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**FAHN**

Farm Animal Health and Nutrition. 2025; 4(4): 41-43

DOI: 10.58803/fahn.v4i4.88

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## Review Article

# Corn Silage for Young Dairy Calves: Forbidden or Forgotten?

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### ARTICLE INFO

#### Article History:

Received: 10/10/2025

Revised: 08/11/2025

Accepted: 01/12/2025

Published: 29/12/2025



### ABSTRACT

Although corn silage is an acceptable forage source for dairy calves, its use in calf diets remains questionable, particularly regarding its digestibility in young animals. The objective of this review article was to elaborate on whether and how corn silage may be fed as a fiber and energy source to young dairy calves. Corn silage is considered as one of the most important forage and energy sources for dairy cattle. Corn silage comprises approximately 50% of total mixed ration (TMR) for dairy cows (as-fed basis). Corn silage is a palatable, digestible, and high-energy forage that can be incorporated into young calf diets, as well. Dry matter content, particle size, starch and energy level, and mycotoxin contamination are the important factors that must be taken into account when deciding to utilize corn silage in diets for young calves. As such, corn silage may be fed to young calves under controlled conditions, and seems to be a forgotten energy-fiber source for young dairy calves. However, proper feeding management care must be taken to avoid corn silage to become a forbidden choice due to its inappropriate use. Future quantitative and qualitative studies are required for optimal uses of corn silage in diets for young dairy calves.

#### Keywords:

Calf  
Corn  
Fiber  
Mixed ration  
Starch

## 1. Introduction

Solid feed intake is the key factor determining young calf growth and health around weaning and afterwards during the post-weaning period. An appropriate smooth weaning transition is critical for alleviating weaning distress and ensuring a satisfactory calf growth and health status<sup>1</sup>. Proper and timely rumen development is highly associated with starter feed intake. Forages may play a significant role in rumen muscularity and volume development. In addition, including forages in young calf diet could stabilize rumen pH and prevent rumen acidosis by stimulating rumination, chewing, and rumen buffering capacity<sup>1,2</sup>. Hence, encouraging young calves to consume high quality and energy-dense fiber such as corn silage may possess biological benefits that can last long<sup>2</sup>. Despite the positive effects of different fiber sources for young calves, supplementing and feeding young calf diets with corn silage is not fully described. Moreover, combination of corn silage with other fiber sources and relevant variables such as animal age, starch level, grain type, and fiber digestibility should be considered in future studies. As such, the present study aimed to elaborate on the novelty of corn silage feeding for young dairy calves from growth, immunity, and overall health perspectives.

## 2. Forage and silage effects on rumen development and health

The ultimate success of any modern dairy farm depends on how its newborn calves are managed during pre- and post-weaning periods. Recent studies have illustrated that growth and health status of calves in early life would affect their future performance as mature dairy cows<sup>1,3</sup>. A healthy and well-managed calf would be able to eat more solid feed and drink optimum levels of milk and water<sup>4</sup>. Rumen development is directly related to feeding regimen of young calves. Rumen microbial colonization, rumen papillae growth and metabolic function, and rumen masculinization are considered as three main portions of the rumen development process<sup>5</sup>. As concentrate feeds such as corn grain or barley grain are responsible for papillae growth, fibrous feeds may be involved in rumen masculinization and developing the rumen volume<sup>5</sup>. It has been reported that replacing 50% of barley or corn grain with corn silage improved rumen wall thickness<sup>5</sup>. In addition, forage provision has an important role in the establishment of rumen cellulolytic bacteria<sup>6</sup>.

Cite this paper as: Nikkhah A, and Alimirzaei M. Corn Silage for Young Dairy Calves: Forbidden or Forgotten?. 2025; 4(4): 41-43. DOI: 10.58803/fahn.v4i4.88

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Despite the positive effects of forage inclusion in starter calf diets, promoting rumen functionality and calf performance may be different among fiber sources. Likewise, chewing activity and saliva production can be affected by inherent characteristics of different source of forages<sup>7</sup>. It seems that neutral detergent fiber (NDF) provision from alfalfa hay is more effective in stabilizing rumen pH and stimulating chewing activity than the NDF provided by beet pulp<sup>7</sup>. Feeding an equivalent amount of NDF from different forage sources to dairy cows may results in different outcomes due to different levels of physically effective NDF contents. Alfalfa hay, oat hay, and wheat straw are the main forages found in young calf starter worldwide. It has been demonstrated that forage type (hay compared to silage) may influence starter intake and calf performance<sup>8</sup>. Furthermore, greater body weight was reported for intake-based weaned calves<sup>8</sup>. Supplementing dairy calf starter diets with alfalfa hay may have positive effects on short- and long-term rumen development, calf immunity and health, and later milk yield when compared with oat hay<sup>9</sup>. In a study conducted to compare the effects of forage type and different rumen undegradable protein (RUP) to rumen degradable protein (RDP) ratios, results revealed greater body weight, blood beta-hydroxy butyrate, and lower urinary N concentrations for wheat straw combined with high RUP:RDP<sup>10</sup>.

