Journal of Integrative Agriculture 2016, 15(5): 1076–1084

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RESEARCH ARTICLE

Performance and plasma concentration of metabolites in transition dairy cows supplemented with vitamin E and fat

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Abstract

The objective of this study was to evaluate the effects of vitamin E (VE; 1 500 or 3 000 international units (IU) d^{-1}) and fat (2% of dry matter calcium salt of soybean oil) supplementation during the transition period on feed intake, milk yield and composition and blood metabolites of dairy cows. 48 multiparous Holstein cows were randomly assigned into one of four treatments in a 2×2 factorial arrangement of vitamin E and supplemental dietary fat during the transition period. Treatments were: 1) 1 500 IU d^{-1} vitamin E without fat supplementation (1 500VE–F); 2) 1 500 IU d^{-1} vitamin E with fat supplement (1 500VE+F); 3) 3 000 IU d^{-1} vitamin E without fat supplementation (3 000VE–F); and 4) 3 000 IU d^{-1} vitamin E with fat supplement (3 000VE+F). Dietary treatments were initiated at approximately 28 d before expected calving dates and continued through 28 d postpartum. Dry matter intake (DMI) was unaffected (P>0.05) by prepartum treatment. Regardless of vitamin E supplementation, DMI was greater (P<0.01) in fat-supplemented cows compared with un-supplemented cows (19.60 *vs.* 18.45 kg d^{-1}; SEM=0.42) during the postpartum period. Energy balance and body weight were not affected (P>0.05) by treatments. Postpartum diets had no significant effect on milk yield or milk composition. Plasma concentrations of non-esterified fatty acids, glucose, and insulin were not affected (P>0.05) by treatments. Regardless of vitamin E supplementation, plasma β-hydroxybutyrate concentration was greater (P<0.05) in fat-supplemented cows compared with un-supplemented cows during the postpartum period. These results showed no indication of positive effects on lactation performance associated with vitamin E and dietary fat supplement in transition cows.

Keywords: transition cow, vitamin E, fat, milk production, blood metabolites

1. Introduction

The transition period is defined as 3 wk before calving through 3 wk after calving in dairy cows (Bell *et al.* 1995; Grummer 1995). This period is regarded as one of the most challenging elements of the production cycle in dairy cattle because of the metabolic changes in the course of transition from pregnancy to lactation (DeFrain *et al.* 2005;

Received 7 March, 2015 Accepted 15 June, 2015
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doi: 10.1016/S2095-3119(15)61090-5

Pezeshki *et al*. 2010). During the last 3 wk of gestation and the first 3 wk of postpartum, a cow experiences a reduction in feed intake and a degree of negative energy balance (NEB), which is related to metabolic and hormonal changes around parturition (Grummer 1995; Rabelo *et al.* 2003). These changes are generally associated with an increased risk of metabolic- and production-related diseases (Friggens *et al.* 2004). Therefore, to improve transition success, it has been suggested that we should increase the nutrient intake (Grummer *et al.* 2004) or net energy density of lactation diets to support high producing cows (Eastridge 2006). Vitamin E is considered as one of the important antioxidants for dairy cows. Together with other metabolic changes, the plasma concentration of vitamin E decreases around the time of calving (Goff *et al.* 2002). The minimal requirement of vitamin E is 150 and 300 international units (IU) d^{-1} for dry and lactating cows, respectively (NRC 2001).

It has been reported that 1 000 IU d^{-1} supplementation of vitamin E around calving is associated with decreased incidence of placental retention, as well as on improved function and activity of the immune system (Smith *et al.* 1997; Allison and Laven 2000). It was suggested that vitamin E supplementation at the level 1 500 to 3 000 IU per cow per day during the dry period reduces both the frequency of intramammary infection and that of clinical mastitis and improves milk quality, decreased plasmin activity and increased oxidative stability of milk (Politis 2012). O'Donnell-Megaro *et al.* (2012) reported that dietary supplementation of 10 000 IU d^{-1} vitamin E increased milk yield in mid-lactation dairy cows. In their study, vitamin E did not prevent the oil-induced (2.5% soybean oil) reduction in milk fat percentage. Bell *et al.* (2006) reported that vitamin E supplementation (2 800 IU d^{-1}) partially mitigated the effect of 6% safflower oil on reduction in milk fat percentage compared with the control groups, but had no significant effect on dry matter intake (DMI) and milk production. Supplementation of dietary fat could enhance the intestinal absorption of vitamin E and transport capacity (Lodge *et al.* 2004), and hence improve energy balance of dairy cows around parturition (Karimian *et al.* 2015). Weiss and Wyatt (2003) reported an improvement in plasma concentrations of α-tocopherol in cows provided with dietary fat supplement.

Weiss and Wyatt (2003) reported that the vitamin E and fat interaction had no effect on DMI, milk yield, and yields and concentrations of milk fat and protein in mid-lactation Holstein cows. To the best of the authors' knowledge, no published reports have assessed the interactions between vitamin E and fat on lactation performance in transition cows. Therefore, it is possible that the supplementation of a vitamin E blend to diets containing rumen inert fat might affect milk yield, milk composition, and energy balance (EB) differently. Therefore, the objective of this study was to determine whether diets supplemented with a combination of fat (calcium salt of soybean oil, CaSO) and vitamin E during the transition period could affect blood metabolites and improve lactation performance.

2. Results

2.1. Feed intake, body weight, energy balance, and lactation performance

Ingredient and nutrient composition of the diets fed during the transition period are provided in Table 1. The mean of DMI, body weight (BW), EB, milk yield and composition are presented in Table 2. No interaction ($P>0.05$) between vitamin E and fat supplementation were observed for DMI, BW, EB and milk yield during the transition period. During the prepartum period, DMI was unaffected ($P>0.05$) by treatment (Fig. 1). Regardless of vitamin E supplementation, DMI was greater ($P<0.01$) in fat-supplemented cows compared with un-supplemented cows (overall, 19.60 *vs.* 18.45 kg d^{-1}; SEM=0.42) during the postpartum period (Figs. 1 and 2). Energy balance during the postpartum period and BW during the pre- and postpartum periods were not affected ($P>0.05$) by treatments. Postpartum diets did not affect ($P>0.05$) milk yield or milk composition during the first 28 d in milk.

2.2. Blood metabolites

The mean of blood metabolites is presented in Table 3. No diet-dependent differences ($P>0.05$) were observed for plasma non-esterified fatty acids (NEFA), β-hydroxybutyrate (BHBA), glucose (Fig. 3), and insulin (Fig. 4) concentrations during the prepartum period and for plasma NEFA, glucose, and insulin concentrations during the postpartum period. Plasma NEFA concentration increased from d 5 before calving until 15 d after calving and then gradually decreased (Fig. 5).

Regardless of vitamin E supplementation, plasma BHBA concentration was greater ($P<0.05$) in fat-supplemented cows compared with un-supplemented cows (overall, 0.56 *vs*. 0.47 kg d^{-1}; SEM=0.04) during the postpartum period. Plasma BHBA concentration continuously increased 5 d before calving until 15 d postpartum and then decreased until 28 d in milk (DIM) (Fig. 6). As parturition approached, the rate of increase in BHBA concentrations was greater for cows fed 1 500VE–F diet (1 500 IU d^{-1} vitamin E without fat supplementation) ($P<0.05$) than cows fed other diets. No diet-dependent differences ($P>0.05$) were observed for plasma BHBA concentration during the prepartum period.