; Mushi *et al*., 2008; Pena *et al*., 2009). The physiological functions of trace elements, particularly their role on metabolic and protective processes make them crucial for the nutrition of human and animal. It is necessary to supplement trace elements to animal feed up to the required level because of their low native dietary concentrations (Pallauf and Muller, 2006). As far as livestock products are concerned in most parts of the world, milk has been regarded as the main source of these elements. Alternatively, Selenium (Se) and Iodine (I) can also be obtained through meat consumption. Studies in pigs (Li *et al*., 2011) bulls (Meyer *et al*., 2008) and broiler chicken (Rottger *et al*., 2011) have demonstrated that I supplementation resulted in higher I levels in their blood, muscle and organs. Kaufmann and Rambeck (1998) reported that despite its inferior effectiveness, the carry-over of I into meat is feasible. Earlier studies in lambs (Vignola *et al*., 2009; Liu *et al*., 2011) indicated that Se supplementation with different levels and source reflected a positive response on its concentration in muscle tissue. There are still selenium (Rayman, 2004) and iodine (Kaufmann and Rambeck, 1998) deficiencies in many populations which justify continuous efforts to increase these two trace elements in food such as eggs, milk and meat through fortification of compound animal feeds with selenium and iodine. Therefore, this study was conducted to examine the effects of supplementing inorganic Se, I and a combination of both on their retention levels in serum, muscle and organs of goats.

MATERIALS AND METHODS

The study was conducted on 24 local Kacang crossbred male goats aged at 7-8 months old with mean initial body weight 22±1.17 kg. The animals were randomly assigned to 4 dietary treatments: T1 (control) basal diet

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without supplementation (background only); T2-basal diet with 0.6 mg Se kg^{-1} DM; T3-basal diet with 0.6 mg I kg^{-1} DM; T4-basal diet with combination of 0.6 mg Se and 0.6 I kg^{-1} DM. The supplementation levels of Se and I chosen in this experiment were twice higher than the levels recommended by the National Research Council (NRC, 1981) at which would be safe for the animals in term of toxicity. The inorganic Se and I were given in the form of Na selenite and K iodide, respectively. Blood samples were collected via jugular venipuncture at days 0, 30, 60 and 95 of the feeding trial, centrifuged and the harvested serum was frozen at -20°C until subsequent analysis. The animals were slaughtered according to Halal slaughter procedure as outlined in the MS1500: 2009 (DSM, 2004) and samples of Semitendinosus (ST) muscle, liver and kidney were collected, vacuum packaged and stored frozen for minerals retention measurements. Inductively Coupled Plasma-Mass Spectrometry (ELAN DRC-e Perkin Elmer, Canada, 2008) was used to determine I and Se concentrations in the ST, liver and kidney (AOAC, 1984) and serum (Schone *et al*., 2001). The data were statistically analyzed using the GLM procedure of SAS Version 9.2 Software (Statistical Analysis System, SAS Institute Inc., Cary, NC, USA) and statistical significance was set at $p<0.05$ for one-way Analysis of Variance (ANOVA). Repeated measurement in time was used for Se and I concentrations in the serum. Differences between the means were determined by Duncan's multiple range test.

RESULTS AND DISCUSSION

In comparison with T1 (control), higher concentration ($p<0.05$) of Se was indicated by the ST muscle and kidney of T2 and T4 animals (Table 1). In line with the results, Shi *et al*. (2011) reported that muscle and kidney Se content of goats received diets supplemented with Na-selenite was significantly higher than control animals.

Table 1: Concentrations of Se (mg kg^{-1}) and I (μg kg^{-1}) in Semitendinosus (ST) muscle, liver and kidney of goats fed different dietary treatments

	Dietary treatments‡				
Concentration	T1	T2	T3	T4	SEM
Se (mg kg^{-1})					
ST	0.50^{c}	0.81^{a}	0.57^{bc}	0.71^{ab}	0.06
Liver	0.79^{ab}	0.87^{ab}	0.65^{b}	0.94^{a}	0.07
Kidney	0.95^{b}	1.73^{a}	0.93^{b}	1.64^{a}	0.08
I (μg kg^{-1})					
ST	3.80^{b}	4.25^{b}	14.95^{a}	6.85^{ab}	2.47
Liver	2.80^{b}	3.85^{b}	32.85^{a}	29.50^{a}	3.52
Kidney	4.00^{b}	4.80^{b}	51.10^{a}	40.55^{a}	5.95

‡T1: [Control, basal diet without supplementation (background only)]; T2: basal diet + 0.6 mg Se kg^{-1} DM; T3: basal diet + 0.6 mg I kg^{-1} DM; T4: basal diet + (0.6 mg Se kg^{-1} DM + 0.6 mg I kg^{-1} DM); a-c Least-square means with different superscripts within the same row differ significantly; ($p<0.05$). SEM: Standard Error of Means