### 3. Corn silage and calf performance

Corn silage is the most popular silage crop as a simultaneous source of fiber and energy for dairy cattle worldwide<sup>1</sup>. Corn silage quality depends on its moisture and starch contents which vary from 25% to 80% and 16 to 40%, respectively. In addition to the high energy content of corn silage, providing moisture and superior digestibility are the factors making corn silage an optimal choice for young calf diets. It is suggested that adding moisture to dry calf starter diet may improve intake and weight gain of pre-weaned calves<sup>11</sup>. It is remarkable to note that there is a traditional belief and practice in some parts of Iran that feed should be moisturized before feeding to calves. It seems that water makes feeds palatable and reduces feed dust. Feeding corn silage solely without a starter diet has been reported to reduce growth performance and impair rumen papillae development and intestinal morphology<sup>12</sup>. It has been reported that supplementing starter diets with 10% corn silage before weaning increased nutrient intake of dairy calves, possibly related to its more moisture content<sup>13</sup>. Similarly, Toledo et al. (2023) have demonstrated that supplementing starter diets with 10% corn silage led to higher feed intake when compared to feeding 0% and 20% corn silage<sup>14</sup>. Furthermore, calves fed 10% corn silage had greater average daily gain (ADG) at weeks 8 and 9. Moreover, chewing activity and ruminating were positively affected by including 10% corn silage. The lower intake in calves fed 20% corn silage may be associated with the rumen filling effect of corn silage that can limit intake in young calves. Stabilizing the rumen environment and ruminal pH by stimulating chewing activity and reducing the risk of ruminal acidosis may describe how corn silage inclusion can enhance feed intake. Other studies have shown that calves in very early ages may successfully consume corn silage-supplemented diets<sup>15</sup>.

During the post-weaning period, the young calf's rumen is

still developing, and dietary treatments may influence its digestive capacity and fermentation characteristics. In a study conducted to evaluate corn silage supplementation effects on rumen fermentation and growth performance of dairy calves, greater weight gain, body length, and chest depth were reported for corn silage offered calves<sup>16</sup>. In addition, corn silage-fed calves had decreased rumen acetate concentrations. Interestingly, decreased acetate and increased propionate production may be related to altered rumen bacteria diversity of corn silage-fed calves. The abundance of *Bacteroidales*-RF16-group increased, whereas *Unclassified-Lachnospirae* decreased in silage-fed calves, which were probably responsible for altered rumen propionate and acetate concentrations<sup>16</sup>. The present results indicated this concept that rumen development in post-weaning calves may be promoted by including corn silage in the diet because of the positive effects of propionate in the rumen development process. Similar to other types of forages included in young calf diets, despite positive effects of feeding corn silage, excessive amounts of corn silage may limit feed intake and growth of developing calves due to its rumen-filling effects. The quality of corn silage fed to the young calves must be ensured to be high because the ensiled products are susceptible to corruption. Spoiled products may have serious health consequences for young calves. Managing corn silage feeding may be different from farm to farm according to varying feeding facilities and labor experience.

### 4. Conclusion

As a simultaneous source of energy and fiber, corn silage can be supplemented into young dairy calf diets to help prevent acidosis and promote feed intake and growth. Corn silage can be used as a fiber source especially when it is cheaper than dry hay. The most important note that the producers should keep in mind is that due to its high moisture content, corn silage could be heated up and spoiled if remains long in feed buckets or feed bunk. Hence, successful corn silage feeding to young dairy calves demands optimal feed bunk management. Ultimately, feeding corn silage to young dairy calves may have been a forgotten part of dairy cattle nutrition and management. Although, its optimal feeding management should avoid corn silage to become a forbidden feeding choice. Future quantitative and qualitative studies on different aspects of corn silage feeding for young dairy calves are required to address the remaining questions.

#### Declarations

#### Competing interests

The authors declared no conflict of interests.

#### Funding

The authors have not received funding for the present study.

#### Availability of data and materials

Data from the study are available upon reasonable request from the corresponding author.

#### Authors' contributions

Akbar Nikkhah developed the original idea, led the study, and conceptualized, strategized, reviewed, edited, and prepared the final manuscript. The initial draft and thoughts were developed and presented by Masoud Alimirzaei. All authors have read and approved the final edition of the manuscript.

### Ethical considerations

The authors have made necessary ethical considerations, including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy. The authors ahavehv not used AI tools for preparing and writing the present manuscript.

### Acknowledgments

Profound thanks to Iran's National Elites Foundation.

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