Immunisation by oral administration to control neonatal calf diarrhoea

Calf diarrhoea is a commonly reported disease in young animals, and still a major cause of productivity and economic loss to cattle producers worldwide in both beef and dairy cattle herds. Moreover, neonatal calf diarrhoea (NCD) creates a problem in terms of animal welfare and farmer distress.

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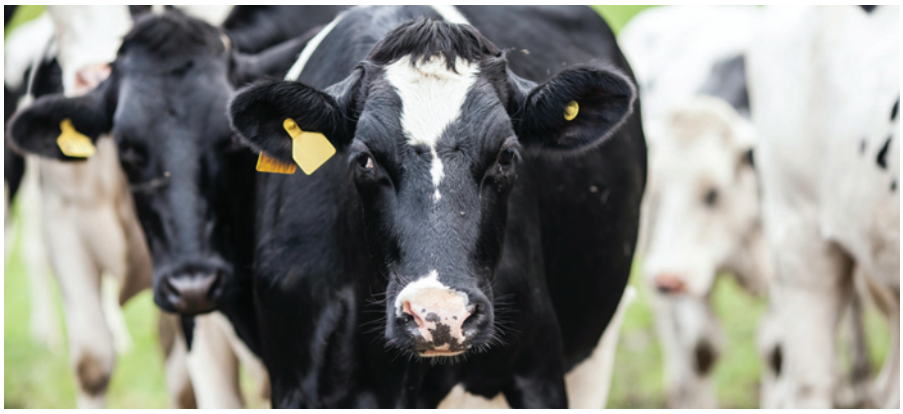

Diarrhoea in calves has a multifactorial aetiology, in which viruses, bacteria, protozoa, and management factors (housing, feeding, hygienic conditions) play a role.

Prevention and control strategies

Prevention and control strategies for calf diarrhoea involve multiple factors such as peripartum calving management, calf immunity, and environmental stress and contamination. Bovine rotavirus (BRV), bovine coronavirus (BCoV), Escherichia coli and Cryptosporidium parvum are the four major enteric pathogens causing neonatal calf diarrhoea.

Due to the structure of the bovine placenta, the calf is born agamma-globulinaemic and therefore depends on the successful passive transfer of maternal antibodies (Ig) from colostrum.

The absorption of maternal Ig across the small intestine during the first 24 hours after birth, termed passive transfer, helps to protect the calf against common disease organisms until its own immature immune system becomes functional.

Calves absorbing high amounts of maternal antibodies are at a significantly lower risk of neonatal diarrhoea than those receiving inadequate amounts.

Multiple studies have shown that failure of passive transfer (FPT), as reflected by low serum immunoglobulin concentrations (IgG <10mg/ml), markedly increases morbidity and mortality in dairy calves.

Because total Ig in colostrum composes of more than 85% IgG (IgA, and IgM approximately 5%, and 7%), the concentration of IgG has traditionally been considered the hallmark for evaluating colostrum quality.

High-quality colostrum has an IgG concentration greater than 50g/L. The incidence of FPT reported in recent studies was 12-20.7% of calves having an IgG concentration <10mg/mL and only 35% having >30mg/ml.

Primary factors influencing passive transfer are the delay of postpartum feeding, amount and quality of colostrum fed.

A generally accepted rule for feeding colostrum to the newborn calf is to feed 10% of body weight within the first six

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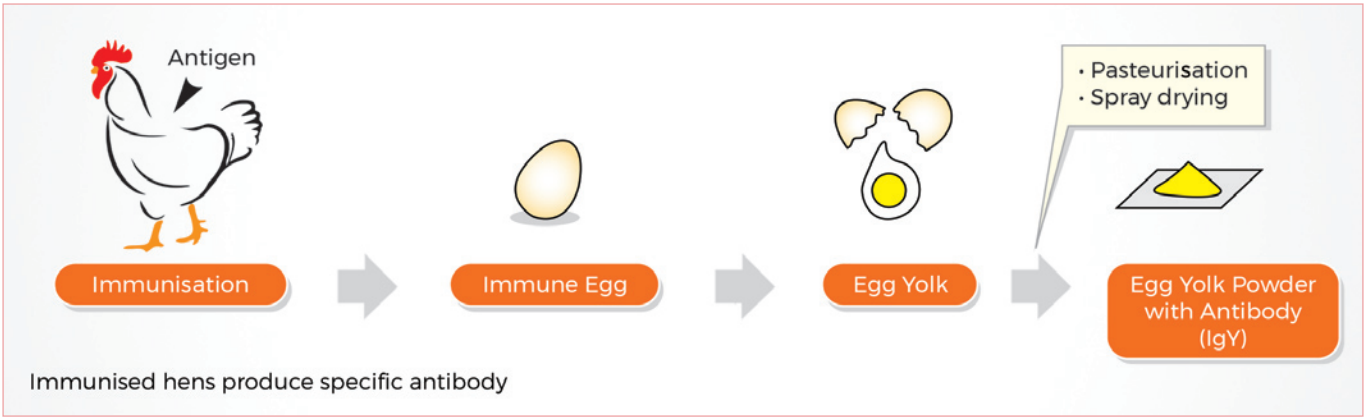
Fig. 1. Passive immunisation by oral administration of specific antibodies from different sources, such as immune colostrum or chicken egg yolk IgY, could represent effective and economic strategies to prevent gastrointestinal infections in food animals.



