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Effects of selenium yeast level in diet on carcass and meat quality, tissue selenium distribution and glutathione peroxidase activity in ducks

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ABSTRACT

The aim of this study was to assess how dietary supplementation of organic selenium affected carcass and meat quality, tissue selenium content and glutathione peroxidase activity in ducks. The study was performed on 240 one-day old ducklings of the same origin (Cherry Valley hybrid), during a 49-day period, that were fed diets supplemented with four different levels of selenium yeast (ALKOSEL® R397): groups with 0 mg/kg, 0.2 mg/kg, 0.4 mg/kg and 0.6 mg/kg added Se. Live weight, carcass characteristics, meat quality characteristics, chemical composition of meat, selenium content in plasma, feces, liver and meat, as well as plasma glutathione peroxidase activity were determined. Animals fed high Se diets (0.4 mg/kg) had higher live weight ($P < 0.05$) compared to those fed diets with inadequate (0 mg/kg) or with supranutritional (0.6 mg/kg) Se levels. Chemical analysis of meat revealed differences in moisture, protein and lipid content among compared groups. Breast meat from the group with the highest dietary Se (0.6 mg/kg) had a higher protein content ($P < 0.01$) compared to breast meat from groups with 0 mg/kg and 0.2 mg/kg added Se. Se supplementation increased significantly Se levels in plasma, liver and muscles, as well as activity of glutathione peroxidase in plasma.

1. Introduction

Selenium (Se) is a trace mineral that is essential for human and animal nutrition, as it is a component of at least 25 selenoproteins that participate in regulation of various functions of the body, including redox balance maintenance and antioxidant defences (Surai and Fisinin, 2014). The importance of Se is principally associated with its role as an essential part of the glutathione peroxidases (GSH-Px) which provide a defense against oxidative stress by catalyzing the reduction of hydrogen peroxide and lipid peroxides to less harmful hydroxides (Arthur, 2000; Hardy and Hardy, 2004). Previous studies

Abbreviations: GSH-Px, glutathione peroxidase; ISO, International Organization for Standardization; TBH, t-butyl hydroxide; GSH, glutathione; GR, glutathione reductase; Hb, hemoglobin; AE, assimilation efficiency; SEM, pooled standard error of means; Initial LW, live weight at start; Final LW, live weight at slaughter; HCW, hot carcass weight; CCW, cold carcass weight; CL, chilling losses; DP, dressing percentage on cold carcass weight.

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Table 1
Ingredients and chemical composition of diets.

Ingredient (g/kg)	Starter (0–14 days)	Finisher (15–49 days)
Maize	548.3	720.2
Full-fat soybean meal	180.0	90.0
Soybean meal	160.0	110.0
Soy protein concentrate	50.0	20.0
Yeast	25.0	25.0
Mono-calcium phosphate	13.0	12.0
Vitamin-mineral premix[a]	10.0	10.0
Limestone	9.0	9.0
Sodium chloride	3.5	3.0
DL-Methionine	1.2	0.8
Chemical composition (g/kg)		
Dry matter	893.2	896.3
Crude protein	226.8	173.9
Crude fat	50.0	43.4
Ash	53.1	44.0
Calcium	8.5	7.7
Phosphorus	6.5	6.3

[a] Vitamin-mineral premix (per kg of diet): Vitamin A, 10,000 IU; Vitamin D3, 4000 IU; Vitamin E, 20 mg; Vitamin K3, 3 mg; Vitamin B1, 2.2 mg; Vitamin B2, 8 mg; Vitamin B6, 5 mg; Vitamin B12, 9 g; folic acid, 1.5 mg; biotin, 130 g; calcium pantotenate, 25 mg; nicotinic acid, 65 mg; iron, 80 mg; copper, 8 mg; manganese, 60 mg; zinc, 40 mg; iodine 0.33 mg.

have shown that body condition, reproduction, survival and antioxidant protection level are affected by dietary Se status in ducks (Dean and Combs, 1981; Hoffman and Heinz, 1998; De Vink et al., 2008; Franson et al., 2011). Although Se is an essential micro-nutrient required in small quantities for normal biological function, it is toxic to vertebrates at concentrations slightly over essential levels (Heinz et al., 1989; Ohlendorf, 2003; Spallholz and Hoffman, 2002). Nutritional Se requirements for poultry have been given as 0.15 mg of Se per kg of diet (National Research Council, 1994), while the maximum allowed level is 0.5 mg of Se per kg of diet (European Commission, 2014). The efficacy of Se in inducing Se-containing enzymes *in vivo* and *in vitro* depends on its chemical form (Ortuno et al., 1996). Currently, sodium selenite is the commercial Se source used as a supplement in animal feeds. However, an organic source of Se derived from yeast (*Saccharomyces cerevisiae*), which contains a high concentration of Se-methionine, has now become commercially accessible following its approval as a feed additive (EEC, 2006). This alternative source of Se proved to be deposited into breast muscle of broilers at a much greater rate than sodium selenite (Payne and Southern, 2005). Moreover, Se supplementation may improve the oxidative stability of meat products, since significant correlations were found between Se content of tissues and muscle GSH-Px activity in poultry (Daun and Akesson, 2004; Cai et al., 2012). The use of organic Se as a possible means of enhancing meat Se content in ducks has not been largely studied. Therefore, the aim of this study was to assess effects of Se-yeast supplementation at different levels on carcass and meat quality, tissue selenium content and glutathione peroxidase activity in Cherry Valley ducks.

2. Materials and methods

2.1. Animals, housing and trial duration

The study was conducted on 240 one-day old ducklings of the same origin (Cherry Valley hybrid). On the first day of the trial all ducklings were marked by individually numbered leg rings and weighed. Birds were randomly allocated to one of four dietary treatments and housed in groups of 20 animals per pen (stocking density = 0.15 m^2/head). Each experimental group contained 60 animals. Pens were bedded with straw and provided with fresh potable water in troughs and with feed in tube feeders *ad libitum*. The trial was conducted over a continuous 49-day period when animals were exposed to their respective experimental diets.

2.2. Experimental diets

From the start of the trial, each group of animals was fed with one of four experimental diets which comprised the same basal diet, but differed only in selenium content. Basal diet was formulated to meet the maintenance and growth requirements of animals used in this study (Table 1). Diets were fed from days 1 to 49 including starter (days 1–14) and finisher (days 15–49). Selenium was added in the diets in the form of selenium yeast at different levels: the first group with no additional selenium (background only); the second with 0.2 mg/kg; the third with 0.4 mg/kg and the fourth group with 0.6 mg/kg of added Se. Selenium was derived from yeast *S. cerevisiae*, where Se-methionine was the dominant compound of organically bound Se (63–68% of total Se) in product ALKOSEL® R397, Lallemand Inc., Canada (EFSA, 2006).