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Review article

Combating Negative Effect of Negative Energy Balance in Dairy Cows: Comprehensive Review

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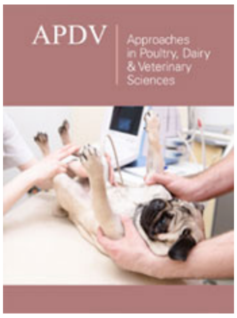

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Abstract

The increase of milk production has been accompanied by increasing incidence of health problems, declining ability to reproduce and declining the fertility of modern dairy cows. High producing dairy cows need to mobilize body reserve to be able to sustain their milk production. During early lactation, there were elevated demand for energy for more milk production, but a lag in feed intake created negative energy balance. Until energy intake assures the requirements, dairy cows, especially high producing breeds, enter a state of negative energy balance (NEB) that leads to economic losses through decreased milk production, decreased reproductive performance and increased risks of disease incidences. Increased energy intake, decreased dry period length and improved fertility are among the universal approach in combating the negative effect of negative energy balance in dairy industry.

Keywords: Combating; Dairy cow; Energy balance; Negative effect

Introduction

The increase in milk yield has been accompanied by declining ability to reproduce, increasing incidence of health problems and declining longevity in modern dairy cows [1]. The energy expended in producing a lot of milk during peak production is not commensurate to the amount of energy derived from the feed consumed due to increased concentration of sex hormones, incipient mobilization of lipid and reduced rumen capacity lead to NEB in early lactation [2]. To compensate for the deficit the cow begins to mobilize its energy reserves, although, this does not enable it to meet the requirement and therefore goes to a state of negative energy balance. The amount of energy for milk production and maintenance exceeds the energy derived from the feed intake and body energy reserves. Soon after parturition, the cow's diet changed from dry cow feed, which is relatively low to a high-energy one, however, the cow's low appetite and capacity cannot allow her to consume adequate amounts required for energy for production of milk and body maintenance. During this struggle, cows are in a state that is referred to as negative energy balance, where daily energy balance is determined by the amount consumed (feed energy) as compared to the requirements for milk production and maintenance [3]. Negative energy balance (NEB) is of interest in the dairy industry because it does not only affect production and reproduction performances but is also an animal welfare matter. Animals in NEB usually loss body condition after calving usually occurring at 50 to 100 days post-calving [4], which is a recognized animal welfare problem. There is appearing evidence that high yielding cows which loose body condition during periods of NEB become lame. Lameness is associated with animal welfare and has substantial negative effects on fertility performance and reproductive parameters, which would eventually lead to culling. However, there is a big gap and inadequate compiled information that clearly indicates on negative effect of negative energy balance on dairy cows and available combating strategies. Hence, it is important to revising the negative effect of negative energy balance on dairy cows and postulating ways of combating.

Concept of negative energy balance in dairy cows

Energy balance is defined as the difference between energy intake from feed and energy required for body maintenance, production and gestation [5]. When animals are in negative energy balance, they undergo several physiological and metabolic changes which may predispose them to several negative effects like poor reproduction performance and poor immunity. Dairy cattle are at increased risk for many diseases and disorders during early lactation, especially during the first third of lactation [6].

Effect of negative energy balance (neb)on reproduction performance

Negative Energy Balance during early lactation in dairy cows leads to alterations in metabolic state that has major effects on the production of insulin-like growth factor (IGF) and related metabolites [7]. Since Insulin Growth Factor (IGF) plays an important role in follicular growth and embryonic development [8]. it becomes evident that reproduction potential is affected in animals that enter a state of NEB. High producing dairy cows have been observed to be more prone to NEB shortly after parturition, a situation that can impair reproductive recovery because EB is negatively correlated with days to first ovulation after calving and cows [9].

Effects on the ovary

Negative energy balance is associated with a greater incidence of irregular cycles that can both increase the interval to first service and reduce conception rates [10,11]. Problems include a delay to the first ovulation (DOV1), cycles which are longer than the normal range (Prolonged Corpus Luteum, PCL) and long intervals between successive luteal phases, when cows fail to ovulate again at an appropriate time (DOV2).

Effects on the uterus

Uterine involution is a critical component of postpartum reproduction, which involves endometrial tissue repair, myometrial contraction and bacterial clearance. Negative energy balance impede uterine recovery due to a delay in the clearance of puerperal pathogens, so histological sections taken from both uterine horns were also examined for the presence of immune cells. Poor energy balance status is associated with a greater degree of uterine inflammation following calving and a slowing of the repair process [12].

Effects on body condition

Body condition score decreases as body reserves are mobilized to compensate for negative energy balance in early lactation leading to detrimental effects on the performance of the animal [13]. Animals that suffered negative energy balance failed to reach peak milk production in 16 weeks and eventually lost weight and had reduced conception rates [14].

