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Selenium and vitamin E in sow diets: I. Effect on antioxidant status and reproductive performance in multiparous sows

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ABSTRACT

This study aimed to evaluate the effects of 2 dietary selenium (**Se**) sources and 2 vitamin E levels during gestation and lactation on antioxidant status and reproductive performance in multiparous sows. The study was conducted in a 2 × 2 factorial arrangement with sodium selenite or Se-enriched yeast at 0.30 mg Se/kg diet each as the Se sources and vitamin E at 30 or 90 IU/kg. A total of 234 multiparous sows were bred and started on 1 of 4 dietary treatment according to parity and body condition, and then maintained on feed until 21-d postpartum. Serum samples were collected from 6 sows per treatment at d 30, 60 and 90 of gestation (**G30**, **G60** and **G90**) and d 11 of lactation (**L11**) for the analysis of Se level and antioxidant status, i.e., total antioxidant capacity (**T-AOC**), the activities of superoxide dismutase (**SOD**), glutathione peroxidase (**GSH-Px**), glutathione (**GSH**) content and malondialdehyde (**MDA**) content. Colostrum and 11-d milk were collected for the analysis of Se, antioxidant status and milk composition. Sows fed organic Se produced more live pigs ($P < 0.10$), had greater litter birth weight ($P < 0.05$) and weaned more pigs ($P < 0.10$) compared to sows fed inorganic Se. Serum T-AOC (G60 and L11), SOD activity (G60 and G90), GSH-Px activity (L11), GSH content (L11) and Se level (G30, G60, G90 and L11) increased, and MDA content (G30, G60, G90 and L11) decreased when sows were fed organic Se ($P < 0.05$). The activities of T-AOC (11-d milk), SOD (colostrum), GSH-Px (colostrum and 11-d milk), GSH content(11-d milk), and Se level (colostrum) were greater and MDA content (11-d milk) was lower when sows were fed organic Se ($P < 0.05$). Total solids, solids-not-fat, protein, and lactose levels were greater in 11-d milk ($P < 0.05$), but similar in colostrum, when sows were fed organic Se. The α-tocopherol level in serum at 30 d ($P < 0.05$), 60 d ($P < 0.10$), 90 d of gestation ($P < 0.10$) and 11 d of lactation ($P < 0.10$) and colostrum ($P < 0.05$) and milk ($P < 0.05$) were increased when sows were fed elevated vitamin E diets. No vitamin E level treatment or Se source × vitamin E level interaction was evident for reproductive performance and the indices measured in serum and milk ($P > 0.05$). In conclusion, sow fed organic

Abbreviations: L11, d 11 of lactation; MDA, malondialdehyde; Se, selenium; SOD, superoxide dismutase; T-AOC, total antioxidant capacity; G30, d 30 of gestation; G60, d 60 of gestation; G90, d 90 of gestation; GSH, glutathione; GSH-Px, glutathione peroxidase.

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Se had improved the antioxidant capacity in serum and milk, the milk composition, and the number of pigs weaned compared with sow fed inorganic Se. However, antioxidant status and reproductive performance were not improved when vitamin E was added at 90 vs. 30 IU/kg, and no Se source × vitamin E level interaction was detected. Organic Se or elevated vitamin E in sows diet did not affect major parameter of sow reproduction.

