THE IMPACT OF INCORPORATION OF ORGANIC SELENIUM INTO MEAT ON GROWTH PERFORMANCE, ANTIOXIDATIVE STATUS, AND IMMUNE RESPONSE IN GROWING RABBITS

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ABSTRACT

Thirty California male rabbits, 6 weeks old, were randomly divided into 3 experimental treatments (10 each). Animals were fed *ad libitum* the basal diet containing 0.13 ppm selenium (Se), supplemented with 0 (control), 0.15 or 0.3 ppm organic Se in the form of a yeast source from 6 to 12 weeks of age. Dietary supplementation of organic Se increased final body weight and daily gain, while feed conversion ratio was reduced in the growing rabbits. Supplementation with 0.15 and 0.3 ppm organic Se increased both hot carcass weight and dressing percentage. Se deposition in hindleg meat significantly increased in proportion to the dietary organic Se concentration. Dietary organic Se had no negative effects on chemical composition in hindleg meat. It is also interesting to note that inclusion of 0.15 or 0.3 ppm Se in the growing rabbits' diets elevated serum total antioxioxidant capacity and reduced the lipid peroxidation expressed as serum malondialdehyde which finally translated into enhancing the immune response. In conclusion, supplemental dietary organic Se enhanced growth performance and carcass weight, increased the Se content in meat, stabilized the antioxidative status, and elevated the humoral immune response in growing rabbits.

Key words: Organic Se, antioxidative systems, immunity.

INTRODUCTION

Rabbit meat is considered a popular Mediterranean food in European and North African countries and it plays an important role in the national economy of these countries. Rabbit meat may be excellent to produce specific functional foods since its good properties such as the fatty acid profile, mineral and vitamin contents which could be further enriched via feeding (Suraï, 2002; Marounek *et al.,* 2009; Dalle Zotte and Szendrő, 2011). Selenium (Se) is an essential element required for normal animal growth and reproduction (Suraï, 2002). Se-enriched meat could be achieved through the fortification of diets with organic Se (selenomethionine) as it is incorporated into proteins in place of methionine (Rayman, 2004). It has been demonstrated that dietary Se supplementation increases Se concentration in the meat of rabbits (Dokoupilová *et al.,* 2007; Marounek *et al.,* 2009), pigs (Zhan *et al.,* 2007) and lambs (Molnár et al., 1998). In fact, Se plays an important role in activating the antioxidative properties via its involvement in the active site of the enzyme glutathione peroxidase (GSH-Px) in blood, liver and edible tissues (Suraï, 2002) which might be connected with enhancing the immune response in mammals (Rayman, 2004). Also, using Se in rabbit diets is beneficial to lipid oxidative stability thus preserving meat quality (Dokoupilová *et al.,* 2007). Contradictory results have been reported concerning the possible effects of such Se-enriched diets on growth performance in fatting rabbits. Additionally, according to our knowledge, there is a lack of information on the effect of dietary supplementation of organic Se on immunity in growing rabbits.

Therefore, the objective of this study was to examine the effect of supplemental dietary organic Se on growth performance, carcass characteristics, meat quality, plasma antioxidative status and immune response of growing rabbit.

MATERIALS AND METHODS

Thirty California male rabbits (weaned at 6 weeks of age) weighing 740±25 g were randomly divided into three experimental treatments (n=10 each) and housed individually in stainless steel cages. Animals were fed *ad libitum* the basal diet containing 0.13 ppm Se, supplemented with 0 (control), 0.15 or 0.3 ppm organic Se in the form of a yeast source (Sel-Plex®, containing selenomethionine as the main selenocompound, Alltech Inc, Nicholasville, KY, USA) from 6 to 12 weeks of age. The basal diet was formulated to meet the recommended nutrient requirements of growing rabbits (NRC, 1977). Body weight and feed consumption were determined weekly throughout the experimental period. At the end of the experimental period (12 weeks old), all rabbits in each treatment were kept off feed for 12 h, weighed and slaughtered for carcass traits and meat analysis. Slaughter procedure and carcass analysis were carried out as described by Blasco and Ouhayoun (1996). Hot carcasses, liver, kidneys, heart, and head were weighed and their proportion to the hot dressed carcass weight was calculated. Dressing percentage was calculated by dividing the hot dressed carcass weight by preslaughter weight and expressed as a percentage. Chemical analyses of hindleg meat were carried out according to AOAC (2000). Se concentration in meat were analyzed by the method of Brown and Watkinson (1977) using a semi-automated fluorometer. Blood samples (5 ml from each rabbit) were collected during slaughter to determine blood components. Blood serum total antioxidant capacity, malondialdehyde, total proteins, albumin, total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides were colormetrically determined using commercial kits (purchased from Bio-diagnostic, Egypt) according the manufacturers' instructions. Serum globulin concentration was calculated as the difference. Total antibody titres against sheep red blood cells (SRBC) were measured in rabbits (n=10) using a microhemagglutination assay according to the method of Wegmann and Smithies (1966). The differences among treatments were statistically analyzed with a one-way ANOVA test in a completely randomized design with the type of diet (Se level) as the main source of variation.

