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Effects of dietary supplementation with selenium enriched yeast or sodium selenite on selenium tissue distribution and meat quality in lambs

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ABSTRACT

The objective was to determine the concentration of total selenium (Se) and the proportion of total Se comprised as selenomethionine (SeMet) and selenocysteine (SeCys), as well as meat quality in terms of oxidative stability in post-mortem tissues of lambs offered diets with an increasing dose rate of selenized enriched yeast (SY), or sodium selenite (SS). Fifty lambs were offered, for a period of 112 d, a total mixed ration which had either been supplemented with SY (0, 0.11, 0.21 or 0.31 mg/kg DM to give total Se contents of 0.19, 0.3, 0.4 and 0.5 mg Se/kg DM for treatments T1, T2, T3 and T4, respectively) or SS (0.11 mg/kg DM to give 0.3 mg Se/kg DM total Se [T5]). At enrolment and at 28, 56, 84 and 112 d following enrolment, blood samples were taken for Se and Se species determination, as well as glutathione peroxidase (GSH-Px) activity. At the end of the study lambs were euthanased and samples of heart, liver, kidney, and skeletal muscle were retained for Se and Se species determination. Tissue GSH-Px activity and thiobarbituric acid reactive substances (TBARS) were determined in Longissimus Thoracis. The incorporation into the diet of ascending concentrations of Se as SY increased whole blood total Se and the proportion of total Se comprised as SeMet, and erythrocyte GSH-Px activity. Comparable doses of SS supplementation did not result in significant differences between these parameters. With the exception of kidney tissue, all other

Abbreviations: BW, body weight; DM, dry matter; GHS-Px, glutathione peroxidase; MAP, modified atmosphere packs; Se, selenium; SeCys, selenocysteine; SeMet, selenomethionine; SS, sodium selenite; SY, selenized yeast; TBARS, thiobarbituric acid reactive substances; TMR, total mixed ration.

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tissues showed a dose dependant response to increasing concentrations of dietary SY, such that total Se and SeMet increased. Selenium content of Psoas Major was higher in animals fed SY when compared to a similar dose of SS, indicating improvements in Se availability and retention. There were no significant treatment effects on meat quality assessments GHS-Px and TBARS, reflecting the lack of difference in the proportion of total Se that was comprised as SeCys. However, oxidative stability improved marginally with ascending tissue Se content, providing an indication of a linear dose response whereby TBARS improved with ascending SY inclusion.

1. Introduction

In the early 1970s a specific biological role for Selenium (Se) became apparent with the discovery of the first selenoprotein, glutathione peroxidase (GSH-Px) (Rotruck et al., 1973). Glutathione peroxidase catalyses the reduction of lipid and hydrogen peroxides to less harmful hydroxides *via* the oxidation and subsequent reduction of selenocysteine (SeCys) which is the active centre of this enzyme (Arteel and Sies, 2001). The antioxidant functions of Se, *via* GSH-Px activity, have been shown to persist post-mortem in poultry muscle tissue (DeVore et al., 1983), delaying the onset of oxidation reactions, which affects adversely both the nutritive value and flavor of meat products (Morrissey et al., 1998).

Plant Se concentration can be extremely variable and dietary Se supplements are generally required for ruminant diets. Selenium supplements are in two forms, inorganic mineral salts, such as sodium selenite (SS; Na_2SeO_3) or selenate (Na_2SeO_4), or in organic forms such as Se enriched yeast (SY), in which selenomethionine (SeMet) is the predominant form of Se (Korhola et al., 1986). The distribution and accumulation of Se and Se species in animal tissues depends very much on the source of the Se supplement. Surai (2006) reported that SeMet is retained in tissue proteins to a greater extent than SeCys or Se derived from inorganic forms.

Selenium absorption occurs within the small intestine and whilst SeMet is absorbed *via* the methionine transporter system, the absorption of inorganic Se, such as SS, is less efficient and occurs mainly by passive diffusion (Weiss, 2003). Following absorption SeMet can be incorporated non-specifically into general body proteins in place of methionine and can act as a biological pool for Se (Suzuki and Ogra, 2002) which can be utilised during periods of suboptimal Se intake. Conversely inorganic sources that are taken up through the small intestine are either utilised or methylated and subsequently excreted. Furthermore, Seko et al. (1989) showed that SS may act as prooxidant, which has the potential to be toxic at high dietary levels, whereas SeMet does not possess these properties.

Irrespective of source, Se must undergo a metabolic transformation to selenide prior to its assimilation into SeCys and subsequent incorporation into selenoproteins *via* the UGA codon (Suzuki and Ogra, 2002). However, no such intermediate step is necessary for the incorporation of SeMet into general proteins. Consequently the biological actions of Se depend on the amount and chemical form of Se consumed and then specific studies measuring the accumulation of Se forms in edible tissues are needed.

In addition, a correlation exits between tissue Se concentration and GSH-Px activity in meat (DeVore and Greene, 1982) and the Se supplementation of livestock diets has the potential to improve the oxidative stability in meat. However, SeCys forms the functional core of the GSH-Px enzyme and increases in tissue Se in the form of SeMet, although improving the nutritional quality of meat, may not necessarily result in improvements in oxidative stability.

Therefore, the objective of this study was to determine the distribution of total Se and the proportion of total Se as SeMet and SeCys, as well as meat quality in terms of oxidative stability, within the post-mortem tissues of lambs that had been offered either comparable doses of SY or SS, or the dose response of graded levels of SY within the diet.