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Metabolic Syndrome and Insulin Resistance in Transition Dairy Cows

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Abstract

Transition period begins from 3 weeks before and proceeds until 3 weeks after parturition, and dairy cows suffer from negative energy balance in this period. Metabolic syndrome generally occurs during transition period in dairy cows and it is related to several physiologic and pathologic processes. Insulin resistance is one of the consequences of this condition that characterized by a decrease in the entry of glucose into the cell. Researchers have suggested various approaches to resolve insulin resistance such as using dietary and parenteral supplements; and the present paper discusses about some of them.
Keywords: Metabolic syndrome, Insulin resistance, Management, Transition dairy cow

Pre-and post-partum periods, known as the transition period, are among the most critical physiological states during a dairy cow's life. This period begins from 3 weeks before and proceeds until 3 weeks after parturition and lactogenesis occurs. Metabolic needs increase during the transition period, and because of the increased rate of cell respiration, the reactive oxygen species (ROS) is generated, disturbing the oxidative balance of cows (Chalmeh et al., 2019). Overproduced ROS damages the cells and changes the metabolism and physiology. These changes cause oxidative stress, which leads to infectious and noninfectious diseases during the peripartum period (Chalmeh et al., 2015). Oxidative stress plays an important role in the occurrence of insulin resistance in transition dairy cows. Also, increased milk production in the first weeks postpartum further increases the demand for glucose by the mammary gland. These demands are mainly due to the synthesis of colostrum and the massive growth of the fetus in the prepartum period and the synthesis of milk in the postpartum period, causing metabolic changes in homeostatic and adaptive processes characterizing this transition period. In addition, low dry matter intake increases the negative energy balance and then exacerbates the metabolic alterations and one of the most important of which is insulin resistance (De Koster and Opsomer, 2013). Also insulin resistance is characterized by a decrease in the entry of glucose into the cell, possibly due to the lower expression of insulin receptors, or the lower insulin produced by the pancreas. Furthermore, the imbalance between energy intake and utilization leads to negative energy balance. This imbalance commonly entails changes in the immune system and oxidant/antioxidant balance, ultimately affecting the health, production, and fertility of cows. Hence, oxidative stress occurs during the transition period and causes insulin resistance (Overton and Waldron 2004).

It should also be noted that the most important factor leading to insulin resistance is the negative energy balance in the transition period. Therefore, researchers have asserted that energy supply for transition cows might be effective in reducing the insulin resistance (Overton and Waldron, 2004), accordingly, based on research by Chalmeh et al. (2019), using of dietary monensin and propylene glycol supplements causes to reduce insulin resistance in transition period. Also, intravenous administration of butaphosphan and cyanocobalamin to the late-pregnant dairy cows reduced their insulin resistance after calving (Chalmeh et al., 2020). Based on the results of Chalmeh et al. (2021), dietary administration of vitamin E and selenium ameliorates oxidative

stress and lipid mobilization and increases insulin sensitivity in transition cows.

With the increase in metabolic demands and activities during the transition period, ROS production is increased in mitochondria during the cell respiration and after the electron transport chain reaction (Overton and Waldron, 2004). As previously stated, oxidative stress occurs in the transition period, with certain changes occurring in the body. Accordingly, adding vitamins and trace elements to cows' diet is an effective approach to reducing the harmful effects of ROS, resulting in improved animal health status and reduced disease rate (Overton and Waldron, 2004). Wong et al. (2017), reviewed the potential role of vitamin E as an interventional treatment for metabolic syndrome in animal models. They reported the anti-oxidative, anti-inflammatory, anti-obesity, anti-hyperglycemic, antihypertensive, and anti-hypercholesterolemic properties of vitamin E; therefore, it is possibly a promising agent for attenuating insulin resistance as a part of metabolic syndrome. Also, Abuelo et al. (2016), revealed that parenteral antioxidant administration in the transition period is one of the possible approaches to increasing insulin sensitivity.

Oxidative stress exacerbates the lipolysis followed by increased quantities of NEFA and ROS (Abuelo et al., 2016), and this indicates that metabolic stress weakens the immune system and exposes the cows to peri-partum diseases and occurs metabolic disease. So, the dietary administration of vitamin E and selenium may cope with lipomobilization along with reducing the oxidative stress and boosting the body antioxidant system and increase the immune system (Abuelo et al., 2016; Chalmeh et al., 2021).

As well as, based on the results of Chibisa et al. (2008), using of dietary propylene glycol supplements causes to reduce metabolic disease and insulin resistance in transition period. In other words, based on the results of Chalmeh et al. (2021), the combined use of butaphosphan, an organic source of phosphorus, and cyanocobalamin, contributing to the gluconeogenesis, has been proven to affect the milk production and negative energy balance of dairy cows.

In conclusion, based on the results of our works and previous researchers, the addition of vitamin E, selenium, monensin and propylene glycol to the transition cows' diet improve insulin responsiveness to glucose and insulin sensitivity. Furthermore, parenteral administration of butaphosphan and cyanocobalamin to late pregnant dairy cows reduces insulin resistance in them after calving. Therefore, vitamin E, selenium, monensin and propylene glycol could be daily administered during the transition period to improve insulin sensitivity in dairy cows, and the same goes for intravenous butaphosphan and cyanocobalamin.

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