RESULTS AND DISCUSSION

Results concerning the effect of dietary organic Se supplementation on growth performance and carcass traits of growing rabbits are presented in Table 1. Supplemented dietary Se showed a positive effect on growth performance of growing rabbits. Dietary supplementation of organic Se increased the final body weight and daily gain, while feed conversion ratio was reduced in the growing rabbits (Table 1). The possible reasons are that organic Se as an antioxidant can protect intestinal mucosa against oxidative damage and pathogens and limit peristaltic activity in digestive disorders preventing diarrhea (Kermauner and Laurenčič, 2008) as well as to the immunomodulating properties of Se (Suraï, 2002). Additionally, Edens (2001) suggested that the increased body weight of broiler chickens fed organic Se could be related to the increased concentration of thyroid hormone (T3) in the serum. Results of the present study are in correspondence with Wang and Xu (2008) who demonstrated that body weight and feed conversion ratio of broiler chickens was affected by dietary Se level. On the contrary, in rabbits, no effect of Se supplementation on body weight, feed intake and feed conversion had been observed in previous experiments (Dokoupilová *et al.,* 2007; Marounek *et al.,* 2009). Carcass traits and chemical composition of meat data are shown in Table 1. Supplementation with 0.15 and 0.3 ppm organic Se increased both hot carcass weight and dressing percentage in growing rabbits, and higher hot carcass weights could be attributed to higher live body weight of rabbits in the present study. The inclusion of organic Se in the diets did not significantly influence the proportions of various carcass organs of the rabbits (Table 1). Dokoupilová *et al.* (2007) and Marounek *et al.* (2009) observed that no significant effect of Se on carcass characteristics of fattening rabbits. It is noteworthy to note that Se deposition in hindleg meat significantly increased in proportion to the dietary Se concentration (Table 1). These results are in agreement with several previous experiments in rabbits (Dokoupilová *et al.,* 2007; Marounek *et al.,* 2009), pigs (Zhan *et al.,* 2007), lambs (Molnár *et al.,* 1998), calves (Skřivanová *et al.,* 2007), and chickens (Wang and Xu, 2008). Organic Se in the form of selenomethionine, it is incorporated into general proteins by the same codon as methionine (Rayman, 2004), so that its bioavailability is higher. Furthermore, an important step in Se

metabolism in the mammalian organism is its incorporation into specific proteins such as myoglobin (Eisler, 1985). As shown in Table 1, dietary Se supplementation had no significant effect on meat chemical composition. These responses were similar to observations by Marounek *et al.* (2009) who revealed that dietary organic Se did not influence protein content in the hindleg meat of rabbits. Also, Dokoupilová *et al.* (2007) indicated that the content of dry matter in meat was not significantly affected by dietary Se supplementation. Similarly, Skřivanová *et al.* (2007) reported that there was no effect of dietary Se on chemical composition of meat in calves.