Effects of negative energy balance on immune functions

The alteration in metabolites associated with negative energy balance can result in an altered immune response to pathogens. In dairy cows the onset of lactation causes nutritional and energy requirements to increase dramatically which leads to a state of negative energy balance. Due to this NEB, mobilization of the body's reserves occur leading to an increase in plasma ketone levels and is often accompanied by health disorders such as mastitis and endometritis. These problems are reflected in the degree of increase in ketone levels and decrease in glucose. The immune system relies on energy availability through oxidative phosphorylation; therefore, in NEB the immune system (e.g. macrophage function) is impaired in association with hypoglycemia and ketosis [15,16].

Effect of negative energy balance (neb) on cows' health status

Animals in negative energy balance have a reduced immune response which later results in several negative events like mastitis, lameness, respiratory diseases and metritis [17]. Dairy cows in severe NEB had increased somatic cell count in milk (SCC). SCC in milk, which can act as an indicator of subclinical mastitis, was observed to be higher in animals with four and more lactations [18]. Since animals in a state of negative energy balance eventually lose weight, this could also contribute to the development of lameness [19]. Lameness is painful and will restrict the animals from normal movement and eventually feed intake, especially for pasture dependant feeding, which would lead to a chain of undesirable events including poor animal welfare. Negative energy balance and Left displaced abomasum (LDA) is positively correlated [20].

Effect of Negative Energy Balance on Udder Health

Subclinical ketosis is highly associated with several periparturient diseases, including subclinical and clinical mastitis. The mechanisms of udder defence against mastitis are impaired in periods of negative energy balance and hyperketonemia. Nutritional management and monitoring program show promise for alleviation of the impact of negative energy balance on mastitis and other periparutrient diseases [21]. Generally, several adverse consequences of NEB have been investigated and documented which include metabolic disorders such as ketosis and acetonaemia, reproduction disorders such as anoestrous and infertility, and other health problems such as increased susceptibility to mastitis [22]. NEB is believed to have an influence on several production and physiological parameters in dairy cows as outlined in the causal diagram in (Figure 1).

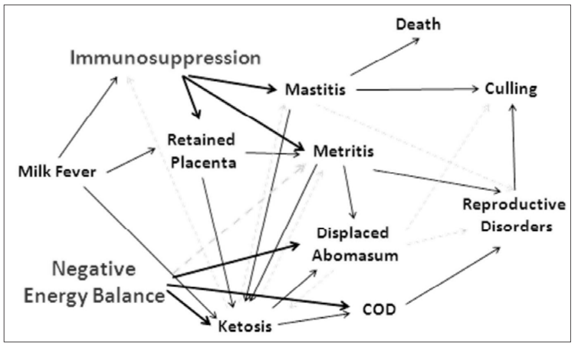

Figure 1: Complex interrelationships of negative energy balance: The light shaded lines represent weak associations among different parameters.

Source: McKay and Heuer, 2000 modified.

Combating Strategies

Increased energy intake

Supplementation with unsaturated FA (trans-octadenoic and linoleic acids) have been shown to improve embryo quality and development, leading to overall higher pregnancy rates and reduced pregnancy losses. Perhaps by the same or a separate mechanism, feeding omega-3 unsaturated Fatty Acid in fish oil exerted immunosuppressive effects during the breeding period in association with improved fertility in dairy cows [23]. Glucogenic diets fed during the transition period and early lactation decreased milk fat and milk energy output and tended to stimulate the partitioning of energy to body reserves and improve the energy balance in early lactation compared with lipogenic diets [24].

Decreased dry period length

An alternative strategy of shortening the dry period has been proposed as a means to improve energy status of dairy cows after calving through enhanced Dry Matter Intake or moderate decreases in milk energy output [25,26]. Reducing the dry period length from 55 to 34days decreased days to first ovulation after calving; percentage of an ovulatory cow, and days to pregnancy. Shortening the dry period, especially for older cows appears to be a successful strategy for improving reproductive efficiency [27].

Rationing software

Computer modeling through rationing software allows educated guesses to be made about how likely a diet is to induce excessive negative energy balance. Using a reputable nutritionist to formulate dry and early lactation diets will help prevent feeding errors that lead to under supply of metabolisable energy. Regular sampling & analysis of conserved forages are a vital part of reducing feeding errors caused by variation in nutritive qualities within the clamp [27-33].

Record keeping

If accurate clinical records are kept, monitoring metabolic disease incidence can gives some indication of how well transition cow management is functioning. Herds with high incidence of metabolic disease or culling within the first 60days should certainly involve their veterinary surgeon for further investigation.

Conclusion and Recommendation

Negative energy balance around calving adversely affects the future fertility of the cow. This is duet the fact that negative energy balances have several adverse consequences on production and production performance and immune function of dairy cows. Considerations therefore need to be given on an individual farm basis as to the optimum genotype to select for that environment, to provide animals in the herd which can achieve reasonable yields whilst maintaining health and fertility. Therefore, based on the above conclusion the following recommendations are forwarded:

1. Nutritional management and monitoring program show promise for alleviation of the impact of negative energy balance in dairy cows;

2. Feeding a controlled energy diet during the dry period, increased feeding frequency and better feed through management to maintain a fresh, adequate supply of feed and multiple sources of clean water are critical for stimulating appetite and maximizing dry matter intake.

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