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hours of life. The efficiency of colostral Ig absorption through the intestinal epithelium of the calf decreases linearly with time from birth to completely closed at approximately 24-36 hours. Feeding colostrum after the gut has closed still offers the benefit of local immunity in the gut lumen, but Ig absorption into the circulation no longer occurs.

Colostrum quality

Some factors affecting colostrum quality, including preparturient vaccination, dry period length, and time to colostrum collection, can be managed by producers but others, such as breed or age of the dam, may be out of the producer's ability to manipulate.

First parity cows for example may produce smaller quantities of colostral antibodies, having been exposed to fewer antigens than older cows.

The immunological characteristics of colostrum are high for four days after delivery. However, its most potent immunological qualities are lost by 14 hours post-partum because immunoglobulin (Ig) concentrations progressively decrease.

The results of some studies demonstrate that even employing optimal dams' vaccination and a proper colostrum intake, the natural challenge with infectious agents associated with neonatal diarrhoea may overcome the passive immunity conferred by maternal Abs as well as the neonatal primary immune response.

Passive immunisation

Passive immunisation by oral administration of specific antibodies from different sources such as immune colostrum or chicken egg yolk IgY could represent effective and economic strategies to prevent gastrointestinal infections in food animals.

It has been shown that the supplementation of the milk diet with immune colostrum significantly reduced diarrhoea and delayed viral shedding onset. However, the development of a product based on colostrum for milk supplementation was not an industrially scalable alternative.

Oral administration of specific antibodies is an attractive approach to establish protective immunity against gastrointestinal pathogens in humans and animals.

Passive immunisation strategy with chicken egg yolk immunoglobulin, referred to as immunoglobulin Y (IgY) provides an efficacious alternative to prevent and control NCD. It possesses a large number of advantages compared to treatment with mammalian IgG, including cost-effectiveness, convenience and high yield.

Laying hens are very good producers of specific antibodies. After immunisation, the specific antibodies are transported to the egg yolk which can then be purified. A laying hen produces more than 100mg of yolk antibodies (IgY) per egg.

IgY also have biochemical properties that make them attractive for oral immunotherapy: they neither activate mammalian complement nor interact with mammalian Fc receptors that could mediate inflammatory response in the gastro-intestinal tract.

Oral administration of specific IgY antibodies have shown efficacy against a variety of intestinal pathogens such as bovine rotaviruses, enterotoxigenic Escherichia coli (ETEC), bovine coronavirus, Salmonella spp.

Some biochemical parameters in the blood such as serum GGT (Gamma-glutamyl transferase) or TP (total protein) and ALB (albumin) concentration reflect the immunity of calves. Calves fed colostrum containing Ig Y had higher levels of TP, ALB and IgG, along with increased GGT activity.

Providing egg proteins appears to prime the neonatal mucosal immune response, helping the calf to deal with enteric diseases early in life, which would prevent a negative impact on growth rate at this critical early stage.

Treatment based on IgY modulates the mucosal immune response in the gut towards higher numbers of antibody secreting cells present in the duodenum and ileum of treated animals.

This may represent higher immune surveillance in the gut mucosa, which is one of the main sites of infection of pathogens during the calves' first weeks of life.

The results of a recent study indicate that feeding immunised egg proteins to calves in the first 14 days of life improves growth performance and concentrate intake.

Passive immunisation by oral administration of IgY shows to be effective to complement current preventive strategies against neonatal calf diarrhoea. ■

References are available from the author on request