1. Introduction

Oxidative stress can have a negative impact on the reproductive performance and welfare of highly prolific sows (Berchieri-Ronchi et al., 2011). Surai and Fisinin (2016) reviewed the link between oxidative status and female performance, and the authors suggested that the antioxidant defence system against oxidatvie stress is extremly important in animal reproduction. The likely mechanism is that reactive oxygen species play a role in pathological progress via influencing multiple physilogical progress from oocyte maturation to fertilization, embryo development and gestation (Surai and Fisinin, 2016). Animal antioxidant status may be improved by dietary supplementation of antioxidants, including vitamin E and antioxidant enzyme co-factors, such as Se (Urso et al., 2015), which is known to be an essential component of at least 25 selenoproteins, from which at least 16 selenoproteins have antioxidant role (Pappas et al., 2008). Exogenous Se is commonly added to sow diets in its inorganic form, as selenite, or in an organic form, as a seleno-amino acid (Kim and Mahan, 2003). It has been reported that sows fed a diet containing a source of organic Se have greater Se contents in their colostrum and milk, and they produce more neonatal pigs and fewer stillborn piglets compared to sows fed inorganic Se (Mahan and Kim, 1996; Mahan, 2000; Mahan and Peters, 2004; Yoon and McMillan, 2006; Peters et al., 2010). Additionally, it has been demonstrated that the dietary addition of vitamin E increases sow milk α-tocopherol levels, prevents vitamin E deficiency in young piglets, and improves the overall health status of the sow (Mahan, 1991, 1994; Shelton et al., 2014). Additionally, the interaction between Se and vitamin E may enhance the production of glutathion peroxidase, which is an important part of antioxidant system (Urso et al., 2015). Therefore, a 2 × 2 factorial design study with 2 Se sources and 2 vitamin E levels is urgently needed to be done to verify the hypothesis that the antioxidant status and reproductive performance of sows could be inpacted by the main effect of Se source, vitamin E level and the interaction effect of Se source and vitamin E level.

Although Chavez and Patton (1986) studied the effects of parenteral injection of 3 mg Se and 408 IU vitamin E per sow at 30, 60 and 100 d post-breeding on reproductive performance of sows, and Wuryastuti et al. (1993) investigated the effects of 2 dietary vitamin E levels combined with 2 inorganic Se levels on immune responses of multiparous sows. However, to our knowledge, no data is available about how the combination of dietary different Se sources and vitamin E levels affect sow performance in a reproductive cycle via a 2 × 2 factorial arrangement so that action of Se sources, vitamin E levels and their interaction can be further dissected. This study was conducted to evaluate the effects of 2 dietary sources of Se and 2 vitamin E levels during gestation and lactation on antioxidant status and reproductive performance in multiparous sows.

2. Materials and methods

The animal use and care protocol was approved by the South China Agricultural University Animal Care and Use Committee.

2.1. Experimental design

This experiment was conducted as a 2 × 2 factorial arrangement in a randomized complete block design. The first factor was Se source [sodium selenite or Se-enriched yeast (Sel-Plex^{TM} 2000, Alltech Inc. USA), each at 0.30 mg Se/kg diet], and the second factor was vitamin E (DL-α-tocopheryl acetate) level (30 or 90 IU/kg). A total of 234 multiparous sows (Landrace × Yorkshire, mean parity 5.1 ± 0.22), located on a 3000-sow commercial pig farm in Jiangmen, Guangdong, China, were allocated equally by parity and body condition to one of four treatments (there were 60, 59, 55 and 60 sows at the four treatment groups, respecticely) and fed the experimental diets from d-1 post-coitus until d-21 postpartum. The feeding trial was carried out between June and December 2013.

2.2. Diets and management

The experimental diets were corn-soybean rations that were formulated to meet or exceed the nutrient requirements of gestating and lactating sows (NRC, 2012). The 3 basal diets were formulated to reflect the physiological status of the sow, i.e., basal diet I = 0–50-d post-coitus, basal diet II = 51–80-d post-coitus, and basal diet III = late gestation and lactation. Diet compositions and nutrient levels are presented in Table 1.

The Se and Vitamin E were included into the diet via the adjustment of mineral and vitamin premix. Briefly, we utilized 5 individual minerals, i.e., $ZnSO_4 \cdot H_2O$, $FeSO_4 \cdot H_2O$, $MnSO_4 \cdot H_2O$, $CuSO_4 \cdot 5H_2O$, CaI_2O_6 and Na_2SeO_3, and zeolite (as carrier) to formulate inorganic Se-containing mineral premix, while we used those individual minerals except for Se-yeast (Sel-