

Fatty Liver Disease in Dairy Cows

Subjects: Zoology

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Frequently occurring fatty liver disease in dairy cows during the perinatal period, a typical type of non-alcoholic fatty liver disease (NAFLD), results in worldwide high culling rates of dairy cows (averagely about 25%) after calving. This has been developing into a critical industrial problem throughout the world, because the metabolic disease severely affects the welfare and economic value of dairy cows. Understanding the mechanisms of the pathogenesis of fatty liver disease will further enhance our understanding of fatty liver disease in human beings and animals, developing safer and effective therapeutics to prevent and/or treat the disease, also providing essential clues in breeding improvement of fatty liver disease-resistant dairy cattle, eventually contributing to sustainable development of dairy industry.

Keywords: dairy cows ; fatty liver disease ; triglycerides (TAG) ; non-alcoholic fatty liver disease (NAFLD) ; negative energy balance

1. Introduction

Fatty liver syndrome, a typical type of metabolic disorder, frequently occurs in populations of dairy cows in commercial farms throughout the world, which is caused by negative nutrient balance after calving. High-yielding dairy cows, especially for cows with 30 kg of daily milk yield and more, are usually inclined to develop fatty liver syndrome in the early lactation period. There are more risk factors available to developing fatty liver syndrome, such as cows with high body condition score (BCS) and/or high body fat, feed intake decreases around calving, etc. The etiology of fatty liver in perinatal dairy cows primarily includes the negative nutrient and energy balance and the accumulation of high level of free fatty acids (FFA) in serum or triglycerides (TAG) deposited in liver [1,2]. Liver, the central organ of energy metabolism for organisms, regulates the metabolic balance of carbohydrate, fat, and protein in mammals [3]. After calving, the food intake of dairy cows further decreases, while lactation slowly increases. Thus, the body lactose consumption easily results in the cow to be susceptible to experiencing an insufficient sugar supply, thus promoting fat mobilization in the liver [4,5]. Additionally, energy and substance metabolism is centered in the liver. The increasing fat mobilization promotes gluconeogenesis, increases the blood sugar concentration, and alleviates the negative nutrient balance. At the same time, the enhanced fat mobilization promotes the dramatic increase of non-esterified fatty acid (NEFA) in the liver [6], which is partly re-esterified to synthesize the triglycerides (TAG), a type of very-low-density lipoprotein (VLDL), that is hardly transported out of the liver [7]. Especially for dairy cattle, TAG is excessively accumulated because of its lack for esterase, resulting in susceptibility to fatty liver disease [4,8].

Our investigation in the last three years indicated that 48.85% of dairy cows ($n = 346$) within 2 weeks after parturition were diagnosed with light or severe fatty liver disease by randomly selecting 710 Holstein dairy cows from four commercial farms [1,2,9]. The suspected fatty liver cows and/or normal cows were firstly distinguished by applying the previously reported model [10] using the detected values of serum biochemical traits (glucose, Glu; non-esterified fatty acid, NEFA; aspartate transaminase, AST), then representative cows with different suspected extents were biopsied for liver tissue samples for fat deposition amount assessment by oil red staining. It is estimated that 40%–60% of high-yielding dairy cows (daily milk yield > 35 kg) develop moderate to severe fatty liver disease within 2 weeks after calving [11]. Moreover, it is not uncommon for the two short weeks after parturition to account for 50% of morbidity on a dairy farm [12], which is in accordance with our results.

The perinatal disorders including fatty liver disease remain as prevalent now as they were 20 years ago [12], causing high culling rate of dairy cows in their early lactation period, which is becoming a critical concern in modern dairy industry. The average culling rate of dairy cows within 60 days of lactation (during parturition period) in populations is about 24% in USA [13,14,15], and about 27% in China [16,17]. In clinical practice, increasing blood calcium levels and using anti-inflammatory drugs after delivery in dairy cows could reduce the incidence of this disease and/or decrease the economic loss [18]. However, these strategies cannot either completely change the situation or alleviate contradictions. The incidence of fatty liver disease at the early lactation not only decreases the milk yield of the coming lactation period, but

also attenuates the future milk production and reproduction performance because of subsequent health problems of dairy herds [1,2,9,15,19], such as ketosis, displaced abomasum, mastitis, etc. It is estimated that economic losses due to the treatment of and reduction in milk production by one dairy cow with ketosis accounts for more than 300 US dollars.

2. Conclusion

Understanding the mechanisms of the pathogenesis of fatty liver disease will further enhance our understanding of fatty liver disease, developing safer and effective therapeutics to prevent and/or treat fatty liver disease in human beings and animals, also providing essential clues in breeding improvement of fatty liver disease-resistant dairy cattle, eventually contributing to sustainable development of dairy industry.

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