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REVIEW

Current research progresses on calf rearing and nutrition in China

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Abstract

Calves are the reserve forces for dairy cattle. Scientific rearing strategy of calves is the basis of efficient cattle breeding. However, many problems exist in current rearing systems of calves and restrict the sustainable development of dairy cattle in China. The absence of basic research is the most highlighted problem among them. Recent researches on growth performance, nutrient digestibility, blood biochemical indices and rumen development in calves were summarized in this paper. Additionally, the optimal levels of energy and protein in milk replacer and starter diets for calves were indicated, and limiting amino acids for calves fed different diets were discussed. A variety of additives, such as acidifiers, probiotics and polysaccharides, are regarded as promising alternatives to antibiotics to reduce disease in calves. Dietary supplementations of these additives have positive effects on growth and health of calves. However, studies on the nutrition of vitamins and minerals in calves have been seldom done, and deserve our further researches. To sum up, the postnatal period is one of the most critical "windows" for rumen manipulation and epigenetic regulation. Any changes from environments, especially early nutrition, may produce long-term effects on growth, health and milk yields in adult cattle.

Keywords: calf rearing, growth, physiology, nutrition, additives

1. Introduction

China produces a surprisingly large number of cattle. As for 2015, China's dairy cow breeding stock numbered 13.69 millions, while its milk production reached 37.55 million tons. However, China is not on the list of developed cattle breeding countries. In China, the average milk yield per cow per year is about 6 tons, which is far below 8–10 tons in developed countries. China still has a long way to go to catch up with requirements of modernized livestock production. One way for China to improve regards to young ruminants refers to the reserve forces for adult animals. Directional rearing of calves determines cattle's growth performance. This reflects an old saying in China: "The strength of the youth generation in one country reflects the strength of this country". Along with the dairy industry's development, calf rearing defects have become the critical problems restricting the development of China's stock breeding industry.

2. The current status of calf rearing in China

At present, calf rearing in China adopts a traditional breeding system. Unfortunately, the death rates of pre-weaned calves are high. This is due to many problems in the system of calf rearing. Firstly, basic research on calves is insufficient,

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especially regarding calf physiology, rumen development, and the establishment process of rumen microorganisms. As a result, the theoretical basis for determining calves' nutrient requirements is absent. Postnatal calves suffer from stresses due to undeveloped organs and intact immune system. Thus, any problems related to dietary nutrition, feeding management, and environment could increase the loss of young ruminants. Secondly, the feeding program is out of date. Currently, on most of China's dairy farms, calves are weaned at 2–3 mon of age. During this period, a calf consumes 400–500 kg of fresh milk. This not only increases rearing costs, but also hinders rumen development. Thirdly, the breeding objectives remain unclear. Calf raisers are lack of knowledge on the optimal growth rate for calves at different ages, and most of them know little about their own calves' growth rate. When poorly managed, calves often gain slowly, and thus the first mating age could be delayed from 14 to 16–18 mon. This seriously affects dairy herds' construction and turnover rate. By contrast, if calves gain too fast, it will increase their body fat deposition and impair their mammary gland development (Sejrsen and Purup 1997). Lastly, feeding facilities are out of date and do not match with the advanced feeding technology. Nowadays, large-scale dairy farms commonly wean calves early using milk replacer (MR). However, the supporting equipment and feeding systems remain relatively rare.

The postnatal period is one of the most important stages of dairy cattle. During this period, a calf's growth rate is the fastest, the body tissues and organs develop rapidly, and the immune system improves progressively. More importantly, with the development of rumen and the colonization of internal microorganisms, a calf experiences a physiological transition from non-ruminant to ruminant. Therefore, the postnatal stage seems to be the most sensitive and plastic period. During this period, any influences from external environment or nutrition could lead to permanent changes in subsequent growth, health, and production performance. Only with a scientific rearing and nutrition system, an optimum growth can be ensured.

3. Growth and physiology

Female animals experience 3 physiological stresses during their lives, namely: birth, weaning, and delivery. Of these stresses, both birth and weaning occur within a few months after birth. Therefore, the physiological stage from birth to weaning is the most important period for these animals.

3.1. Growth performance

We followed up the growth performance of Chinese Holstein calves from 5 d to 12 mon (Table 1). The calves were fed MR, and the feeding amount was 12% of body weight from age 7 to 60 d. Starter feed and forage were supplemented during d 14 and 60, respectively. The results showed that the average daily gain (ADG) of pre-weaned calves was 516 g. The body weight of calves at weaning was 1.67 times of their birth weight. After weaning, the ADG of calves aged from 2–6 and 6–12 mon were 1 022 and 890 g, respectively. The body size measurements were in line with body weight. Regressions could be used to predict body weights of calves based on their body size measurements (Table 2).

Weaning affected the ADG of calves (Table 3). A total of 60 Angus×Simmental calves were allocated to 5 treatments: calves in control were fed by their mother cows until d 150, whereas calves in early-weaned treatments were weaned on d 28, 42, 56 and 70, respectively, and then fed a MR until d 90. The results indicated that the ADG values of mother-fed calves were similar with those of early-weaned calves during d 0–70. However, as the solid feed intake increased, early-weaned calves had a greater ADG than mother-fed calves during d 91–150. Weaning stress was observed in early-weaned calves regardless of weaning age. However, the impact of weaning stress on ADG could be eliminated within 20 d (Guo *et al*. 2015).

3.2. Nutrient digestibility

Nutrient digestibility reflects digestion capability of calves.

Table 1 Body weight and body measurements of calves aged from 5 d to 12 mon

Age	Body weight (kg)	Wither height (cm)	Body length (cm)	Chest circumference (cm)	Hip height (cm)	Hip width (cm)
5 d	42.1±3.8	77.0±2.0	74.2±3.1	80.9±2.9	81.1±2.4	19.0±1.1
1 mon	51.3±4.1	79.8±1.8	80.4±2.8	87.6±2.7	83.5±2.0	21.3±0.7
2 mon	70.5±7.9	83.1±2.5	87.6±3.1	96.7±4.4	88.1±2.8	23.4±1.0
3 mon	91.5±16.6	89.4±3.5	91.2±6.3	107.7±6.7	95.0±4.0	25.5±1.7
4 mon	122.5±17.5	94.7±4.6	103.7±7.5	114.1±7.0	100.5±4.4	28.7±2.3
5 mon	153.0±19.3	100.3±3.9	113.8±5.3	120.9±5.5	106.7±3.8	30.7±2.1
6 mon	193.1±19.3	106.2±3.3	121.1±4.5	132.1±4.9	112.1±3.7	32.2±1.6
9 mon	275.4±25.8	121.3±4.0	135.8±5.6	151.4±5.3	128.1±3.3	37.9±2.5
12 mon	353.3±27.3	128.6±3.4	149.7±4.4	165.8±4.6	134.8±3.1	41.6±1.8

Data were expressed as means±SD.