Feeding essential fatty acids improves immunity and fertility in dairy cows

The intensive genetic selection for milk yield in past decades has led to decreased immunity, fertility and longevity in the Holstein breed. Many countries have improved their genetic evaluations of other traits than only milk production, and increased the weight of health and fertility traits in the selection process.

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Despite this, poor health (hoof and udder), immunity and reproductive performance are still among the most common causes for replacing dairy cows.

Modern high producing dairy cows suffer severe negative energy balance during the first eight weeks after calving, which leads to poor immunity and reproduction performance. Also, poor hoof health and heat stress are implicated in reducing immunity, fertility and reproductive performance in dairy cows.

The transition period

Many studies indicate that the immune system is not functioning at an optimal level during the transition period (mainly due to hormonal and metabolic changes but also due to negative energy balance). Some studies showed that high producing dairy cows experience a decreased mitogen-induced proliferation of lymphocytes and a decreased antibody response.

Other studies confirmed that during the transition period cows experience a decreased chemotaxis and molecule adhesion by neutrophils in addition to a decreased capacity of neutrophils to kill pathogens.

Fat has been used as an energy source to increase energy density in rations, especially for early lactating cows. However, fat (dependent on its type and composition) has also been found to influence rumen function, fibre digestion, intake and metabolic, hormonal and immunological reactions.

In recent years, polyunsaturated fatty acids (PUFA) especially omega-6 (linoleic acid) and omega-3 (alfa linolenic acid) fatty acids have received attention because they are classified as essential fatty acids (EFA) for dairy cows.

Furthermore, there is emerging evidence that PUFA may play a role in cow immunity and reproduction and hence improve fertility and longevity and reduce culling and replacement rate.

A number of studies have reported enhanced reproductive performance in dairy cows following dietary supplementation with sources of omega-3 FA.

Several hypotheses about the mechanisms through which dietary PUFA could enhance reproduction performance in dairy cattle have been proposed.

One of these hypotheses is that omega 3 FA influences steroidogenesis (i.e. progesterone) and alters the production and release of prostaglandin F2α (PF2α) which causes regression of the corpus luteum (CL), improving conception and reducing embryo loss and detachment. Recent studies also concluded that feeding essential FA can modulate innate and adaptive cellular immunity, affect phagocytic activity and capacity of leukocytes, and trigger a proinflammatory response in high producing dairy cows.

Some PUFA, such as linolenic acid (omega-3) is a proven inhibitor of PGF2α secretion from the uterus, thereby reducing PGF2α concentration and decreasing the sensitivity of the CL to PGF2α. This helps prolong the life and functionality of the CL and allows it to increase progesterone (P4) concentrations.

Higher pre-breeding concentrations of P4 have a positive impact on conception rates. Other PUFA such as linoleic acids (omega-6) are used preferentially by polymorphonuclear leukocytes (PMN) which play a primary role immediately postpartum for the breakdown of foetal/maternal attachment, allowing foetal membranes to be shed and expelled.

This response is important to the timely recovery of the uterus after calving. In a few studies involving large numbers of cows, the overall pregnancy rate was higher and the number of services per conception was lower (1.62 vs. 2.4) in cows fed high omega 3 rations compared to cows fed the control diets. In many small reproductive physiology studies using a hormonal experimental protocol, cows fed omega-3 high rations had significantly lower plasma PGF metabolites than the control cows indicating a suppression of uterine PGF2α release.

A more recent study showed that linolenic acid (omega-3) can reduce PGF2α secretion by bovine endometrial cells under in-vitro conditions. In a Canadian animal experiment with dairy cows, feeding formaldehyde treated or intact linseed (supplying omega-3 FA) from a few weeks after calving improved conception rate, pregnancy rate to first AI and overall cumulative pregnancy rate.

From the above it can be seen that different PUFA are involved in the stimulation and/or inhibition of many reproductive hormones and, hence, it is important to know which PUFA to supplement to the cow at which stage of the reproduction cycle.

A higher omega-6 to omega-3 ratio during late gestation and early postpartum will most likely improve calving ease and uterus recovery and health, whereas a higher omega-3 to omega-6 ratio just before and during breeding (insemination period) will most likely improve conception rate, embryo survival rate and hence pregnancy rate.

Rumen microbe activity

One complicating factor is the activity of rumen microbes that extensively hydrogenate dietary PUFA into many intermediates and saturated fatty acids, making it difficult to estimate the type and amount of omega-6 and omega-3 that will be absorbed into the bloodstream and be available for metabolism.

Therefore, protecting PUFA from rumen bio-hydrogenation is necessary to successfully utilise them in reproduction management programs. Nutriad's coated linseed oil (Nutri-Flax) and fish oil (Nutri-Omega-3 FA) are effective sources of protected (rumen by-pass) omega-3 FA that can be used to increase omega-3 FA concentration in blood and modulate reproductive hormones to improve follicular and oocyte development and improvements in fertility.

In conclusion, essential fatty acids, mainly linoleic (omega-6) and linolenic (omega-3) acids have direct effects on reproductive hormones, immune function and physiological processes. Clearly, they are important to uterine health, embryo viability and the immune system.

Targeted supplementation of protected PUFA to the dairy cow during different phases of the production cycle may improve immunity and reproduction performance in dairy cows.

For these positive results to be achieved, the PUFAs must be protected from rumen bio-hydrogenation to make sure that they will be absorbedinto the bloodstream intact. ■