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Influence of macro and micro minerals in the peri-parturient period on fertility in dairy cattle☆

D. Wilde

Alltech (UK) Ltd., Alltech House, Ryhall Road, Stamford, Lincolnshire PE9 1TZ, UK

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Abstract

Infertility in dairy cattle is a complex, multi-factorial problem that cannot be evaluated in isolation of other diseases and disorders. Clearly there is a role for the prevention of problems in the peri-parturient period, in particular hypocalcaemia, mastitis, lameness and retained placenta (RP), that all have a negative impact on the subsequent fertility of the cow. Minerals, trace elements and vitamins play a vital role in the prevention of these disorders at this time. Macro minerals are involved in the acid base status of the dairy cow and influence calcium metabolism. The use of anionic salts in combination with adequate calcium and magnesium supplementation may help to improve dry matter intakes and reduce negative energy balance in the post-calving period as well as prevent hypocalcaemia. Vitamin E and zinc are effective in prevention of mastitis that occurs predominantly in the first weeks of lactation, through enhanced antioxidant function and keratinisation of the teat canal. Lameness in dairy cattle also occurs mainly in lactation though most of the original insults to the hoof can occur prior to calving. Zinc and biotin are implicated in improving keratinisation of the hoof and prevention of this disease. Organic forms of zinc are retained better than inorganic sources and may provide greater benefit in disease prevention. Retained placenta can be reduced by prevention of hypocalcaemia and also adequate selenium status of the dairy cow. Selenium yeast is known to have higher retention in tissues and may play an important role in ensuring sufficient selenium is available to the cow for reduction of disease.

Keywords: Mastitis; Retained placenta; Hypocalcaemia; Lameness; Dairy cow; Minerals

1. Introduction

When considering fertility in the dairy cow, much attention is focussed on the energy and protein status of the cow, particularly at the point of insemination and, increasingly, in the

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E-mail address: dwilde@alltech.com.

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peri-parturient period. This transition phase generally refers to the period of 3 weeks pre-calving to 3 weeks post-calving. There is a usually a decrease in dry matter intake in the pre-calving period of the transition period whilst the energy requirements of the cow are rising rapidly to meet the demand for milk production. However, the role of minerals and vitamins fed at this time on subsequent fertility is poorly understood.

Fertility in the UK, as measured by conception rate to first service, is on the decline at a rate of around 1% per year (Royal et al., 1999) for the last 20 years. At the same time, milk yield has increased and there has been a genetic shift from mainly Friesian cows to predominantly Holstein animals. Royal et al. (1999) showed that this infertility was largely due to an increase in atypical hormone patterns, specifically a significant increase in the incidence of delayed luteolysis types I and II.

The role of minerals in improving fertility has been studied during lactation in the months prior to insemination. Boland et al. (1996) examined different forms of Cu, Zn, Mn and Se (inorganic versus organic) showing improvements in conception rates and days to first service. Ballantine et al. (2002) reported similar improvements from replacing inorganic sulphate salts of Cu, Mn, Zn and Co with organic forms.

But what about the impact of minerals and vitamins supplemented in the dry period on subsequent fertility? This article briefly reviews the role that macro minerals, trace elements and vitamins may have in the prevention of peri-parturient diseases and thus potential improvements in fertility later in lactation.

2. Hypocalcaemia

The incidence of clinical hypocalcaemia in dairy herds in the UK runs at about 4–7% (Esslemont and Kossaibati, 2002) and Kelly and Whitaker (2001) reporting a 5% incidence, with individual farms as high as 41%. Financial losses associated with the disease can vary enormously depending on the severity and are put at £210 per average case (Esslemont and Kossaibati, 2002), though there is no account taken in this cost for poor fertility.

Many studies have shown the deleterious impact of a negative energy balance (NEB) post-calving on fertility (Formigoni et al., 1996; Grummer, 1996). Dry matter intake decreases dramatically in the last 2–3 days pre-calving by as much as 20–30% and takes several days to recover post-calving (Goff, 1999; Hayirli et al., 1998). Evidently, if dry matter intakes are not optimal, the cow is predisposed to a more severe NEB and thus reduced fertility and milk yield. Maximising dry matter intake must, therefore, be a priority. Peri-parturient complications, such as milk fever, retained placenta (RP), displaced abomasum and ketosis are factors that may reduce dry matter intake (Goff, 1999), with milk fever, even at sub-clinical levels, being implicated in causing the other three (Curtis et al., 1983).

One of the functions of calcium is to allow muscle to contract. Whilst milk fever may not actually present itself until plasma calcium reaches 4 mg/dl, it has been shown that plasma calcium concentrations of 5 mg/dl reduce abomasal motility by 70% and the strength of the contraction by 50% (Daniel, 1983). Clearly a reduction in muscle contractility will lead to a decrease in dry matter intakes as rumen function decreases, leading to a severe NEB. As a consequence, there is an increase in fat mobilisation that may result in fatty liver syndrome and ketosis. An excess of ketone bodies can further suppress appetite (Grummer, 1996). (Low calcium concentrations also prevent insulin production, further exacerbating this situation (Goff, 1999)). Ultimately, milk yield will be reduced and, as previously described, fertility will suffer. Muscle tone in the uterus will also be adversely affected with cows experiencing prolonged calvings and retained placenta.