Additionally, Vignola *et al*. (2009) mentioned that muscle tissue Se concentration of the lambs supplemented with Na-selenite was significantly increased with respect to the non-supplemented control. Results of liver Se content was indicated no significant differences between Se supplemented animals (T2) and control animals (T1). Similar to the results, Mateo *et al*. (2007) reported that liver Se content of pigs fed on diets supplemented with Na-selenite did not differ from liver Se content of pigs fed non-supplemented diets while the muscle Se concentration for the supplemented group was greater than the muscle Se concentration of control. In the liver, a significant elevation in Se concentration was noted in the T4 group but only in comparison with the T3. Skrivanova *et al*. (2007) indicated that the response in Se deposition to dietary supplementation is tissue-dependent. In this study, I contents in the ST muscle, liver and kidney of T3 goats were significantly higher than those from the T1 (control) and T2 groups. In agreement with the results, Kaufman and Rambeck (1998) observed positive response for pigs to dietary I supplementation, the accumulation of I in supplemented group increased significantly than control. The highest I concentration was in the kidney followed by the liver, heart and muscle. Similarly, I-supplementation of growing fattening bull's diets significantly increased I concentration in the kidney followed by liver and meat (Meyer *et al*., 2008). The content of Se and I in ST, liver and kidney of T4 animals (Se + I) was markedly increased (Table 1). However, I content of ST was 2 fold higher than control. The total content of Se and I in the ST muscle, liver and kidney of the T4 animals were almost similar compared to the animals of T3 and T2, respectively. The results of this study showed that Se concentration was higher than that of I. In pigs, Schone *et al*. (2006) postulated that the limitation of I accumulation in the meat could be explained by unequal distribution of the element in the body with the highest content normally presented by the thyroid gland.

The Se and I concentrations in serum of the animals supplemented with either I (T3) or Se (T2) or combination of both (T4) were higher ($p<0.05$) than those in the control group (T1) (Fig. 1 and 2). In agreement with the results in serum Se concentration, Shi *et al*. (2011) in meat goats and Petrera *et al*. (2009) in dairy goats reported that serum Se concentration of the animals received Se supplemented diets was significantly higher than control animals. In line with our result of serum I concentration, He *et al*. (2002) reported significant serum thyroxine (T_4) concentration in all supplemented pigs received either potassium iodide (KI) or the algae Laminariadigitata than non-supplemented animals. Meyer *et al*. (2008) also indicated that higher

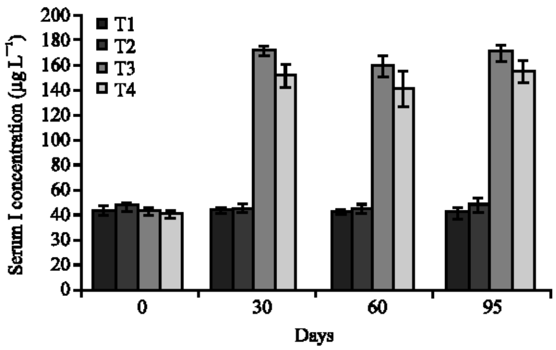

Fig. 1: Serum iodine concentration (μg L^{-1}) in goats fed different dietary treatments; T1: [control, basal diet without supplementation (background only)]; T2: basal diet + 0.6 mg Se kg^{-1} DM; T3: basal diet + 0.6 mg I kg^{-1} DM; T4: basal diet + (0.6 mg Se kg^{-1} DM + 0.6 mg I kg^{-1} DM); the significant differences in serum I concentration were observed at day 30 of the feeding trial. However, there is no further increase in serum I concentrations at days 60 and 95 of the experiment

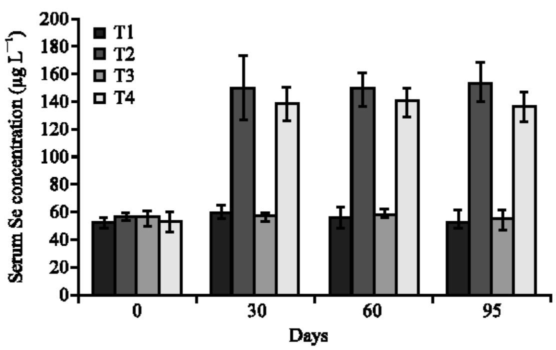

Fig. 2: Serum selenium concentration (μg L^{-1}) in goats fed different dietary treatments; T1: [control, basal diet without supplementation (background only)]; T2: basal diet + 0.6 mg Se kg^{-1} DM; T3: basal diet + 0.6 mg I kg^{-1} DM; T4: basal diet + (0.6 mg Se kg^{-1} DM + 0.6 mg I kg^{-1} DM); the significant differences in serum Se concentration were observed at day 30 of the feeding trial. However, there is no further increase in serum Se concentrations at day 60 and 95 of the experiment

dietary I supplementation in growing fattening German Holstein bulls significantly increased serum and plasma I concentration. The significant differences in Se and I concentration in serum were observed at day 30 of the feeding trial. However, there were no further increase in Se and I concentrations at days 60 and 95 of the experiment. This suggests that both I and Se could have attained their steady state at day 30 of the experiment. The supranutritional supplementations of I and Se for 30 consecutive days may have triggered homeostasis of serum I and Se through absorption, distribution, activities and secretion. The remaining period of feeding could have allowed minerals to accumulate in the organs and muscles. Zachara *et al.* (1993) reported that plasma Se concentration in the sheep treated with dietary Se level of 0.58 mg kg^{-1} DM have reached steady state after 32 days of the experimental feeding.

CONCLUSION

The results of this study highlight the potential of supplementation of Se and I at the level of 0.6 mg kg^{-1} DM as a dietary intervention to increase their contents in the blood, muscle, liver and kidney. The increased Se in ST muscle, liver and kidney may positively impact the human nutrition. However, chevon has to be classified as low iodine food to consumer's daily requirement. The findings generated through this study may also provide a scientific basis for future researches on the influence of inorganic I and Se on meat eating quality traits.

ACKNOWLEDGEMENTS

The researchers would like to thank all staffs and graduate students in the Meat Science Laboratory, Department of Animal Science, Universiti Putra Malaysia for their technical support and assistance throughout the conduct of the study. This project was funded by the Ministry of Higher Education, Malaysia through the Fundamental Research Grant Scheme (Project No. 015-01-07-370).

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