One of the major results in the present study was that the incorporation of organic Se into diets of growing rabbits appeared to improve the serum total antioxioxidant capacity and reduce the lipid peroxidation expressed as serum malondialdehyde which finally translated into enhancing the immune response (Table 1). These responses were similar to observations in rabbits (Erdélyi *et al.,* 2000) and chickens (Wang and Xu, 2008) which postulated that dietary Se supplementation with selenized yeast increased the activity of serum GSH-Px. Similarly, Ebeid (2009) indicated that serum lipid peroxidation decreased significantly in a dose-dependent manner when dietary organic Se level was increased in cockerels. As presented in Table 1, dietary organic Se has a positive effect in enhancing the antibody titers against SRBC of growing rabbits. These results are in accordance with Spallholz *et al.* (1981) who reported that antibody titers in rabbits increased after administration of Se. Se intake appear to confer additional health benefits on the immune system and reduction of inflammation (Rayman, 2004). Also, Se has been found to be necessary for maintaining a healthy immune system (McKenzie *et al.,* 1998; Suraï, 2002). Therefore, it could be suggested that the enrichment of rabbit meat with organic Se might enhance the antioxidative status and reduce lipid peroxidation, which probably resulted in improvement of the immune responsiveness in growing rabbits in the present study.The dietary treatment with organic Se did not modify total cholesterol content, LDL-cholesterol, LDL-cholesterol, total protein and albumen in serum while serum triglycerides and globulins were significantly affected (Table 1). Serum globulins findings were in harmony with immune response in the present study.

Table 1: Effect of dietary organic Se on growth performance, chemical composition of meat, antioxidative status and immune response in growing California rabbits (means±SE).

	Organic Se (ppm)			Significance
	0	0.15	0.3	
Growth performance				
Initial body weight (g)	745.6± 3.60	749.7± 3.60	745.85± 3.60	NS
Final body weight (g)	2100±19	2229±19^{a}	2230.66±18.77^{a}	*
Daily gain (g)	16.26±0.11^{b}	18.91±0.11^{a}	18.94±0.11^{a}	*
Daily feed intake (g)	83.97±1.2	84.12±1.0	84.24±1.1	NS
Feed conversion ratio (g feed/g gain)	5.01±0.09^{a}	4.67±0.04^{b}	4.68±0.08^{b}	*
Carcass traits				
Hot carcass weight (g)	1227±30^{b}	1369±31^{a}	1374±30^{a}	*
Dressing (%)	58.40±1.0^{b}	61.81±1.1^{a}	61.78±1.2^{a}	*
Head (%)	17.61±0.34	16.76±0.34	16.77±0.34	NS
Heart (%)	0.59±0.02	0.59±0.02	0.57±0.02	NS
Liver (%)	6.67±0.08	6.63±0.08	6.27±0.08	NS
Kidney (%)	1.63±0.04	1.69±0.04	1.62±0.04	NS
Chemical composition of hindleg meat				
Moisture (%)	74.80±1.98	74.17±1.98	75.44±1.98	NS
Crude protein (%)	22.83±1.79	22.02±1.79	22.76±1.79	NS
Ether extract (%)	4.89±0.40	5.13±0.40	4.76±0.40	NS
Ash (%)	1.68±0.84	1.85±0.84	1.89±0.84	NS
Se in hindleg meat (µg/g)	0.097± 0.004^{c}	0.276± 0.004^{b}	0.542± 0.004^{a}	*
Blood plasma parameters				
Antibody titre (Log2)	2.94±0.002^{b}	4.75±0.002^{a}	4.56±0.002^{a}	*
Total antioxidant capacity (nmol /l)	1.30±0.59 ^{b}	1.83±0.59 ^{ab}	2.02±0.59 ^{a}	*
Malondialdehyde (mmol/l)	6.07±0.41^{a}	2.21±0.41^{b}	1.23±0.41^{c}	*
Total cholesterol (mg/dl)	91.29±1.25	91.56±1.33	91.67±1.64	NS
LDL- cholesterol (mg/dl)	37.56±0.23	37.53±0.23	37.61±0.23	NS
HDL- cholesterol (mg/dl)	38.41±0.44	38.03±0.44	38.98±0.44	NS
Triglycerides (mg/dl)	55.25±2.08^{a}	43.08±2.08^{b}	44.89±2.08^{b}	*
Total protein (g/dl)	5.14±0.14	5.36±0.14	5.25±0.14	NS
Albumin (g/dl)	3.22±0.17	2.47±0.17	2.46±0.17	NS
Globulin (g/dl)	1.98±0.18^{b}	2.67±0.18^{a}	2.76±0.18^{a}	*

Means in the same row without common superscripts are significantly different, *P ≤ 0.05, NS = not significant.

CONCLUSIONS

Based on the data presented above, it could be concluded that supplemental dietary organic Se enhanced growth performance and carcass weight, increased the Se content in meat, stabilized the antioxidative status, and elevated the humoral immune response and from a commercial point of view, getting such benefits in growing rabbits is a necessity.

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